# Computer Science & Information Technology 51

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# Computer Science & Information Technology

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# Preface

The Second International Conference on Computer Science, Engineering and Information Technology (CSITY 2016) was held in Chennai, India, during April 02~03, 2016. The Second International Conference on Signal and Image Processing (SIGPRO 2016), The Second International Conference on Artificial Intelligence & Fuzzy Logic Systems (AIFZ 2016), The Second International Conference on Networks & Communications (NWCOM 2016), The Second International Conference on Data Mining (DTMN 2016) and The Seventh International Conference on Applications of Graph Theory in Wireless Ad hoc Networks and Sensor Networks (GRAPH-HOC 2016) were collocated with the CSITY-2016. The conferences attracted many local and international delegates, presenting a balanced mixture of intellect from the East and from the West.

The goal of this conference series is to bring together researchers and practitioners from academia and industry to focus on understanding computer science and information technology and to establish new collaborations in these areas. Authors are invited to contribute to the conference by submitting articles that illustrate research results, projects, survey work and industrial experiences describing significant advances in all areas of computer science and information technology.

The CSITY-2016, SIGPRO-2016, AIFZ-2016, NWCOM-2016, DTMN-2016, GRAPH-HOC 2016 Committees rigorously invited submissions for many months from researchers, scientists, engineers, students and practitioners related to the relevant themes and tracks of the workshop. This effort guaranteed submissions from an unparalleled number of internationally recognized top-level researchers. All the submissions underwent a strenuous peer review process which comprised expert reviewers. These reviewers were selected from a talented pool of Technical Committee members and external reviewers on the basis of their expertise. The papers were then reviewed based on their contributions, technical content, originality and clarity. The entire process, which includes the submission, review and acceptance processes, was done electronically. All these efforts undertaken by the Organizing and Technical Committees led to an exciting, rich and a high quality technical conference program, which featured high-impact presentations for all attendees to enjoy, appreciate and expand their expertise in the latest developments in computer network and communications research.

In closing, CSITY-2016, SIGPRO-2016, AIFZ-2016, NWCOM-2016, DTMN-2016, GRAPH-HOC 2016 brought together researchers, scientists, engineers, students and practitioners to exchange and share their experiences, new ideas and research results in all aspects of the main workshop themes and tracks, and to discuss the practical challenges encountered and the solutions adopted. The book is organized as a collection of papers from the CSITY-2016, SIGPRO-2016, AIFZ-2016, NWCOM-2016, DTMN-2016, GRAPH-HOC 2016.

We would like to thank the General and Program Chairs, organization staff, the members of the Technical Program Committees and external reviewers for their excellent and tireless work. We sincerely wish that all attendees benefited scientifically from the conference and wish them every success in their research. It is the humble wish of the conference organizers that the professional dialogue among the researchers, scientists, engineers, students and educators continues beyond the event and that the friendships and collaborations forged will linger and prosper for many years to come.

David C. Wyld
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# COQUEL: A CONCEPTUAL QUERY LANGUAGE BASED ON THE ENTITY-RELATIONSHIP MODEL

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### *ABSTRACT*

*As more and more collections of data are available on the Internet, end users but not experts in Computer Science demand easy solutions for retrieving data from these collections. A good solution for these users is the conceptual query languages, which facilitate the composition of queries by means of a graphical interface. In this paper, we present (1) CoQueL, a conceptual query language specified on E/R models and (2) a translation architecture for translating CoQueL queries into languages such as XQuery or SQL..*

### *KEYWORDS*

*Conceptual Query Language, SQL, final user*

## 1. INTRODUCTION

As brilliantly explained in [1], database systems are difficult to use due to a set of five pain points including (1) the cognitive load of learning the concepts of a query language and (2) the need to deal with implementation issues of the underlying database.

Moreover, with the spread of the web, more and more collections of data are becoming available to everyone in fields from biology to economy or geography. End users, but not experts in Computer Science, demand easy ways to retrieve data from these collections.

In an effort to simplify the query of databases, in this paper we propose to add a conceptual layer on which the user can specify the queries. For this layer, we have chosen the Entity/Relationship model (E/R model for short) because it is widely recognized as a tool which facilitates communications with end users and we would strongly argue that it also facilitates query writing. To put this into practice, we propose a new architecture which integrates: (1) the CoQueL language, which allows us to specify conceptual queries on an E/R model (2) a graphical interface built on the CoQueL language and (3) a translation from the graphical query to a target language such as XQuery or SQL.

The advance of this paper with respect to other works is twofold. First, it is thought to query data in several formats as relational or XML from a conceptual level. Second, we have gathered the best recommendations about visual queries and we have integrated them into our interface.

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There have been several papers in the literature about query languages for end users. Some of the papers such as QBE [2] or spreadsheet algebra [3] lack a conceptual level unlike our paper which includes it because it facilitates the specification of queries. Other papers such as SQBE [4] or the query system for NeuronBank [5] are intended for a particular format of data unlike our paper which is intended for formats such as relational or XML. The paper QueryViz [6] does the reverse work because it generates conceptual queries from SQL queries. The paper CQL [7] also includes a conceptual level and we have borrowed from it concepts such as query abbreviation. However, its interfaces are a bit cluttered, so we offer a more simplified interface.

The rest of the paper is organized as follows. In Section 2, we explain the E/R metamodel and the relational metamodel as well as a running example. In Section 3, we introduce the CoQueL query language. Section 4 describes the query architecture and Section 5 its implementation. In Section 6, the graphical interface is presented. Moreover, in Section 7 we detail the related work and in Section 8 we show the conclusions and future work.

## 2. METAMODELS

CoQueL queries are specified in a context consisting of an E/R model, the corresponding relational model and a physical model populated with data in a particular RDBMS against which the queries are executed. So, let us explain the metamodels for building E/R models and relational models.

### 2.1 Entity/Relationship Metamodel

For building E/R models, we will use a conceptual metamodel based on the model proposed by Chen in [8].

According with the metamodel, an E/R model includes entity types, which are described by means of attributes. An attribute only describes one entity type and an entity type is described by one or more attributes.We can establish one or more relationship types between two entity types. Each entity type participates in a relationship type in the first position or in the second position. Each entity type participates in a relationship type with a cardinality, which denotes the number of instances of the other participant with which an instance of the initial participant can be related. The possible cardinality values are 0-1, 0-N, 1-1, 1-N where the first(second) value indicates the minimum(maximum) cardinality.

There are some integrity constraints associated to the metamodel: (ic1) two distinct entity types must have different names, (ic2) two distinct relationship types must have different links and (ic2) the names of the entity types and the links of the relationship types must be different.

In this paper, we will use as an example the E/R model of Figure 1, about the employees of an entreprise.

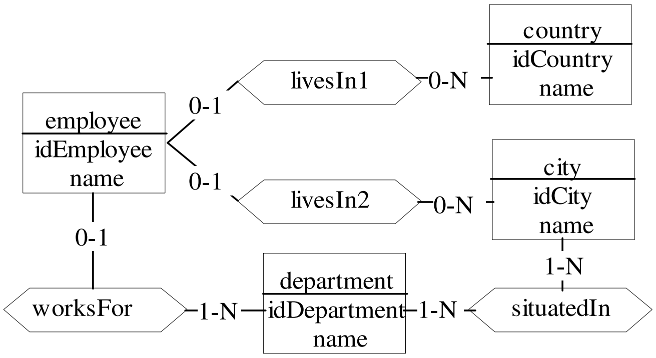


Figure 1. First example of an E/R model

### 2.2 Relational Metamodel

For building relational models, we will use the relational metamodel proposed by Codd in [9].
A relational model includes tables, which are described by means of columns. A column describes only one table and a table is described by means of two or more columns. Each table has a name. Each column has a name and a datatype. Each table has a primary key, which is formed by exactly one column. There are some integrity constraints associated to the metamodel: (ic4) two distinct tables must have different names, (ic5) two distinct columns of the same table must have different names. For translating an E/R model to a relational model there are, basically, two options [10]. The first one consists of translating every relationship type into a table. The second one translates the relationship types depending on the cardinality of the participants. When the relationship type is 0-N or 1-N for both participants, it is translated into a table; otherwise, it is translated into a foreign key. In this paper, we will follow the latter option. So, for the E/R model of Figure 1 the corresponding relational model is:
employee(idEmployee, name, idCountry, idCity, idDepartment)

country(idCountry, name)

city(idCity, name)

department(idDepartment, name)

situatedIn(idDepartment, idCity)

## 3. CoQueL Language

The CoQueL language allows us to specify three kinds of conceptual queries on E/R models: linear, star and mixed. The linear queries are those which linearly traverse the E/R model. The star queries includes a root entity type and several relationship types whose common participant is the root entity type. The mixed queries are combinations of linear queries and star queries. For formalizing these intuitive ideas, we first define our notion of path, next the notion of CoQueL query and finally we show some examples of CoQueL queries.

### 3.1 Path

For formalizing the notion of CoQueL query, we previously introduce several notions of paths defined on E/R models. We present some examples of paths on the E/R model of Figure 2, where for simplicity we have omitted the attributes.

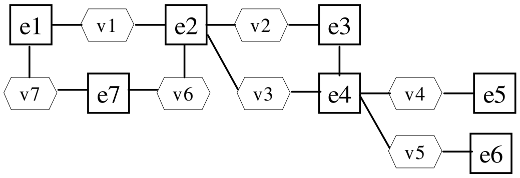


Figure 2. Second example of an E/R model

**Definition 1** A lpath is an expression of the form

e1v1e2v2 . . . envn

where

n >= 1

ei i=1. . . n is an entity type

vi is the link of a relationship type between ei and ei+1

en is an entity type or an spath. If n=1, then e1 is an entity type

When en is an entity type, the lpath is called basic lpath.

**Definition 2** A spath is an expression of the form

e(&(v1f1)&(v2f2) . . . &(vmfm))

where

m >= 2

vi is the link of a relationship type between e and fi i=1. . . m

fi is a lpath or a spath

When every fi is an entity type, the spath is called basic spath. An arm of the path is a linear path of the form evifi

**Definition 3** A qpath is an lpath or an spath

Next we show examples of paths on the E/R model of Figure 2.

Three examples of basic lpath are: e1 e1v1e2 e1v1e2v2e3

An example of basic spath is e2(&(v2e3)&(v3e4))

Two examples of qpaths are e2(&(v2e3)&(v3e4(&(v4e5)&(v5e6))))

e1v1e2(&(v2e3)&(v3e4(&(v4e5)&(v5e6))))

## 3.2 CoQueL Query

A CoQueL query is a qpath with extra information for the entity types of the qpath. A complete specification of an entity type of a qpath consists of four clauses as follows: `entityTypeName(attributes; attributesCondition; attributesGroup; groupCondition)`

where attributes are the attributes which take part of the result of the query, attributesCondition is a conditional expression on the attributes of the entity type, attributesGroup are the attributes through which the instances of the entity type are grouped and groupCondition is a conditional expression on the groups indicated by means of attributesGroup.

Let us explain briefly each component.

**Attributes** The clause attributes indicates the selected attributes of the entity type to be displayed in the result. If we want to select all the attributes of the entity type, we can write only an asterisk instead of the name of all the attributes. It there is no condition on the attributes of the entity type and we do not want to select any of these attributes, we write the name of the entity type without parentheses. Let us see some examples. $e1$ means that we need the entity type $e1$ for the query but we do not select any attribute of this entity type and we do not impose any condition on these attributes. $e1(*)$ means that all the attributes of $e1$ are selected but we do not impose any condition on them. $e1(a11)$ means that the attribute $a11$ is selected but we do not impose any condition on the attributes of $e1$. In this clause, we can also include aggregation functions on the attributes.

**Conditions** The conditions on attributes and on groups can be simple or compound. A simple condition is a comparison condition or a condition with the LIKE predicate. A compound condition is the union by means of AND, OR or NOT of conditions.

A comparison condition has the form expr1 op expr2 where expr1, expr2 are scalar expressions and op is a comparison operator. The comparison operators are the usual ones: = < > <> <= >=. For example, $e1(*;\ a11 = 1)$ means that all the attributes of $e1$ are selected but only for those instances of $e1$ for which the value of attribute $a11$ is 1. $e1(a12;\ a11 = 1)$ means that attribute $a12$ of $e1$ is selected but only for those instances of $e1$ for which the value of attribute $a11$ is 1.
A LIKE condition has the form expr1 LIKE pattern where expr1 is a string expression and pattern is a representation of a set of strings.

**Scalar expression** The scalar expressions can be numeric expressions or string expressions.
A numeric expression is an arithmetic expression which includes as primaries one or more of the following: attribute names, possibly qualified, or numeric literals or aggregate functions or numeric expressions enclosed between parentheses. The aggregate functions, used for elaborating statistics, are COUNT, SUM, MIN, MAX and AVG.

If the numeric expression is used in an attributesCondition, then the primaries are attribute names, possibly qualified, or numeric literals or numeric expressions enclosed between parentheses. If the numeric expression is used in a groupCondition, then the primaries are numeric literals or aggregate functions or numeric expressions enclosed between parentheses.

A string expression is an expression which includes as primaries one or more of the following: attribute names, possibly qualified or string literals or the concatenation of several of them.
The complete syntax of a CoQueL query can be seen in Appendix A. To date, the CoQueL queries are equivalent to SQL single-block query expressions as defined in [3].

### 3.3.Examples

Let us see some examples of queries on the E/R model of employees shown in Figure 1.
Query 1 (linear). Find the employees who work in the purchasing department in Zaragoza

```
employee(*) worksFor department(;name='Purchasing')
situatedIn city(;name='Zaragoza')
```

Query 2 (mixed). For each department, find its name, the name of its employees, the name of the city and the country where the employees live.

```
department(name) worksFor employee(name)
```

```
(& (livesIn1 country(name)) & (livesIn2 city(name)))
```

Query 3 (with group conditions). Find the name and identifier of the countries where more than five employees live.

```
employee(-;-;-;COUNT(idEmployee)>5) livesIn1
country(idCountry, name;-;idCountry,name;-)
```

## 4. ARCHITECTURE FOR TRANSLATING GRAPHIC QUERIES INTO TARGET QUERIES

One of the main purposes of this work is to facilitate querying databases for non-expert users. To this end, we have defined a generic architecture which translates graphical queries into queries in a target language(such as XQuery or SQL) by using the CoQueL language in an intermediate step. Also, the CoQueL queries can be stored to be retrieved later or to be exchanged between different systems.

The architecture (see Figure 3) has two components: the models component and the query component. The models component consists of three models: the E/R model, the logical model and the correspondence model. The latter stores the correspondence between the E/R elements and target query language expressions. It is generated by the model translator when the E/R model is translated into the logical model and by taking into account the translation rules applied to the E/R model.

The query component includes three modules: the text query generator, the query validator and the target query generator. It works as follows: the final user graphically builds a query, based on the E/R model, and sends it to the text query generator, which transforms it into a CoQueL query. This query is validated syntactically by the query validator module. If the query is wrong, a message is sent to the user informing about this fact. If the query is right, it is the input for the target query generator module. This module uses the correspondence between E/R elements and target expressions of the model component and produces the target query as output.

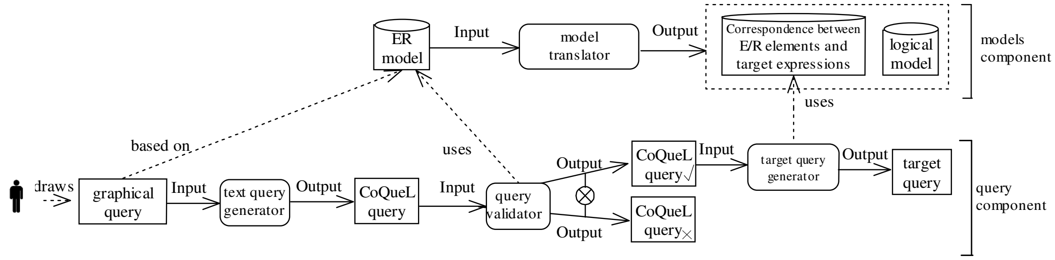


Fig. 3.Architecture for conceptual queries

## 5. AN IMPLEMENTATION OF THE ARCHITECTURE

Next, we specifiy how the models and algorithms of the architecture are implemented for SQL as target language.

### 5.1. Models Component Implementation

The E/R model is implemented as a relational database whose tables are entityType, relationshipType and attribute.

The correspondence between E/R elements and SQL expressions is implemented as a table called er2SQL. By SQL expressions, we refer to the following expressions which form part of a SQL query: table names, fully qualified column names and join conditions. The rules for generating the rows of the table er2SQL are as follows:

– For each entity type, the column table stores the name of the table into which the entity type is translated. The column expression is always null (see an example in row 1 of Table 1).

– For each relationship type, the column table stores the name of the table into which the entity type is translated or null if there is no such table. For example, if according to the translation rules, only the 0-N or 1-N relationship types are translated into a table, then the rest of the relationship types will have null value in the column. Moreover, the column expression stores

| **row** | **conceptual element** | **table** | **expression** |
|---|---|---|---|
| 1 | employee | employee | null |
| 2 | livesIn1 | null | employee.idCountry=country.idCountry |
| 3 | situatedIn | situatedIn | situatedIn.idDepartment=department.idDepartment AND situatedIn.idCity=city.idCity |
| 4 | idEmployee | null | employee.idEmployee |

Table 1. Some rows of table er2SQL

## 5.2 Query Component Implementation

The text query generator, the query validator and the target query generator are implemented as the algorithms graphic2CoQueL, isValid, splitCoQueLQuery and writeTargetQuey. All of them are specified next.

Algorithm graphic2targetQueryLanguage(p language)

Input: Graphical specification of the query

Output: Query specified in the target query language

Pseudocode

```
repeat
coquelQuery← graphic2CoQueL()
until isvalid(coquelQuery)
(l entityTypes, l relationshipTypes, ll attributes ,l conditions,
ll groupAttributes, ll groupConditions) ← splitCoQuelQuery(coquelQuery)
writeTargetQuery (l entityTypes, l relationshipTypes, ll attributes,
l conditions, ll groupAttributes, ll groupConditions, p language)
```

Algorithm splitCoQueLQuery(q)

Input: CoQueL query

Output: Lists of entity types, relationship types, attributes, groups and conditions involved in the query

Pseudocode

```
l entityTypes←getEntityTypes(q)
ll attributes←getAttributes(q,l entityTypes)
l relTypes← getRelTypes(q)
l conditions← getConditions(q)
ll groupAttributes← getGroupAttributes(q)
l groupConditions← getGroupConditions(q)
```

Algorithm writeTargetQuery (pl entityTypes, pl relationshipTypes, pll atttributes,

pl conditions, pll groupAttributes, pl groupConditions, p language)

INPUT: Lists of entity types, relationship types, attributes, groups and conditions

involved in the query

OUTPUT: target query

Pseudocode

```
IF p language='SQL' THEN
SELECTclause←buildClause('SELECT', pl entityTypes, pll atttributes)
FROMclause←buildClause('FROM', pl entityTypes, pl relTypes)
WHEREclause←buildClause('WHERE',pl entityTypes, pl relTypes,
pl conditions)
GROUPBYclause←buildClause('GROUP BY',pl entityTypes,
pll groupAttributes)
HAVINGclause←buildClause('HAVING',pl entityTypes, pl groupConditions)
SQLquery←buildSQL(SELECTclause, FROMclause, WHEREclause,
GROUPBYclause, HAVINGclause)
return SQLquery
END IF
```

The way of working is as follows: once the user has specified the graphical query, the graphic2CoQueL algorithm translates the graphical query into Co- QueL and it is validated until a correct CoQueL query is obtained. Then, the splitCoQueLQuery extracts the entity types, relationship types and attributes from the CoQueL queries into variables. Finally, the writeTargetQuery algorithm uses these variables to generate the SQL query.

Next we offer relevant features of these algorithms. First of all, we have separated the graphical part from the query generation part. As a consequence, we can improve the query interface and only the algorithm graphic2CoQueL will have to be modified. The algorithms splitCoQueLQuery and writeTargetQuery will remain invariable.

The algorithm splitCoQueLQuery extracts the entity types, relationship types and attributes involved in the query. In this extraction, the path structure is forgotten, as the translation can be done for the conceptual elements one by one taking into account the er2SQL table.

In some algorithms, there are variables prefixed by l or ll . The prefix l means a list while the prefix ll means a list of lists. For example, l entityTypes is a list of entity types while ll attributes is a list of lists of attributes, one list for each entity type. We add the letter p when dealing with a parameter. Thus, pll means a parameter which is a list of lists.

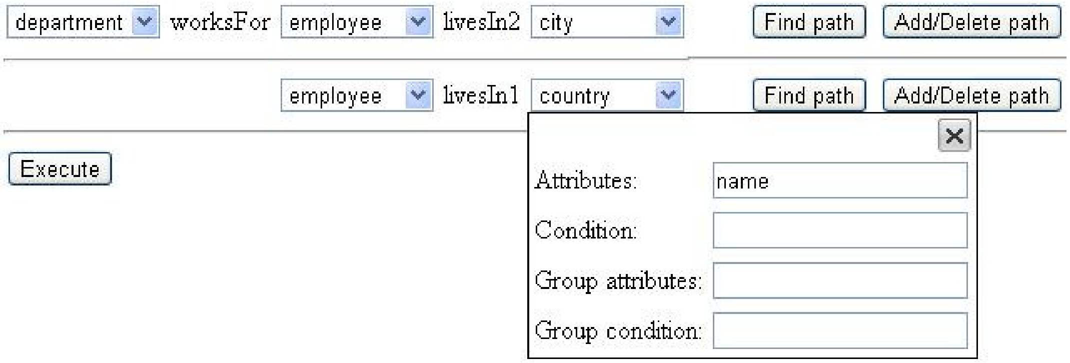
In the algorithm writeTargetQuery for the language SQL, the clause FROM is obtained from the list of entity types and of the list of relationship types. It is a comma separated list whose items are the tables, encountered in the column table of table er2SQL, corresponding to the entity types and relationship types of the query. If this column is null, nothing is added to the comma separated list. The clause WHERE is obtained by concatenating by AND two kinds of conditions: (1) conditions specified on the entity types and (2) conditions arising from the relationship types. With respect to the first kind, they are obtained by replacing, in the list of conditions, each attribute by its corresponding column as stored in table er2SQL. With respect to the second condition, they are retrieved from the column expression of table er2SQL. If this column is null, nothing is added to the ANDed conditions.

## 5.3 Examples

Let us suppose the user has specified queries 2 and 3 as in Figures 4 and 5 respectively. Then, the result of applying the algorithm graphic2targetQueryLanguage are the SQL queries shown next.
Query 1. Find the employees who work in the purchasing department in Zaragoza

```
SELECT *
FROM employee, department, situatedIn, city
WHERE employee.idDepartment=department.idDepartment AND
department.idDepartment=situatedIn.idDepartment AND
situatedIn.idCity=city.idCity AND city.name=‘Zaragoza’ AND department.name=‘purchasing’
```

Query 2. For each department, find its name, the name of its employees, the name of the city and the country where the employees live



department worksFor employee livesIn2 city

employee livesIn1 country

Attributes: name

Condition:

Group attributes:

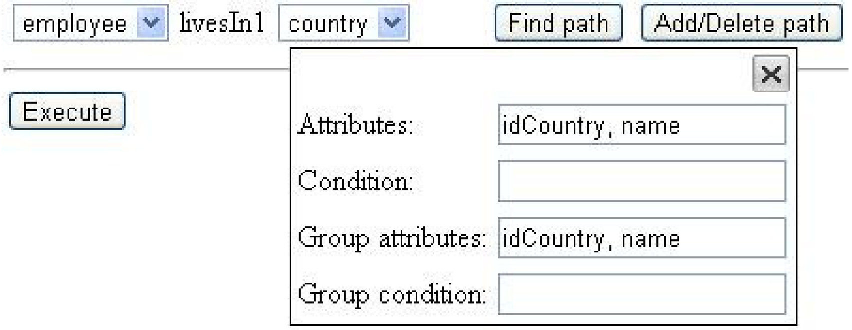
Group condition:

Fig. 4.Query 2, about departments, in the CoQueL interface

```
SELECT department.name, employee.name, country.name, city.name
FROM department, employee, country, city
WHERE country.idCountry=employee.idCountry AND
employee.idDepartment=department.idDepartment AND
country.idCountry=employee.idCountry AND
```

city.idCity=employee.idCity

Query 3. Find the name and identifier of the countries where more than five employees live



Attributes: idCountry, name

Condition:

Group attributes: idCountry, name

Group condition:

Fig. 5.Query 3, about countries, in the CoQueL interface

SELECT country.idCountry, country.name

FROM country, employee

WHERE country.idCountry=employee.idCountry

GROUP BY country.idCountry

HAVING COUNT(employee.idEmployee)>5

## 6. GRAPHICAL INTERFACE

For designing the interface, we have gathered recommendations available in the literature such as the principles of data manipulation [3] or the idea of query abbreviation [7] and we have integrated them into our interface.

The idea of query abbreviation consists of using built-in metaknowledge to determine the paths between the entity types involved in the query so that users do not need to know the conceptual schema. With respect to data manipulation, we have incorporated the principle of offering the user physical actions or labeled button presses instead of complex syntax. With this purpose, we have chosen a form-based interface where the user makes physical actions for specifying the origin and destination of the paths and presses buttons for actions like finding the complete paths involved in the query. The initial aspect of the interface can be seen in Figure 6.

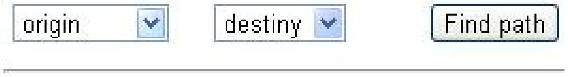


Fig. 6. Initial aspect of the CoQueL interface

At the beginning, the user has to specify the first path of the query. For doing this, (s)he has two options: (1) to choose only the origin entity type or (2) to choose both the origin entity type and the destination entity type. For option (1), when the user clics the ‘Find path’ button, the maximal basic spath whose origin is the selected entity type appears. There, the user selects the appropriate arms of the spath for the query. For option (2), when the user clics the ‘Find path’ button, the collection of lpaths between the entity types origin and destination appears and the user picks one of them for the query. Regardless of the chosen option, at this moment each line of the interface corresponds to a basic lpath.

To complete the rest of the paths involved in the query, the following typical actions are available under the ‘Add/Delete path’ button for each path: Add path. Add a new path just below the path where the ‘Add/Delete path’ button is. Its aspect is the same as the first path of the query (Figure 4) and the interaction is as previously described for this first path. Delete path. Delete the path situated next to the ‘Add/Delete path’ button.

Once every path needed for the query has been chosen, the user must complete the query in the entity types of the paths. To do so, the user double-clicks on the name of the entity types and, in the frame which appears, (s)he adds the attributes, the conditions about attributes, the groups and the conditions about groups. For example, for the query examples number 2 and 3, the specification on entity type country can be seen in Figure 5 and Figure 6.

We are currently implementing a prototype of our CoQueL query system in a laptop with Windows 7, using the Visual C# programming language.

## 7. RELATED WORK

Query languages for end users have been widely discussed in papers. The first work on this subject was QBE [2]. The paper [3] presents a spreadsheet algebra, adapted from relational algebra, and a spreadsheet interface. The expressive power of expressions in the spreadsheet algebra is the same as that of core SQL single-blocks query expressions. Unlike our paper, both papers lack a conceptual level, which facilitates query writing.

The paper ConQuer [11] inspired our work but unlike ConQuer, we have chosen the E/R model because it is widely extended. ConQuer is a conceptual query language built on ORM models. It enables end users to formulate queries without needing to know how the information is stored in the underlying database. ConQuer queries may be represented as outline queries, schema trees or text.

The papers SQBE [4] and NeuronBank [5] concentrate on a particular data format, unlike our work, which is intended for formats like relational or XML. SQBE [4] is a visual query interface intended for the semantic web, where the data model is RDF and the query languagge is SPARQL. Those users with partial or no knowledge of RDF specify queries visually as a query graph. Then, the algorithm TRANSLATE translates the query graph into a SPARQL query. In NeuronBank [5] a visual web query system is presented aimed at meeting the challenges of extracting information of complex and quickly evolving life science in data. It offers a form-based interface with which queries on an ontology about neurons of different species are specified in the web client.

The paper [7] proposes a conceptual query language, called CQL, built on E/R models where query formulation does not require the user to specify query paths. From the specification, the system derives the corresponding semantically correct full query. Once specified, conceptual queries are translated into SQL. A user-centered approach was adopted in the development of CQL, specifically it was guided through trials and feedback from end-users. Its interface is a bit cluttered, so we have tried to improve it.

The paper [6] deals with query visualization, that is, the process of visualizing queries starting from their SQL expression. Queries are visualized by means of familiar UML notations and incorporate visual metaphors from diagrammatic reasoning. This notation could also be used for specifying conceptual queries. It has been implemented in the QueryViz tool, which is available on the web.

## 8. CONCLUSIONS AND FUTURE WORK

As more and more collections of data are available on the Internet, end users but not experts in Computer Science demand easy solutions for retrieving data from these collections. In this paper, we have presented a new architecture for querying databases which integrates (1) the CoQueL language, which allows us to specify conceptual queries on an E/R model (2) a graphical interface built on the CoQueL language and (3) a translation from the graphical query to a target language such as XQuery or SQL.

As future work, we plan to extend the expressive power of the CoQueL queries. To date, they are equivalent to SQL single-block query expressions as defined in [3] and we intend CoQueL queries to have the same expressive power as SQL. Second, according to [12], the conceptual query languages have not become widely accepted and one of the reasons is that they lack formal semantics. So, another future work is to provide a formal semantics for the CoQueL language.

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## APPENDIX. COMPLETE SYNTAX OF A COQUEL QUERY

entityType = entityTypeName(attributes; conditional-expression; attributes; conditional-expression) attributes = * | attribute-expression

attributeexpression = attribute-list | attribute-name

attribute-list = attribute-list, attribute-name

lpath = [entityType link]* /entityType|spath/

spath = entityType ( [&(link/lpath|spath/)]+)

CoQueLquery = lpath | spath

conditionalexpression = conditional-term | conditional-expression OR conditional-term

conditional-term = conditional-factor | conditional-term AND conditional-factor

conditional-factor = simple-condition | conditional-expression

simple-condition = comparison-condition | like-condition

like-condition = string-expression LIKE pattern

comparisoncondition = scalar-expression comparison-operator scalar-expression

comparisonoperator = < > <= >= <> =

scalar-expression = numeric-expression | string-expression

numeric-expression = numeric-term | numeric-expression /+|-/numeric-term

numeric-term = numeric-factor|numeric-term/*| // numeric-factor

numeric-factor = [+|-]primary-number

primary-number = attribute name possibly qualified or numeric literal or aggregate function or numeric expression between parenthesis

string-expression = concatenation | primary-string

concatenation = string-expression || primary-string

primary-string = attribute name possibly qualified or string literal or string expression between parenthesis

entityTypeName = name of some of the entity types of the E/R model

link = link of some of the relationship types of the E/R model

The entry point is CoQueLquery. The symbols [ ] / / |are part of the metasyntax and are never written. [. . . ] means one ocurrence at most of the content of the brackets. [. . .]∗ means zero or more ocurrences of the content of the brackets. [. . .]+ means two or more ocurrences of the content of the brackets. /a|b/ means exactly one ocurrence of the elements separated by the vertical bars. The symbols ; & ( ) stand for themselves. The same applies to the operators AND OR ||LIKE =<><=>=<> + − ∗/.

*INTENTIONAL BLANK*

# FILESHADER: ENTRUSTED DATA INTEGRATION USING HASH SERVER

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### ABSTRACT

*The importance of security is increasing in a current network system. We have found a big security weakness at the file integration when the people download or upload a file and propose a novel solution how to ensure the security of a file. In particular, hash value can be applied to ensure a file due to a speed and architecture of file transfer. Hash server stores all the hash values which are updated by file provider and client can use these values to entrust file when it downloads. FileShader detects to file changes correctly, and we observed that it did not show big performance degradation. We expect FileShader can be applied current network systems practically, and it can increase a security level of all internet users.*

### KEYWORDS

*SHA-1, File Integration, Web Cloud, File Transfer*

## 1. INTRODUCTION

In the network system, file download and upload procedures are done by packet transfer. Usually file size is much bigger than normal packet size, and it causes packet fragmentation. When the file is delivered to other machines such as a server, a lot of fragmented packets will be transferred. However, some fragmented packet can be changed by eavesdrop and it could have a malicious attack pattern. In addition, entire file can be changed to malicious attack file during an uploading process. By this weakness of file transfer procedure, we need to detect file changes due to a possibility of file changes.

Hash server can be worked to solve this problem. Hashing has two advantages, speed and simple. Using hash value, we implemented FileShader which detects file changes before and after file transfer. It gets the correct hash value from the hash server who provided by original file provider, and compare with calculated hash value of downloaded or uploaded file.

While it checking file changes, a small overhead is possible. We evaluated this overhead and showed FileShader is practical and possible to be adopted to a current network system, so that user can prevent malicious attack pattern caused by file changes in the middle step of overall file transfer.

## 2. RELATED WORK

We proposed FileShader which is a hash-based solution for file security and network forensics issues. Below are previous related works.

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pp. 15–25, 2016. © CS & IT-CSCP 2016 DOI : 10.5121/csit.2016.60402

### 2.1 Secured File System

The Secure File System (SFS) [1,2] provides strong authentication and a secure channel for communications. It includes an extensive authentication mechanism for individual users, and provides strong security for data in transit between clients and servers. It also allows servers to authenticate their users and clients to authenticate servers.

However, it still relies upon trusted file servers that data is stored by them. If a "trusted" server is physically compromised by the attacker, the data on it may be changeable to the attacker. In an environment where data storage is outsourced to companies, this security risk is unacceptable.

### 2.2 Network Forensics

Network forensics is the act of capturing, recording, and analyzing network audit trails in order to discover the source of security breaches or other information assurance problems. The term network forensics was introduced by the computer security expert Marcus Ranum in the early 90's [3], and is borrowed from the legal and criminology fields where "forensics" pertains to the investigation of crimes. According to Simson Garfinkel, network forensic systems can be implemented in two ways: "catch it as you can" and "stop look and listen" systems [4].

The main focus in this paper is to automate the process of detecting all the attacks and to prevent the damaged caused by further security issues. Our idea is to identify all possible security violations and prevention mechanisms to prevent further problems.

### 2.3 Hash Function

According to S. Bakhtiari[5], a one-way hash function, also known as a message digest, fingerprint or compression function, is a mathematical function which takes a variable-length input string and converts it into a fixed-length binary sequence. Furthermore, a one-way hash function is designed in such a way that it is hard to reverse the process, that is, to find a string that hashes to a given value (hence the name one-way.) A good hash function also makes it hard to find two strings that would produce the same hash value.

MD4 & MD5: Both MD4 and MD5 were invented by Ron Rivest. [6] MD stands for Message Digest. Both algorithms produce 128-bit hash values. MD5 is an improved version of MD4.

SHA: SHA[7] stands for Secure Hash Algorithm. It was designed by NIST and NSA. SHA produces 160-bit hash values, longer than MD4 and MD5. SHA is generally considered more secure that other algorithms and is the recommended hash algorithm.

## 3. DATA INTEGRATION

Data center is entrusted to people who have no role in creating and changing the data. Users trust these servers without any doubt. Security decisions are driven by preventing link level attack rather than internal data center security. However, most of recent security incidents are shown up by internal members. In particular, the data centers are operated by hired people who are physically insecure. They are able to change a data which is stored in a server. Thus, we can say data centers cannot be trusted anymore.

This paper proposes that how to transfer a file to user safely in unsecured and outsourced data center companies which is managed by people who have no permission to write data.

## 3.1 Security

The security is becoming a crucial part of the network. In the common sense, security has no deal with current network innovation. However, if the security is not managed, unimaginable disaster could be come up and it can cause huge damages to the network system.

Up to this point, most of the companies are increasing their investment to the security and trying to build security system by themselves, such as IDS (Intrusion Detection System) or firewalls. However, security is not an issue of companies anymore. All the network users are facing on the security issue. We suggest FileShader which can increase a security level of the entire internet user by using trusted hash server.

## 3.2 Data Integration

From the user's point of view, data integration checking by users themselves could have big overheads to their system itself. However, data integration should prevent various attacks and eliminate a potential security risk. Furthermore, the data integration process can be done without changing exist network device in the world.

By adding new secured hash server, data integration checking will be done automatically when the data transfer is finished. After that, the host can use the file from the unsecured server safely. If there are some suspicious bits or parts of the file, data integration process will let users know and let them to decide whether they discard file or not.

## 3.3 Case Study

The digital information such as image, video and data concerned with security issues require detection method for tampering data. Image can be modified easily for inappropriate propose. However, Image is very hard to authenticate its changes. Figure 1 shows how easy it is to modify and use. In forensic and criminal investigation, Digital data would be the most important evidence to determine the crime. In Figure 2, three suspects had disappeared in modified video without any unusual. Therefore, a valuable data such as contract, agreement and CCTV should be protected and verified by a trusted method.

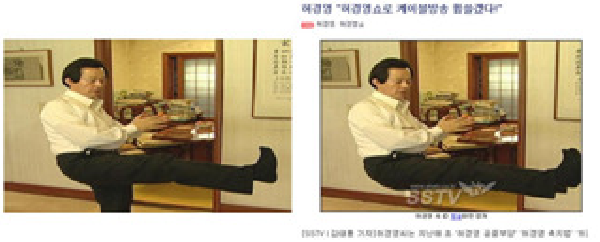


Figure 1: Huh Kyung-young modifies his picture to increase his fame.

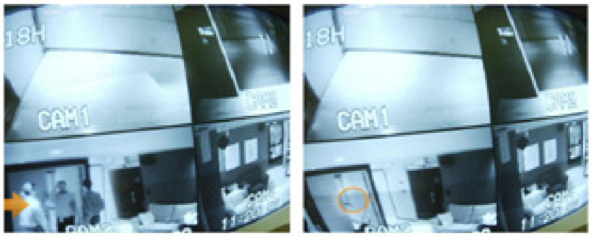
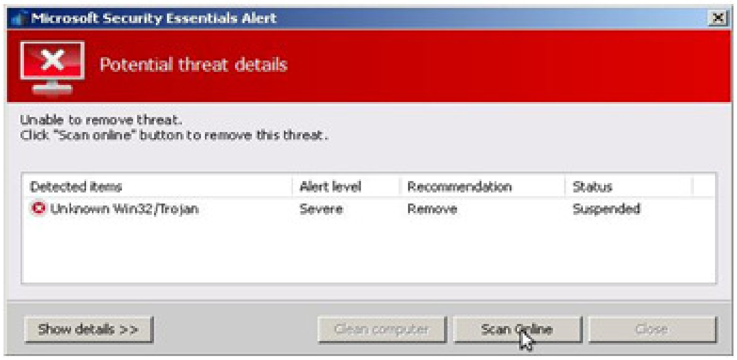


Figure 2: There are three men in first picture but no one in second picture

Some hackers insert malicious code into a normal program to make zombie computer. It can be used to perform malicious tasks of one sort or another under remote direction and launch Distributed Denial of Service (DDoS) attacks against targeted systems. Malicious software will typically install modules to zombie computer. Figure 3 shows that anti-virus programs warn you about malicious software. However, anti-virus programs can't find all malicious software because malicious software may delete itself, or may remain present to update and maintain the modules.



Microsoft Security Essentials Alert

Potential threat details

Unable to remove threat.
Click "Scan online" button to remove this threat.

| Detected items | Alert level | Recommendation | Status |
|---|---|---|---|
| Unknown Win32/Trojan | Severe | Remove | Suspended |

Figure 3: Trojan is flagged as malicious software and removed by anti-virus program.

# 4. Problem Description

## 4.1 Hijacking Data

While the file transfer is processing, some malicious hackers can get the packet information doing Eves-Drop, and send the packet which has malicious code with same flow information, to the receiver who was getting the file. After the malicious packets are delivered, receiver side will reconstruct the file with malicious packets. When the receiver runs this reconstructed file, the host would be injected by virus or bots (Figure 4). Up to this point, we need file a integration process to ensure the file came from the source.

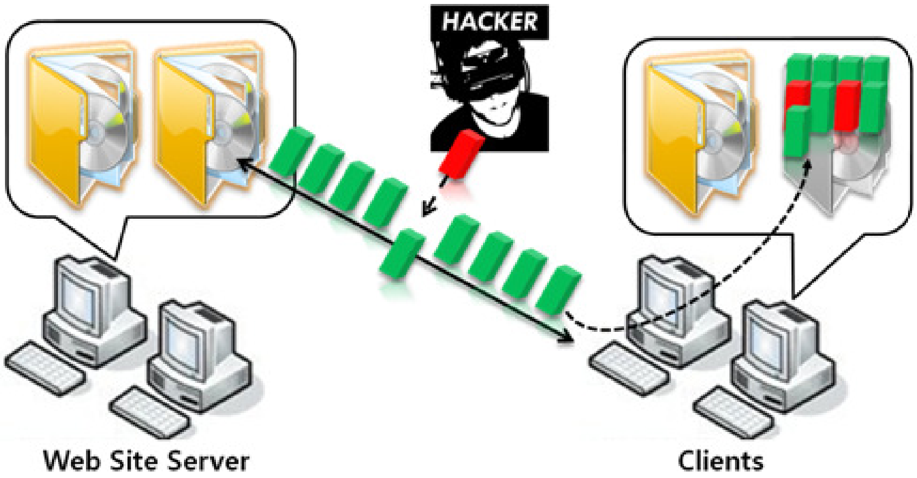


Figure 4: Receivers will construct the file with malicious packets.

### 4.2 Problem Definition

The problem of current network is file insurance. When the people download a file, no one knows this file is exactly same as the file which the file provider uploaded. File can be changed at a lot of spots and it can contain some malicious attack patterns. Up to this point, we need a file integration checking tool which can give us the fact that this file is certificated.

### 4.3 Assumption

Our problem starts with an assumption that transport layer has already supported sufficient security. Transport Layer Security (TLS) and Secure Sockets Layer (SSL) provide high communication security over the Internet. There is no longer the data modification in the current network.

Most of the recent security problems occur from the internal people or infected computer in a data server. Consequently, we presume the file has been changed in a server if there is the attacker who accesses to the data server. Furthermore, we suppose the hash server is trusted by users. The hash server operates in the high secured and validated authority. Hash server has the unique hash value updated by data owner.

### 4.4 Goal

The aim of our approach is to guarantee the file-integrity. We envisage warning clients when data has been changed and dealing with “forensics” issue. In the current network, it is hard to detect file changes due to the file integration process. Let’s say, the file is fragmented to some packets, and one of them are changed by eavesdrop or some other attack. The receiver cannot detect file changes after it integrated the packets to one file.

Up to this point, we propose the FileShader which can detect file changes not in the packet level but in the file level using hash values. Another possible issue is a malicious file provider. When the clients are attacked by malicious data, it is important to figure out who provides the malicious data on the web server. We expect our system is able to identify the exact malicious file provider.

## 5. SOLUTION

### 5.1 Problem Approach

Being able to access your files from anywhere and from any computer is one of the great conveniences of the always-on Internet. These are so cheap and easy to use that there is almost no reason not to back some of your files up into the cloud. Most online storage providers also give you the ability to then share these files with your friends and colleagues. Cloud services have a good track record of keeping your data while providing you easy access to your files from wherever you are. However, it's dangerous to put data in the cloud as it becomes controlled by the provider and the company can’t really know how secure the data and the infrastructure are in general.

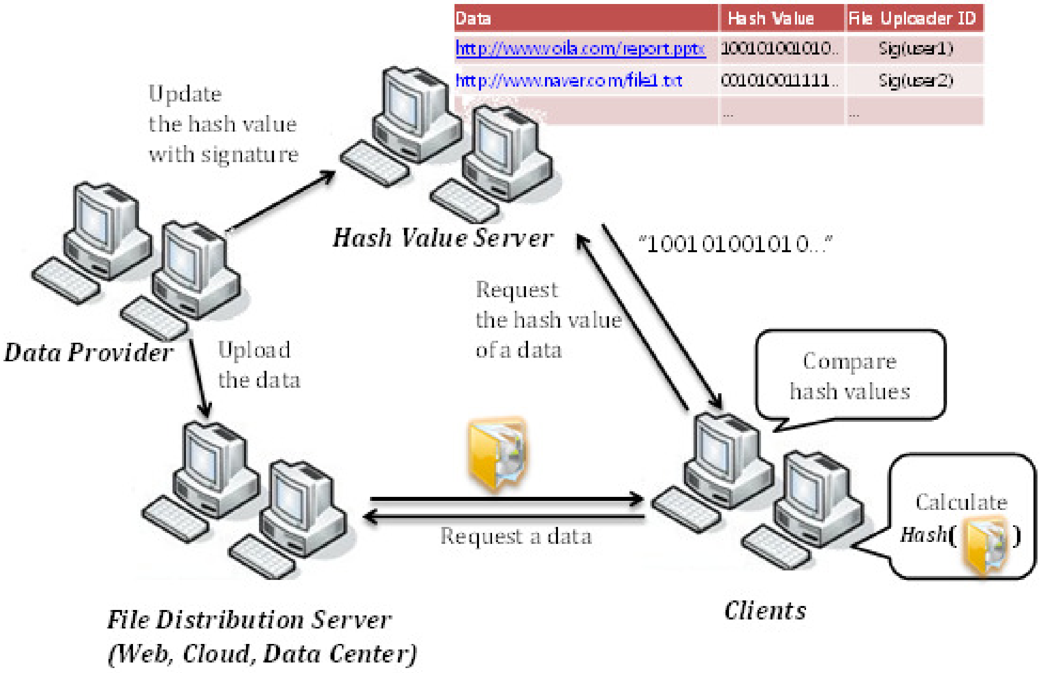
Therefore, Client wants to independently prove the integrity of their data when they use public or sharing data in a web and cloud services environment. Cloud Services platforms can use data integrity protection of its storage but don’t provide the guarantee of modification caused by an inappropriate user. For customers to have confidence in cloud service implementations, File provider need to build security into the structure of their clouds and not totally rely on cloud vendors to provide those capabilities. Security in the cloud is ultimately the responsibility of the file provider use cloud vender. File provider will provide security with their customer. Table 1 shows the comparison of each service.

Table 1. Comparative benefit analysis

| | Self-managed Data | Cloud-managed Data | Self-managed Data+FileShader | Cloud-managed Data+FileShader |
|---|---|---|---|---|
| COST | × | ○ | × | ○ |
| RISK | △ | × | ○ | ○ |
| TRANSPARENCY | △ | △ | ○ | ○ |
| LEGALLY DEFENSIBLE | × | × | ○ | ○ |

## 5.2 FileShader Design

FileShader operates a data integrity protection service that enables users to protect the integrity and independently verify of their data, files or any digital content throughout hash algorithms. We design that FileShader is an Internet-based application that can work from any platform without a lot of changes. We propose the effective process to provide data insurance you can get from any server. Figure 5 shows our process of FileShader.



| Data | Hash Value | File Uploader ID |
|---|---|---|
| http://www.voila.com/report.pptx | 100101001010.. | Sig(user1) |
| http://www.naver.com/file1.txt | 001010011111.. | Sig(user2) |
| | ... | ... |

Figure 5: Integrity of a file is checked by comparing two hash values

FileShader Sealing and Validating Process

1. FileShader Sealing Process
   A. Data Provider creates a hash of a data or file from
   B. FileShader sends Hash to hash value server, via secure Internet connection such as SSL

C. Hash value server securely and verifiably bind the hash, and data provider to create the data integrity seal.
D. Hash value server sends the data integrity seal to the data provider
E. FileShader of data provider verifies and archives the data integrity seal.

2. FileShader Validating Process
   A. Client create a hash value of a file to compare it to the hash value in Hash value server
   B. Client sends a meta-data to Hash value server.
   C. Hash value server receives a meta-data from client and finds the data integrity seal.
   D. Hash value server sends the data integrity seal to the client. And then client compares it and the data integrity seal from validation process.

## 6. EVALUATION

### 6.1 Key Factor

Correctness: verifying file changes and show FileShader can detect file changes with exact hash values.

Performance: comparing between normal network downloading speed without FileShader and downloading speed with FileShader. It describes FileShader will not take that much overhead so that the user will not feel any downloading speed degradation and also FileShader is practical.

### 6.2 Method

We will evaluate the detection accuracy as well as the system overhead. To evaluate how accurately the system detects the data changed, the data center generates partially changed data. This data constructs a data pool with normal data. Then, the data center sends any data between this pool to the client. We check how many times the client detects the file changed accurately. This will show security robustness of our proposed approach.

As far as the system overhead is concerned, we will record the time taken when sending data with and without our proposed file integrity method. Accordingly, the system overhead is evaluated by the number computed by the time taken using our approach over that using existing approach. Since we add the process of calculating hash values, the number is over 1. Our objective is to reduce this number as possible as we can.

When using 128-bit hash values, we expect the system to detect the file changes100% since it is unlikely the hash collision is occurred. The size of hash values is relevant to the system overhead, however. To deal with the tradeoff between robustness and overhead, we will experiment by reducing the size of hash values. We will find the optimal point having small enough size where the detection rate is over the determined threshold.

### 6.3 Environment Setup

We prototyped client, web server, and hash value server. Different IP addresses and port numbers are assigned to web server and hash value server. Client tries connecting with these servers with two different sockets. Client has two functions: upload/download a file to a web server. Unlike other client/server systems, client connects with hash value server. When uploading a file to a web server, client computes the hash value of the file and uploads the value to hash value server. Similarly, client receives the corresponding hash value from a hash value server as soon as downloading a file from a web server. Then, it compares the hash value to the newly computed hash value with the downloaded file. SHA-1 hash algorithm outputs completely different hash values if contents of file is changed. Consequently, client can easily validate files from a web server by comparing two hash values.

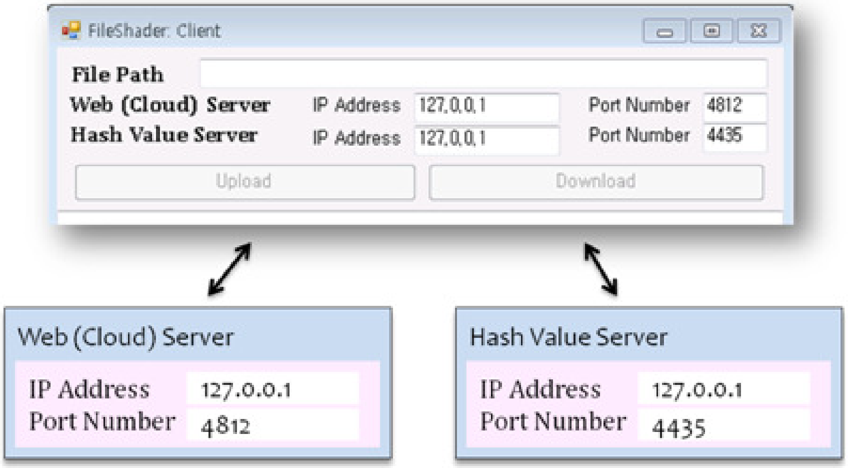
Our objective of the experiments is to reduce the overhead between the systems with/without the hash value server. To compute the overhead by calculating, uploading, and downloading the hash values; we measured the time taken with and without hash value server. Since the network is dynamic, execution time strongly depends on the network environments. File size may also affect the overhead. Accordingly, we tested a file for 10 times and calculated the average execution time.

## 7. RESULT

We implemented FileShader using C# to provide graphical user interface, so that user can easily use the FileShader and also FileShader can be more practical. We had a test with various file sizes; 64 byte, 512 byte, 1kB, 1MB, and 2MB.

### 7.1 Environment Setup

Basic user interface of FileShader is as shown below. When we put the file address at the file path section, FileShader will be automatically connected to web cloud severs and hash server. From the web cloud server, FileShader will download the file and calculate the hash value. On the other hand, from the hash server, FileShaer will send a request message to get the hash value of the file and wait. After FileShader gets the hash value from the hash server, it will compare both hash values, so that we can verify the downloaded file.



FileShader: Client

File Path

Web (Cloud) Server IP Address 127.0.0.1 Port Number 4812

Hash Value Server IP Address 127.0.0.1 Port Number 4435

Web (Cloud) Server

IP Address 127.0.0.1

Port Number 4812

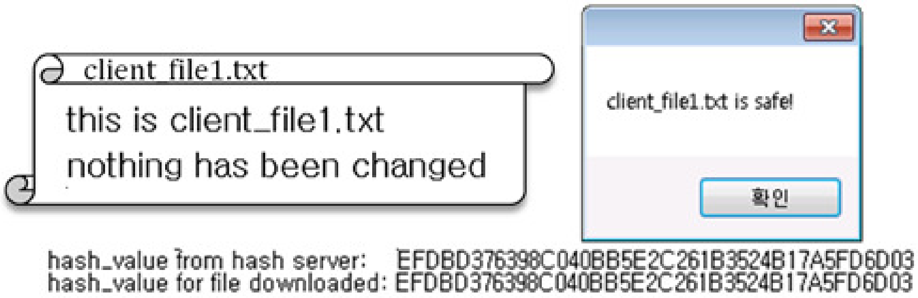
Hash Value Server

IP Address 127.0.0.1

Port Number 4435

Figure 6: user interface

The next two pictures describe the correctness of the FileShader. We used file1.txt which has the data as shown left. The client connects to the hash server and gets the hash values to compare with file1.txt. The hash values were same, so the FileShader says “client_file1.txt is safe” which means this file is same as the file which uploaded by original file provider.



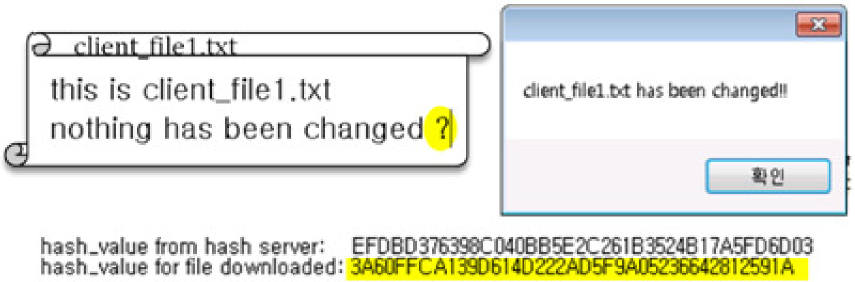
this is client_file1.txt
nothing has been changed

client_file1.txt is safe!

```
hash_value from hash server:    EFDBD376398C040BB5E2C261B3524B17A5FD6D03
hash_value for file downloaded: EFDBD376398C040BB5E2C261B3524B17A5FD6D03
```

Figure 7: correct result of file1.txt

What if the file data is changed? We tried to change file1.txt manually with adding one question mark, '?', and kept experiment. FileShader calculates the hash value of changed file and compares with the hash value which comes from the hash server. In this time, two hash values are different, so it prints out file1.txt is not safe. This means this file is different from the file provider's uploaded file even the file name is same.



this is client_file1.txt
nothing has been changed?

client_file1.txt has been changed!!

```
hash_value from hash server:    EFDBD376398C040BB5E2C261B3524B17A5FD6D03
hash_value for file downloaded: 3A60FFCA139D614D222AD5F9A05236642812591A
```

Figure 8: wrong result of file1.txt

FileShader uses hash value to verify the file. Thus, there is no weakness of file name and file size. Even the file name and file size is same, FileShader will detect the file changes.

## 7.2 System Overhead

We have done some experiments for the performance of Shader on a typical network system. We quantified the overheads of FileShader with various file sizes. The file size was changed from 64kB to 2MB. Figure 9 shows the system overhead with different file size in a file downloading process. The FileShader has a system overhead in a hash calculation and file verifying process. As we can see that normal download performance and FileShader performance has not big difference, less than 100ms, regardless of file sizes. This means that hash value calculation doesn't overheads a lot, and file verification is also light work due to the comparing hash values only.

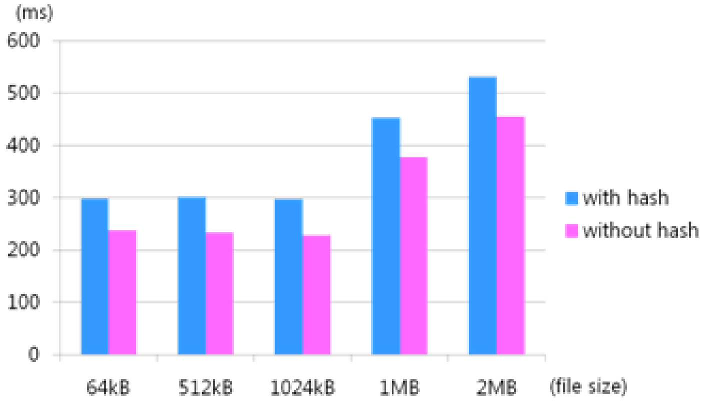


Figure 9: Overhead comparison of the download

Figure 10 shows the overhead of the uploading process. As we can see in the figure, overall system overheads are increasing when the file size is increased. The process of "without hash" is a normal uploading process. The difference between "with hash" and "without hash" is an overhead of FileShader. When a file is uploaded, FileShader should calculate the hash value of the entire file and store it in the hash server, so that it can use this value when the user downloads the file at the other machine through cloud interface. This process takes overheads, that is why, the system overheads is increased regards of file sizes.

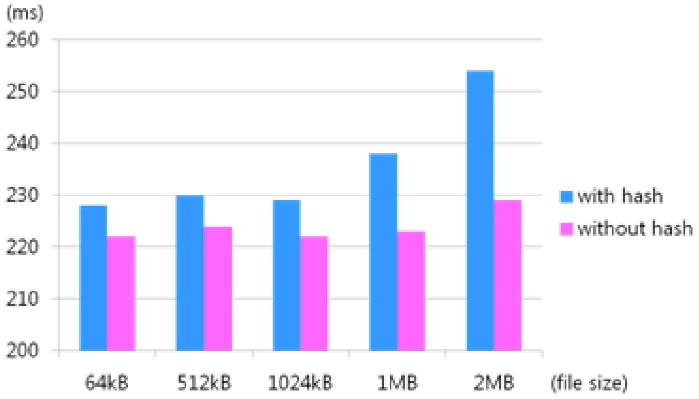


Figure 10: Overhead comparison of the upload

When downloading, client requests a file to the web server. The buffer size of client affects system overheads while in our experiment, two buffer sizes, of uploading and downloading, are different. Consequently, the downloading overheads are bigger than that of uploading.

This experiment has been done with simple file to test FileShader. It shows that the FileShader detects file changes correctly, and also it is totally acceptable to current network system.

## 8. CONCLUSION

We proposed FileShader which provides entrusted file integration and transfer using hash server. It detects file changes correctly, and performance degradation was negligible. We evaluated FileShader with correctness point of view, and performance point of view. With the evaluation result, we showed FileShader is practical and can be applied to current network system. We expect FileShader can give a higher security level for the file transfer and efficiently prevent malicious attack from the implied attack pattern in the file which is injected in the file transfer process.

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# FEATURE SELECTION-MODEL-BASED CONTENT ANALYSIS FOR COMBATING WEB SPAM

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### ABSTRACT

*With the increasing growth of Internet and World Wide Web, information retrieval (IR) has attracted much attention in recent years. Quick, accurate and quality information mining is the core concern of successful search companies. Likewise, spammers try to manipulate IR system to fulfil their stealthy needs. Spamdexing, (also known as web spamming) is one of the spamming techniques of adversarial IR, allowing users to exploit ranking of specific documents in search engine result page (SERP). Spammers take advantage of different features of web indexing system for notorious motives. Suitable machine learning approaches can be useful in analysis of spam patterns and automated detection of spam. This paper examines content based features of web documents and discusses the potential of feature selection (FS) in upcoming studies to combat web spam. The objective of feature selection is to select the salient features to improve prediction performance and to understand the underlying data generation techniques. A publically available web data set namely WEBSPAM - UK2007 is used for all evaluations.*

### KEYWORDS

*Web Spamming, Spamdexing, Content Spam, Feature Selection & Adversarial IR*

## 1. INTRODUCTION

As the scope of web grows beyond limits, it is more prone to profanation. From accessing information to interacting and connecting with people, from e-commerce to e-businesses, Internet covers almost each and every aspect of our lives. It helps in bringing new opportunities to people. According to Sam Lucero, analyst at ABI Research in Oyster Bay, "anything intelligent would have an online presence” [1]. But, as it is said, every massive technology has its own benefits and challenges, same is the case with Internet and World Wide Web. Accurate and quality information retrieval is one of those major challenges. As business vendors recognize the value of web for reaching out to millions of customers, they try to gain high visibility for their websites on search engine result page (SERP). This rising need to rank highly in search results in order to recognize among web users, gives birth to the term *web spamming* (or, *spamdexing*) [2]. Spamdexing, as the name implies, takes advantage of web indexing system, allowing spammers to deceive search engine (SE) ranking of specific documents.

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Ranking system of SEs involves various content-based and graph-based measures. Spammers exploit these parameters to artificially inflate the ranking of web documents. Spam techniques range from stuffing a page with large number of authority references or popular query keywords, thereby causing the page to rank higher for those queries, to setting up a network of pages that mutually reinforce their page value to increase the score of some target pages or the overall group.

Recently [3; 4], all major SEs such as Google, Yahoo etc. have identified web spam as a tangible issue in IR process. It not only deteriorates the search quality but also cause wastage of computational and storage resources of a SE provider. A financial loss of $50 billion was caused due to spam in the year 2005 [5]. In the year 2009, it was estimated at $130 billion [6]. Further, it weakens people’s trust and might deprive legitimate websites of user’s visibility and revenue. Therefore, identifying and combating spam becomes a top priority for SE providers.

According to web spam taxonomy presented in the work of Spirin and Han [7], web spam is broadly classified into four categories namely content spam [8], link spam [9; 10], cloaking and redirection [11; 12], and click spam [13]. This research work primarily focuses on the detection of content spam which is the most common and frequently occurring spam [14].

IR systems examine the content of pages in the corpus to retrieve the most relevant document with respect to a specific search query. “Term Frequency-Inverse Document Frequency” (TF-IDF) or another similar approach is used to access the “most similar” (relevant) documents to the search query. In TFIDF, “the relevance of the search terms to the documents in corpus is proportional to the number of times the term appeared in the document and inversely proportional to the number of documents containing the term.” Spammers exploit Term Frequency (TF) scoring by overstuffing content fields (title, body, anchor text, URL etc.) of a page with a number of popular search terms so as to boost its relevancy score for any search query. It can be measured as:

$$TFIDF\,(q,p) = \sum\nolimits_{(t\in q)\land(t\in p)} TF\,(t).\,IDF\,(t) \qquad (1)$$

where *q* refers to query, *p* denotes a web page in the corpus, and *t* denotes the term.

Machine learning is a field of study that deals with automated learning of patterns, within the data belonging to different classes or groups, with an aim to differentiate between the classes or groups. An effective machine learning algorithm is expected to make accurate predictions about categorization of unseen data based on the learnt patterns. Specifically, supervised machine learning involves predicting the class of an unseen (new) data sample based on the decision model learnt using the existing (training) data. Therefore, knowledge of machine learning may be appropriately utilized for web spam detection.

Several machine learning methods to combat content spam were introduced in the past researches of adversarial IR and web spam domain. Egele et al. [15] examined the importance of different text and link metrics in web ranking system and utilize C4.5 supervised learning algorithm to remove spam links. They deployed their own mechanism to generate data to carry out the experiment.

Ntoulas et al. [16] presented an approach for detecting spam based on content analysis. They extracted several content features and presented a comprehensive study about the influence of these features in web spam domain.

Prieto et.al [17] suggested a number of heuristics to identify all possible kinds of web spam and developed a system called SAAD (Spam Analyzer and Detector) for efficient web spam detection. The beneficial trait is that the system was tested on different data sets and proved to be effective for more accurate classification of spam pages.

Araujo and Romo [18] proposed an interesting approach of spam detection by comparing the language models (LM) [19] for anchor text and pages linked from these anchor text. KL-divergence [20] was used to measure the discrepancy between two LMs.

However, spammers are continuously adapting themselves to circumvent these barriers. This research work presents a content-based spam detection approach using supervised learning. The aim of this study is to draw a clear understanding of underlying process of web spamming by examining already extracted features. Moreover, the work aims at selecting salient features from the existing ones to stimulate further studies in the domain of "adversarial information retrieval [21]". A filter based feature selection technique is employed to uncover important patterns in order to classify websites as spam or ham (non-spam). The proposed method is observed to be efficient in terms of both computational complexity and classification accuracy.

The rest of the paper organizes as follows. A general methodology of applying feature selection technique for adversarial classification is presented in section 2. Finally, experimental results are shown in section 3 and section 4 concludes the paper.

## 2. METHODOLOGY

### 2.1 Experimental Data Set

Widely known web spam data set WEBSPAM-UK2007 [22] is used to carry out the experiments. This dataset was released by Yahoo especially for Search Engine Spam project. The data set was also used for "Web Spam Challenge 2008". It is the biggest known web spam data set having more that 100 M web pages from 114,529 hosts. However, only 6,479 hosts were manually labelled as spam, non-spam and undecided. Among these, approx 6% hosts are spam, i.e., data is imbalanced in nature. The data set consist a separate training and testing data set, but we combined the two sets together to evaluate our model since the percentage of spam hosts were small in both of them. Further, we neglect the hosts labelled as "undecided" and conduct our experiment for a group of 5,797 hosts. The training set was released with pre-extracted content feature set which are examined in this study to select salient and optimal features.

*Existing content- based heuristics for detecting web spam*

The content feature set proposed by Ntoulas et al. [16] comprises of 98 features based on following heuristics:

- Number of words in the page: "Term Stuffing" is a common spamming technique to increase visibility of a web document on typical queries or search terms. Sometimes the proportion of common terms in a page is very high. Therefore, authors suggest counting number of words per page. Very large value of the proposed heuristic indicates the strains of spam in the page.
- Number of words in the title: Many times, a page title is stuffed with unrelated keywords and terms because of its high weightage in search engines text metrics. As a spam detection method, authors propose measure of number of words in the title
- Average word length of the document: In order to combat composite keywords spamming, authors propose to measure the average word length

- Fraction of anchor text in the page: Due to the fact that “anchors” are used to describe the association between two linked pages, spammers misuse them to create false associations

$$fraction\ of\ anchor\ text\ per\ page = \frac{total\ number\ of\ words\ in\ the\ page}{number\ of\ words\ in\ anchors} \quad (2)$$

- Ratio of visible text: The authors propose this heuristic to detect “hidden content” in a page
- Compression Ratio: The proposed features helps in determining the level of redundancy in the page

$$compression\ ratio = \frac{size\ of\ normal\ web\ page}{size\ of\ compressed\ page} \quad (3)$$

- Independent and Dependent LH: These techniques utilize the independent and dependent n-grams probability to detect spam. More precisely, content of each page is divided into n-g of *n* consecutive words to calculate the probability of document by individual n-g probabilities. However, this feature is computationally expensive.

The performance analysis of these features and its comparison after applying feature selection techniques is presented in section 3.

## 2.2 Proposed Methodology

This research work focuses on the contribution of feature selection in adversarial IR applications. The common issues in the spam domain are listed as: small sizes of samples, unbalanced data set and large input dimensionality due to several pages in a single web document. To deal with such problems, a variety of feature selection methods have been designed by researchers in machine learning and pattern recognition. This work employs univariate filter feature selection to improve the prediction performance of decision model. The existing heuristics on which feature selection is performed are already discussed in previous subsection. The idea of applying feature selection in the existing features is two-fold: these features were utilized in many previous studies [16; 17; 18; 23] for effective spam detection; the heuristics recognized as baseline for further studies in the underlying domain.

Due to aforementioned reasons, it can be expected that, for spam documents classification, feature selection techniques will be of practical use for later researches in information retrieval and web spam.

### 2.2.1 Methods for Web Spam Detection

This section describes the algorithms and methods used for evaluation of this work.

*Classification Algorithm*

For the appropriate prediction, we have tried various classification methods, namely, *k*-nearest neighbour, linear discriminant analysis, and support vector machine (SVM). As per experiments, SVM is observed to achieve better results for binary classification in comparison to other classifiers. Therefore, this research work SVM is utilised to learn decision model.

SVM [24] classify objects by mapping them to higher dimensional space. In this space, SVM train to find the optimal hyperplane, i.e., the one with the maximum margin from the support vectors (nearest patterns).

Consider a training vector $\mathbf{x}_i, i = 1, 2, \ldots, n,$ we define a vector **y** such that $y_i = \{1, -1\},$ decision function can be defined as:

$$f(\mathbf{x}) = sign\ (\mathbf{w}^{\mathrm{T}}\mathbf{x} + b) \quad (4)$$

The weight vector **w** is defined as:

$$\mathbf{w} = \sum_i \alpha_i y_i \mathbf{x}_i \qquad \alpha_i \geq 0 \quad \forall i \tag{5}$$

where $\alpha_i$ is the Lagrange's multiplier used to find the hyperplane with maximum distance from the nearest patterns. Patterns for which $\alpha_i > 0$ are support vectors.

The possible choice of decision function when data points are not separable linearly can be expressed as:

$$\min_{\mathbf{w},\mathbf{b},\alpha_i} \frac{1}{2}\left(\mathbf{w}^{\mathbf{T}}\mathbf{w}\right) + C\sum_{i=0}^{n} \alpha_i \tag{6}$$

where, $0 \leq \alpha_i \leq C, \quad i = 1, 2 \ldots., n$ and *C* is the penalty parameter. Value of *C* =10 is used for experimental evaluation.

*Performance Evaluation*

In order to evaluate the model, 10-fold cross validation technique is used. The results are shown in terms of classification accuracy, sensitivity, and specificity, whose values are obtained by analysing the cost matrix [25].

Sensitivity can be defined as the number of actual positive instances (spam) that are correctly predicted as positive by the classifier. Conversely, specificity determines proportion of actual negatives (non-spam hosts) that are correctly classified. Accuracy can be defined as total number of instances that are correctly predicted by the classifier.

*Univariate Filter Feature Selection: Simple yet efficient*

In order to improve the performance of SVM, feature selection is implemented. Univariate filter based feature selection has been utilised due to the fact that it is computationally simple, fast, efficient, and inexpensive. In filter based feature selection, "features are selected independently to induction algorithm" [26; 27; 28]. The measurement for feature selection is chosen as Mutual Information Maximization (MIM) [29]. It is a simple method to estimate rank of features based on mutual information. Mutual information is defined as a relevancy measure, determining how relevant a feature is for corresponding targets. The criterion can be expressed as follows:

$$J_{MIM}(\mathbf{x}_n) = \max\left[I(\mathbf{x}_n; \mathbf{c})\right] \tag{7}$$

where $\mathbf{x}_n$ is the $n^{\text{th}}$ feature of training matrix **X**, **c** is the class label and $I(\mathbf{x}_n; \mathbf{c})$ refers to mutual information between the two. Mutual Information between two random variables p and q can be determined as:

$$I(p; q) = \sum P(p, q) log \frac{P(p,q)}{P(p)P(q)} \tag{8}$$

## 3. EXPERIMENTAL RESULTS AND DISCUSSION

Table 1 shows the performance of SVM on existing feature set whereas Table 2 shows the prediction performance after feature selection. It is clearly visible that feature selection technique on precompiled measures outperforms the performance of complete feature set. The results show a significant gain in classifier's accuracy in terms of both valuation measures (i.e., specificity and sensitivity). Approximately 3% increase in specificity and 2% increment in accuracy and sensitivity is reported.

Table 1: Performance of content- based feature sets using SVM

| Feature Set | Performance Measure (in percentage) | | |
|---|---|---|---|
| (98 features) | Accuracy | Sensitivity | Specificity |
| Content | 79.9 | 61.8 | 79.2 |

Table 2: Performance of content- based feature sets after feature selection using SVM

| Filter based Feature Selection | | Number of features | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Top 10 | Top 20 | Top 30 | Top 40 | Top 50 | Top 60 | **Top 70** | Top 80 | Top 90 |
| Performance Measure (in percentage) | Accuracy | 76.7 | 78.6 | 81.6 | 81.6 | 81.4 | 81.1 | **82.1** | 80.8 | 80.7 |
| | Sensitivity | 46.6 | 51.2 | 51.3 | 55.3 | 55.3 | 57.1 | **63.1** | 63.1 | 62.7 |
| | Specificity | 81.5 | 81.6 | 81.6 | 82.6 | 82.7 | 82.7 | **82.9** | 80.8 | 80.7 |

## 4. CONCLUSIONS AND FUTURE PERSPECTIV

In this study, we take into account existing heuristics for detecting spam by means of content analysis. This experiment compares the performance results of pre-determined features with the performance of features achieved after feature selection. The experimental results demonstrate that classifier performance increases with reduced (reduced from 98 features to 70 features) set of salient features. Furthermore, we believe that feature selection undermines the inherent risk of imprecision and over-fitting caused due to unbalanced nature of dataset. However, a robust and optimal feature selection model is still a need to uncover.

Multivariate feature selection and wrapper based feature selection can be addressed as a prominent future study in web spam community. A second line of future research will be extension of heuristics extracted using both content analysis and web graph mining. Other interesting opportunities oriented towards different machine learning approaches such as fuzzy logic, neural network etc. Since, there is no clear separation between spam and ham pages, i.e., definition of spam may be vary from one person to another, use of fuzzy logic can be seen as a promising line of future work in detection of web spam.

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# GEOMETRIC CORRECTION FOR BRAILLE DOCUMENT IMAGES

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### ABSTRACT

*Braille system has been used by the visually impaired people for reading.The shortage of Braille books has caused a need for conversion of Braille to text. This paper addresses the geometric correction of a Braille document images. Due to the standard measurement of the Braille cells, identification of Braille characters could be achieved by simple cell overlapping procedure. The standard measurement varies in a scaled document and fitting of the cells become difficult if the document is tilted. This paper proposes a line fitting algorithm for identifying the tilt (skew) angle. The horizontal and vertical scale factor is identified based on the ratio of distance between characters to the distance between dots. These are used in geometric transformation matrix for correction. Rotation correction is done prior to scale correction. This process aids in increased accuracy. The results for various Braille documents are tabulated.*

### KEYWORDS

*Braille to text Conversion, Skew detection, skew correction*

## 1. INTRODUCTION

Braille is a system of writing that uses patterns of raised dots to inscribe characters on paper. It therefore allows visually –impaired people to read and write using touch instead of vision. Its characters are six- dot cells, two wide by three tall. Any of the dots may be raised, giving 64 possible characters including 26 English alphabets, punctuations, numbers etc. Although Braille cells are used world-wide, the meaning of each cell depend onthe language that they are being used to depict.

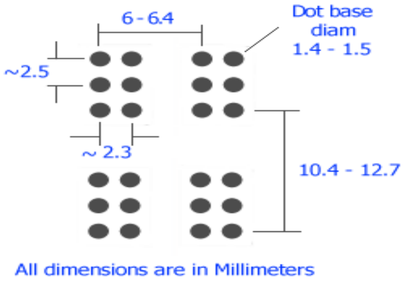

Figure.1- Braille Cell Dimensions

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The dimension of a Braille character is a standard one irrespective of the Language. Each dot in a Braille cell has a diameter of 1.5 mm. Within each cell the dot centres are placed at a distance of 2.5 mm vertically and 2.3 mm horizontally. Two cells are separated by a distance of 6 to 6.4 mm horizontally and 10.4 to 12.7mm vertically. These are illustrated in Figure.1.

Since the number of Braille books available are limited in number, when an ordinary text book is scanned and converted to text or audio, benefits many people who are in need. This also enables the corresponding document to be sent across the web. Identifying the Braille cells and decrypting them to the corresponding language are the major processes involved in the conversion[ 7]. Identifying Braille cells is difficult if the scanned documents are rotated or if those sheets are at different scale. These issues are briefed as follows

- When tilted to some angle, mapping of Braille to text is inappropriate and hence results in incorrect text.

- An inverted document may result in different mapping. An example of 2 Tamil letters, Inverted இis equivalent toஈ. Their Braille representations are in shown in Figure.2.

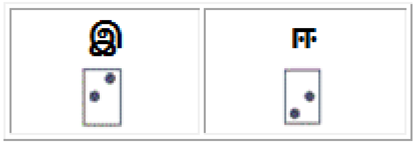


Figure 2.Inverted symbol mapping

- If the documents are either zoomed or shrunk their scaling varies and the spacing between the Braille dots or cells will be different from standard measurements.

Hence, the identification of Braille cells becomes difficult.

This paper proposes a technique which corrects the tilting of the Braille documents and brings the scanned document to the standard scale. The scanned document is converted to binary image before processing. The tilt or skew angle is identified by fitting a straight line to the set of first encountered vertical pixels. An inverse rotation matrix is used to correct the tilt. This paper utilizes the fact that ratio of the between character separation to within character separation should remain constant irrespective of scaling factor. A wide separation and a narrow separation horizontally signify the horizontal distance between two Braille cells (i.e. 2 characters and horizontal distance between the dots of the same Braille cell respectively. These distances cannot be calculated directly as the presence of dots varies for the characters present in the document. Since the dots raised may occur in different position, these distances varies for different character combinations. The ratio of distance between characters to distance between dots is between 2.6 to 2.78 in horizontal direction and 2.08 to 2.54 in vertical direction irrespective of the scaling factor. The distance pair satisfying these criteria is chosen and compared with the standard values to calculate the horizontal scale factor. A similar procedure is used for vertical distance and the vertical scale factor is calculated. An inverse geometric transformation matrix is used to bring the scale to the standard form. Once the documents are brought to the standard form the Braille characters could be converted to text as explained in [7].

In this paper, section 2 discusses about some of the methods proposed for finding rotation and scaling of scanned documents. Third section explains in detail about the solution proposed and fourth section covers the outcomes of the proposed method. Final section concludes with issues involved in implementing the proposed method and future works.

## 2. LITERATURE REVIEW

The issues that must be taken into consideration when implementing Braille to text conversion are scaling and rotation factors. Some of the methods to find them are as follows: Using the deviation over the sum of rows, [1] image was slanted over an angle. Each time it was slanted one pixel in vertical direction, deviation over sum of rows was calculated. When dots are horizontal, maximum was obtained. In [3], a probabilistic approach was proposed to estimate skewness and line-spacing of the Braille documents. Idea is to extract locations of the pixels belonging to shadow regions of dots and consider them as samples drawn from a two-dimensional Probabilistic Density Function (PDF). Parameters of the PDF are related to skewness and scale properties of the document. These parameters are estimated in a Maximum-Likelihood framework using the Expectation Maximum approach. Paper [4] does the following for finding the rotation angle: Geometric correction aims to bring all scanned Braille document images to a common reference point. A simple technique is used to solve this issue: manually draw a 15x10 mm rectangle using black ink pen at a fixed position on each page of Braille document. By detecting the 15x10 mm rectangle in the scanned image and estimating the position and orientation of the rectangle, transform the scanned image to a common reference point. Abdul Malik Al-Salman et al.[2] have proposed a probabilistic algorithm to correct any de-skewing in tilted scanned images. They also mention that maximum degree of recognizing a de-skewed image is 4 degrees from either the left or the right side.

As referred in [8] Supernova is a window-based magnifier, screen reader and a Braille system that supports the conversion of text to speech, Braille displays and note-takers. [9] refers to a paper on Braille word segmentation and transformation of Mandarin Braille to Chinese character. [10] discuss the main concepts related to OBR systems; list the work of different researchers with respect to the main areas of an OBR system, such as pre-processing, dot extraction, and classification. [11] focuses on developing a system to recognize an image of embossed Arabic Braille and then convert it to text. [12] proposes a software solution prototype to optically recognise single sided embossed Braille documents using a simple image processing algorithm and probabilistic neural network. [13] describes an approach to a prototype system that uses a commercially available flat-bed scanner to acquire a grey-scale image of a Braille document from which the characters are recognised and encoded for production or further processing. [14] presents an automatic system to recognize the Braille pages and convert the Braille documents into English/Chinese text for editing.[15] describes a new technique for recognizing Braille cells in Arabic single side Braille document. [16] developes a system that converts, within acceptable consrtraints , (Braille image) to a computer readable form. [17] provides a detailed description of a method for converting Braille as it is stored as characters in a computer into print.

## 3. PROPOSED SOLUTION

Most of the commercial software focuses on converting text to Braille and vice versa. Very few consider scanned Braille documents as input and the geometric corrections are done based on probabilistic models. This paper proposes a method that uses a geometric transformation matrix for rotation and scale correction. The parameters of the matrix are identified using standard measurement of the Braille cells. The overall block diagram for the method proposed is shown in Figure 3.

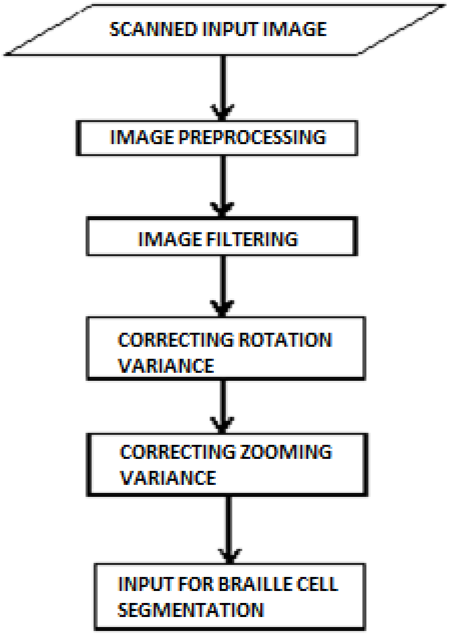

SCANNED INPUT IMAGE
IMAGE PREPROCESSING
IMAGE FILTERING
CORRECTING ROTATION VARIANCE
CORRECTING ZOOMING VARIANCE
INPUT FOR BRAILLE CELL SEGMENTATION

Figure.3. Block diagram of proposed method

The Braille document is scanned and taken as input. The scanned document is converted to gray scale and the noises are removed using Gaussian filter. To identify the dots, the image is convolved with the Prewitt filter and thresholding the resulting image. The skew correction of the document is done in two steps. First the rotation is corrected which is followed by scale correction. The Braille dots are represented as white and non-dots are represented as black in the resulting binary image.

### 3.1 Rotation Correction

Since the document is scanned, the maximum tilt is assumed to be 4 degrees in clockwise or anticlockwise direction. The extreme coordinate of the white dots are used to identify the direction of the tilt.

Let $x_{min}$ and $x_{max}$ represent the minimum and maximum x coordinates of the white dots. Their corresponding y values are represented as $y(x_{min})$ and $y(x_{max})$ respectively. Then the conditions in Eq(1) and (2) specify the anticlockwise and clockwise rotation as illustrated in Figure.4. and Figure.5 respectively.

$$(x_{min})<y(x_{max}) \tag{1}$$

$$y(x_{min}) >y(x_{max}) \tag{2}$$

If both conditions fail then the document is not rotated.In the rotated document the global $y_{min}$ is identified and vertical lines are drawn to the first encountered white dots from $y_{min}$. The dots are chosen only if its Y value falls in the range $[y_{min},T]$, where T represents a threshold.

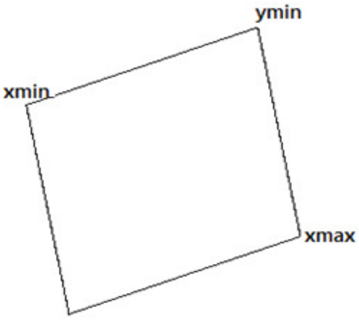


Figure.4. Sample image for anticlockwise rotation

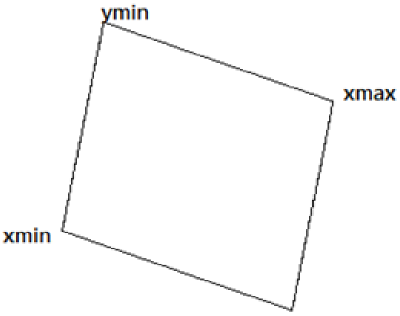


Figure.5. Sample image for clockwise rotation

A straight line is fit on the dots selected such that it minimizes the squared deviations of observed Y co-ordinates from any alternative line as in Eq(4).

$$y'_i= a + b\ x_i \tag{3}$$

$$\sum e_i^2=\sum (y_i - y'_i)^2 \tag{4}$$

Where $y_i$ is actual y value, $x_i$ is independent variable x value at $i^{th}$ position, $y'_i$ is the predicted value of dependent variable, *a* is a constant which representsthe point at which the line crosses the Y axis when X = 0, b is regression slope, $\sum e_i^2$is the sum of squared errors in prediction. The angle made by this line with the x-axis is calculated and identified as the tilt angle 'α'. The sign of the tilt angle varies based on the direction of rotation. The rotation is corrected by applying the geometric transformation matrix as given in equation (5).

$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} \cos\alpha & \sin\alpha & 0 \\ -\sin\alpha & \cos\alpha & 0 \\ 0 & 0 & 1 \end{bmatrix} \text{x} \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} \tag{5}$$

## 3.2 Scale Correction

The tilt corrected image is used for scale correction to fit the Braille document to standard measurements. The binary image when projected on to Y axis gives the frequency of the white dots for each horizontal line. A zero frequency signifies the horizontal blank lines, which may occur between dots and between characters. A similar projection on X axis gives the frequency of white dots for each vertical line. A zero frequency here signifies the vertical blank lines that occur between dots and between characters. The presence of dots varies depending on the Braille character, hence the distance between the dots and characters also vary. To get a reasonable judgement of the distances, a sufficiently large sub-window near the top left corner is considered. This portion of the image is cropped such that the left and top blank lines are removed. The centroids of the dots in the cropped image are considered for further processing. The ratios of the horizontal distance between characters to distance between dots remain same irrespective of horizontal scaling factor. It ranges from 2.6 to 2.78. A similar concept is applicable for vertical distance ratio, which ranges from 2.08 to 2.54. The horizontal distance between every successive pair of dot centroids are calculated. If the ratio of the distance falls in the specified range those distances are considered. Since the ratio falls in a range, the most frequently occurring value is found and its corresponding distance is used for calculating the scaling factor as shown in equation (6)

$$Sf = \frac{distance\,of\ chosen\ cell}{standard\ distance} \tag{6}$$

Where $S_f$ is the scaling factor. The standard distance differs according to the dpi of the input image.For a 100 dpi image, pixel-mm equivalence could be found as follows. We know,

$$1\text{ inch}=25.4\text{ mm} \tag{7}$$

$$100\text{ pix/inch}=100\text{pix}/25.4\text{mm} \tag{8}$$

$$1\text{mm} = 100\text{ pix}/25.4=3.93\text{ pix} \tag{9}$$

Hence from the Braille cell dimension the standard horizontal distance between characters varies from 23.58 to 25.15 pixels, the standard vertical distance between characters varies from 39.3 to 47.16 pixels. Once the scaling factor is known the image is de-scaled to standard size using scaling inverse transformation matrix in equation (10).

$$\begin{bmatrix} x \\ y \\ 1 \end{bmatrix} = \begin{bmatrix} 1/p & 0 & 0 \\ 0 & 1/q & 0 \\ 0 & 0 & 1 \end{bmatrix} \text{x} \begin{bmatrix} x' \\ y' \\ 1 \end{bmatrix} \tag{10}$$

where p and q are the scaling factors obtained in horizontal and vertical direction from the input image respectively and (x’,y’) are input pixel values and (x, y) are their corresponding output pixels.

Simple Braille cell overlapping could be done on the scale corrected image. The extracted cells can converted to Braille characters which can then be mapped to the corresponding alphabet as in [7].

## 4. EXPERIMENTAL RESULTS

Several Braille documents of different dpi’s (say 100,300,400,600) were taken as input for both scaling and rotation correction. The result shown below refers to documents of 100 dpi. A portion of the scanned Braille document is shown in Figure.6.

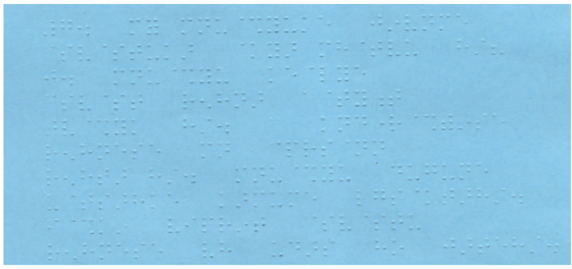


Figure.6. Scanned input image

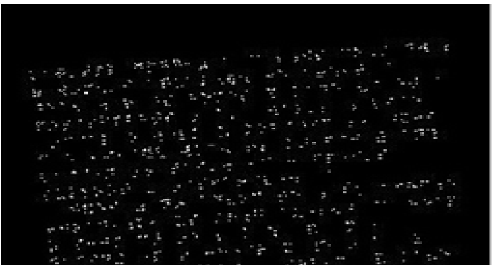


Figure.7. Binary image

The image is pre-processed and converted into binary image as discussed in previous section. A portion of the binary image is shown in Figure.7.

## 4.1 Rotation

The first occurring white dot when tracing vertically up to a threshold distance T is found. All such dots along the horizontal direction is indicated by vertical yellow lines in Figure.8. These dots are horizontally joined by the cyan line.

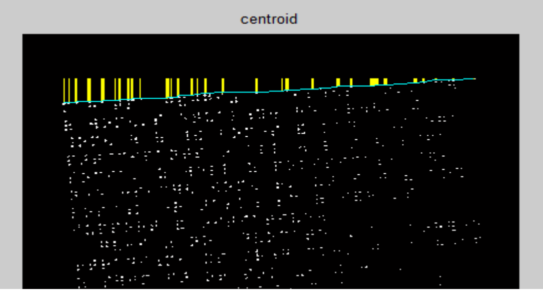


Figure.8 Before line fitting algorithm

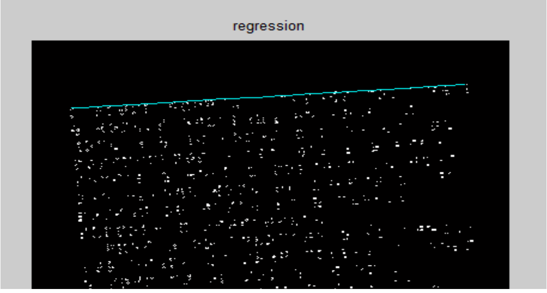


Figure.9. After line fitting algorithm

Image obtained after using line fitting algorithm for the dots which are lying in the cyan line in the Figure.8 is shown in the Figure 9

The coordinates of dots so obtained are plotted as shown in Figure.10. It also shows the line with minimum error.

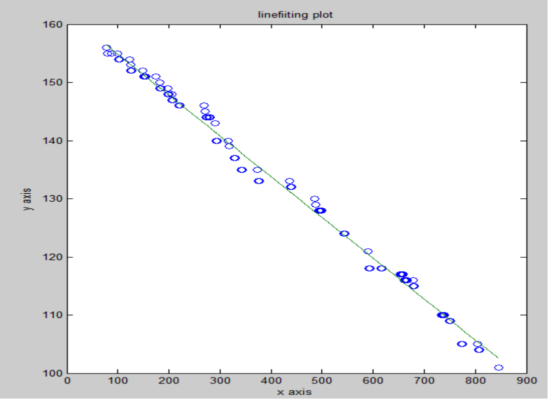


Figure.10 (a)graph for anticlockwise line fitting

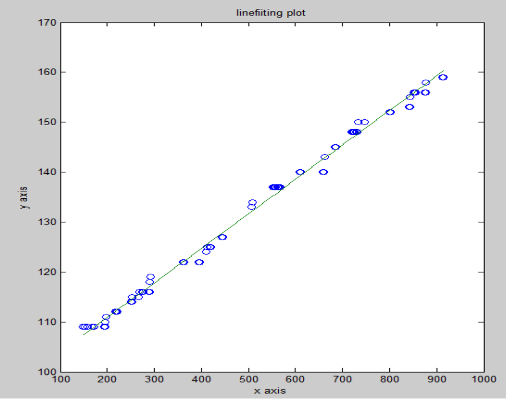


Figure.10(b)graph for clockwise line fitting

The final image obtained after removing tilt is shown in Figure.11.

The actual rotation angle ($\theta$) the starting point and end point before line fitting ($S_b$ and $E_b$) and after line fitting ($S_l$ and $E_l$), the experimentally calculated angle $\theta_c$ and mean error of line fitting $M_{err}$ are tabulated for different anticlockwise rotation angle in Table.1. A similar listing is done for clockwise rotation angle in Table.2.

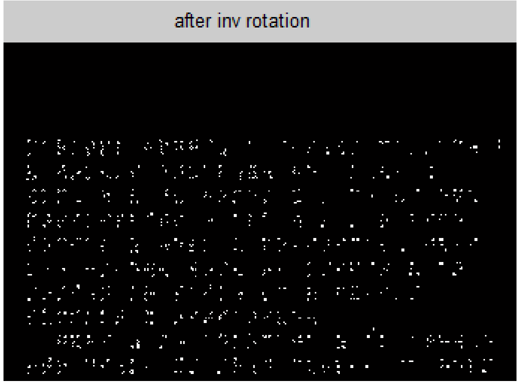


Figure.11. Re-rotated image

Table.1 anticlockwise rotation

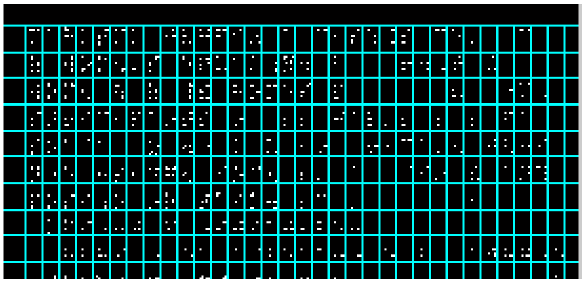
| Actual $\theta$ | -4 | -3 | -2 | -1 |
|---|---|---|---|---|
| Start point ($S_b$) | (79,155) | (77, 144) | (79,137) | (73,116) |
| End point ($E_b$) | (845,101) | (843,102) | (850,107) | (844,103) |
| Start point ($S_l$) | (79,156) | (77,143) | (79,136) | (73,115) |
| End pt ($E_l$) | (845,103) | (844,103) | (850,107) | (844,102) |
| $\theta_c$ | -4.01 | -2.99 | -2.177 | -0.97 |
| $M_{err}$ | -2.24 | -2.04 | 5.35 | -1.69 |

Table.2 clockwise rotation

| Actual $\theta$ | 4 | 3 | 2 | 1 |
|---|---|---|---|---|
| Start point($S_b$) | (915,159) | (897,144) | (883,136) | (861,116) |
| End point($E_b$) | (149,109) | (140,108) | (126,110) | (141,106) |
| Start point($S_l$) | (915,160) | (897,145) | (883,137) | (861,116) |
| End pt ($E_l$) | (149,107) | (140,107) | (126,109) | (141,105) |
| $\theta_c$ | 3.95 | 2.89 | 2.09 | 0.91 |
| $M_{err}$ | -4.06 | 5.53 | -4.40 | 8.31 |

## 4.2 Scaling

The image obtained as a result of rotation correction is given as input for scaling correction. Horizontal and vertical projections profiles are calculated. The horizontal and vertical lines with zero frequency after eliminating consecutive zeros are identified as Braille cell boundary and are shown in blue in Figure.12.



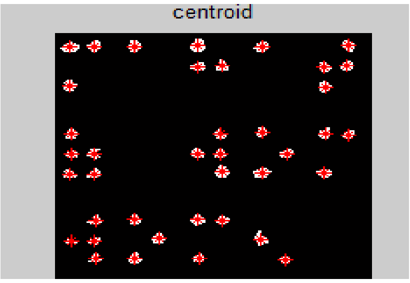


Figure.12 Image after Profiling

Figure.13. image with centroids marked

To decide the scaling factor and the ratio, 4 standard distances are considered. These distances are calculated with the dot centres as reference.

**Case 1:** distance in horizontal direction within the same cell ($w_h$), which is 2.3 mm or 9.04 pixels for a standard Braille cell (Std $w_h$).

**Case 2:** distance in horizontal direction between 2 consecutive cells ($b_h$). This distance according to standard measurement ranges from 6-6.4mm i.e. 23.58 to 25.15 pixels (Std $b_h$).

**Case 3:** distance in vertical direction within the same cell ($w_v$), whose standard measurement is 2.5mm or 9.82 pixels (Std $w_v$).

**Case 4:** distance in vertical direction between 2 consecutive Braille cells ($b_v$). This distance according to standard measurement ranges 10.4 to 12.7 mm or 39.3 to 47.16 pixels (Std $b_v$).
Part of the profiled image is cropped and the centroids of each Braille dot are marked red in colour as shown in Figure. 13. From the cropped image the distances and ratios are calculated as specified in section 3. The top 3 most frequently occurring ratios that fall within the valid range and their counts are tabulated in Table.3 for various % of scaling. The horizontal distance values ($w_h$ and $b_h$) for the most frequently occurring ratio is listed in Table.4. Factr1 and Factr2 represent the horizontal scale factor which are calculated from $w_h$ and $b_h$ respectively using the formula

$$\text{Factr1} = w_h \div \text{Std}(w_h) \tag{11}$$

$$\text{Factr2} = b_h \div \text{Std}(b_h) \tag{12}$$

Table.3. Horizontal Ratio-count

| size % | Ratio | | | Count | | |
|---|---|---|---|---|---|---|
| | r1 | r2 | r3 | c1 | c2 | c3 |
| 25 | 2.60 | 2.64 | 2.69 | 6 | 3 | 2 |
| 50 | 2.61 | 2.68 | 2.72 | 3 | 3 | 2 |
| 75 | 2.66 | 2.70 | 2.60 | 5 | 2 | 1 |
| Orig | 2.70 | 2.64 | 2.67 | 4 | 2 | 2 |
| 125 | 2.64 | 2.75 | 2.68 | 4 | 2 | 1 |
| 150 | 2.61 | 2.66 | 2.73 | 3 | 1 | 1 |
| 175 | 2.60 | 2.73 | 2.76 | 3 | 2 | 1 |

Table.4 Horizontal distance and scale factor

| Dist<br>% | Within char ($w_h$) | Betwn char ($b_h$) | Ratio $b_h \div w_h$ | Factr 1 | Factr 2 |
|---|---|---|---|---|---|
| 25 | 2.3 | 6 | 2.6 | 0.25 | 0.24 |
| 50 | 4.67 | 12.2 | 2.61 | 0.51 | 0.49 |
| 75 | 6.9 | 18.36 | 2.66 | 0.76 | 0.75 |
| Orig | 9.04 | 24.47 | 2.7 | 1 | 1 |
| 125 | 11.43 | 30.25 | 2.64 | 1.26 | 1.24 |
| 150 | 13.56 | 35.45 | 2.61 | 1.5 | 1.45 |
| 175 | 16.38 | 42.58 | 2.6 | 1.81 | 1.74 |

A similar procedure is adopted for vertical distances. The valid vertical ratios range from 2.08 to 2.54. Factr3 and Factr4 in the Table.6 represent the vertical scale factors, calculated from $w_v$ and $b_v$ respectively using the formula

$$\text{Factr3} = w_v \div \text{Std}(w_v) \tag{13}$$

$$\text{Factr4} = b_v \div \text{Std}(b_v) \tag{14}$$

Table.5 Vertical Ratio-count

| size % | Ratio | | | Count | | |
|---|---|---|---|---|---|---|
| | r1 | r2 | r3 | c1 | c2 | c3 |
| 25 | 2.16 | 2.41 | 2.34 | 4 | 2 | 2 |
| 50 | 2.19 | 2.22 | 2.10 | 3 | 2 | 1 |
| 75 | 2.21 | 2.32 | 2.25 | 4 | 2 | 1 |
| Orig | 2.24 | 2.43 | 2.35 | 3 | 2 | 2 |
| 125 | 2.25 | 2.15 | 2.41 | 4 | 2 | 1 |
| 150 | 2.26 | 2.12 | 2.38 | 3 | 1 | 1 |
| 175 | 2.24 | 2.36 | 2.17 | 3 | 2 | 1 |

Table.6 Vertical distance and scale factor

| Dist<br>% | Within char ($w_v$) | Between char ($b_v$) | Ratio ($b_v \div w_v$) | Factr3 | Factr 4 |
|---|---|---|---|---|---|
| 25 | 4.61 | 10 | 2.16 | 0.26 | 0.25 |
| 50 | 9.04 | 19.87 | 2.19 | 0.50 | 0.49 |
| 75 | 13.48 | 29.9 | 2.21 | 0.76 | 0.74 |
| Orig | 17.74 | 39.9 | 2.24 | 1.00 | 1.00 |
| 125 | 22.18 | 49.8 | 2.25 | 1.25 | 1.24 |
| 150 | 25.9 | 58.65 | 2.26 | 1.46 | 1.48 |
| 175 | 31.04 | 69.8 | 2.24 | 1.75 | 1.74 |

To show the calculated distance between the Braille cells in horizontal and vertical direction, the centroids of the dots are marked in yellow colour in (Figure.14). The distance between one

Braille character to another which lie in the range of standard measurement in either direction are marked in yellow colour in the figure.

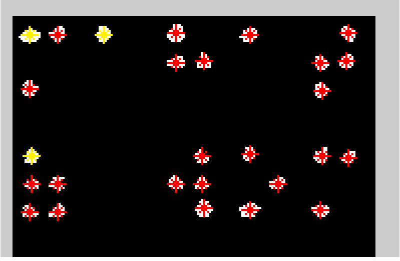


Figure.14. Horizontal and vertical distances

## 5. CONCLUSION

Extraction of text from the Braille document images requires skew detection and correction like normal document images. The skew detection for Braille documents is more challenging because it consists of dots only. This paper suggests a line fitting based skew correction method. The presence of noises could be mistaken for dots and hence noise removal and binarization process plays an important role in skew angle detection. A simple template matching could be used for Braille character extraction when the scale of the scanned document agrees with the standard measurement. The scale factor of the skew corrected image is calculated using the ratio of within character distance to between character distance.The arbitrary presence of dots is eliminated comparing with standard range and the maximum is calculated by voting system.

Braille documents when created manually, there is a possibility that the Braille dots may not be in a straight line, can be slanting between characters. This kind of skews could not be corrected by the method. An algorithm for skew correction for 180 degrees has to be modelled in future.

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# GAUSSIAN KERNEL BASED FUZZY C-MEANS CLUSTERING ALGORITHM FOR IMAGE SEGMENTATION

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### ABSTRACT

*Image processing is an important research area in computer vision. clustering is an unsupervised study. clustering can also be used for image segmentation. there exist so many methods for image segmentation. image segmentation plays an important role in image analysis.it is one of the first and the most important tasks in image analysis and computer vision. this proposed system presents a variation of fuzzy c-means algorithm that provides image clustering. the kernel fuzzy c-means clustering algorithm (kfcm) is derived from the fuzzy c-means clustering algorithm(fcm).the kfcm algorithm that provides image clustering and improves accuracy significantly compared with classical fuzzy c-means algorithm. the new algorithm is called gaussian kernel based fuzzy c-means clustering algorithm (gkfcm)the major characteristic of gkfcm is the use of a fuzzy clustering approach ,aiming to guarantee noise insensitiveness and image detail preservation.. the objective of the work is to cluster the low intensity in homogeneity area from the noisy images, using the clustering method, segmenting that portion separately using content level set approach. the purpose of designing this system is to produce better segmentation results for images corrupted by noise, so that it can be useful in various fields like medical image analysis, such as tumor detection, study of anatomical structure, and treatment planning.*

### KEYWORDS

*CLUSTERING, K-MEANS, FCM, KFCM, GKFCM*

## 1. INTRODUCTION

Image segmentation plays crucial role in many applications, such as image analysis and comprehension, computer vision, image coding, pattern recognition and medical images analysis. Many algorithms have been proposed for object segmentation and feature extraction [1]. In this method, a clustering algorithm for medical and other image segmentation will be considered. Clustering is useful in several exploratory pattern-analysis, grouping, decision-making, and machine-learning situations, including data mining, document retrieval, image segmentation, and pattern classification. However, in many such problems, there is little prior information (e.g., statistical models) available about the data, and the decision-maker must make as few assumptions about the data as possible. It is under these restrictions that clustering methodology is particularly appropriate for the exploration of interrelationships among the data points to make an assessment (perhaps preliminary) of their structure. Clustering is a process of partitioning or grouping a given

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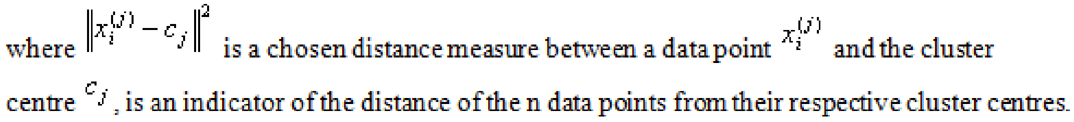
set of unlabelled objects into a number of clusters such that similar objects are allocated to one cluster. There are two main approaches to clustering [2].One method is crisp clustering (or hard clustering) ,and the other one is fuzzy clustering. A characteristic of the crisp clustering method is that the boundary between clusters is fully defined. However, in many cases, the boundaries between clusters cannot be clearly defined. Some patterns may belong to more than one cluster. In such cases, the fuzzy clustering method provides a better and more useful method to classify these patterns. The FCM employs fuzzy partitioning such that a data pixel can belong to all groups with different membership grades between 0 and 1.FCM is an iterative algorithm. The aim of FCM is to find cluster centers (centroids) that minimize objective function. The KFCM is derived from the original FCM based on the kernel method [3].KFCM algorithm is extended which incorporates the neighbor term into its objective function [4].Fuzzy clustering is a widely applied method for acquiring fuzzy patterns from data and become the main method of unsupervised pattern recognition. Drawback for FCM algorithm is sensitive to noise or outlier. Drawbacks of FCM were solved by introducing KFCM .In Wu and Gao's paper [5], the Mercer Kernel based method was investigated. They proposed the KFCM algorithm which is extended from FCM algorithm. It is shown to be more robust than FCM .N.A.Mohamed , M.N.Ahmed et al.[6] described the application of fuzzy set theory in medical imaging. In the proposed system, the content set for the various MRI real time images is used to calculate the low intensity area in the in homogeneity form will attain best result for the segmentation and outperforms existing techniques resulting in better accuracy and predicting factor. This method is applicable in different scale of image for different orientation in segmenting the images. Intensity In homogeneity images based Clustering approach is used to overcome the curve in the images, to represent the pure segmented images. Here in previous approach such as Fuzzy c means it fails to target the clustered set point, which fits in the imperfect noisy scaled images in the analysis domain, process of imperfection occurrence in the images due to overlap of the pixel with the different intensity, outcomes lower cluster segmentation in the minimum level for MRI images. GKFCM clustering approach will calculate the estimated parameter automatically for the image data. The clustering process is applied in MRI medical image, for separate group according to their pixel intensity, which is done with the process called Kernel based Fuzzy C means clustering. Where kernel value is selected based on the activities of the membership function. Group of features will selected based on the proper tuning rate of the kernel value, helps in detecting the region separately, level based segmentation is analyzed to detect the intensity region separately, when it comes to in homogeneity Medical images, it is a difficult task for this approach to identify the low intensity region, it can be done by applying the suitable filters to process those images. Initial Impact in clustering of medical images is the drawback in extracting the biological features and it became difficult in identifying the clustered region in similar part of the medical images. Reduction of inhomogeneity in the noisy Medical Images is the extreme end task, and analyzing it feature is open problem and challenging task which yields less attention of approach, which effect the less segmentation accuracy.

## 2. LITERATURE SURVEY

### 2.1 K-Means Algorithm

K-means is one of the simplest unsupervised learning algorithms that solve the well known clustering problem. The procedure follows a simple and easy way to classify a given data set through a certain number of clusters (assume k clusters) fixed a priori. The main idea is to define k centroids, one for each cluster. These centroids shoud be placed in a cunning way because of different location causes different result. So, the better choice is to place them as much as possible far away from each other. The next step is to take each point belonging to a given data set and associate it to the nearest centroid. When no point is pending, the first step is completed and an early groupage is done. At this point we need to re-calculate k new centroids as barycenters of the clusters resulting from the previous step. After we have these k new centroids, a new binding has to be done between the same data set points and the nearest new centroid. A loop has been generated. As a result of this loop we may notice that the k centroids change their location step by step until no more changes are done. In other words centroids do not move any more. Finally, this algorithm aims at minimizing an objective function, in this case a squared error function. The objective function

$$J = \sum_{j=1}^{k} \sum_{i=1}^{n} \left\| x_i^{(j)} - c_j \right\|^2 ,$$



where $\left\| x_i^{(j)} - c_j \right\|^2$ is a chosen distance measure between a data point $x_i^{(j)}$ and the cluster centre $c_j$ , is an indicator of the distance of the n data points from their respective cluster centres.

**ADVANTAGES**

1) K-Means algorithm is very fast.
2) It is robust and easier to understand.
3) Relatively efficient in the sense it runs in O(tknd) where t is the number of iterations ,k is the number of Clusters ,n is the number of objects and d is the dimension of each object.

**DISADVANTAGES**

1) K-Means algorithm requires a priori specification of the number of cluster centers.
2) If there are two highly overlapping data then k-means algorithm will not be able to resolve that there are two clusters and is said to be the use of exclusive assignment.
3) It is not invariant to non-linear transformations in the sense we get different results with different representation of data. Data represented in form of cartesian co-ordinates and polar co-ordinates will give different results.
4) It provides the local optima of the squared error function.
5) Randomly choosing of the cluster center cannot lead to the good result.
6) Applicable only when mean is defined.
7) Unable to handle noisy data and outliers.
8) It fails for non-linear data set.

## 2.2. The Fuzzy C Means Clustering Algorithm(FCM)

The fuzzy c-means (FCM) algorithm is one of the most traditional and classical image segmentation algorithms. The FCM algorithm can be minimized by the following objective function. Consider a set of unlabeled patterns X, let X={x1,,x2,. ..,xN}, x ∈ Rf, where N is the number of patterns and f is the dimension of pattern vectors (features). The FCM algorithm focuses on minimizing the value of an objective function. The objective function measures the quality of the partitioning that divides a dataset into c clusters. The algorithm is an iterative clustering method that produces an optimal c partition by minimizing the weighted within group sum of squared error objective function. Fuzzy c-means (FCM) is a method of clustering which allows one piece of data to belong to two or more clusters. This method is frequently used in pattern recognition. It is based on minimization of the following objective function

$$J_m = \sum_{i=1}^{N} \sum_{j=1}^{C} u_{ij}^{m} \left\| x_i - c_j \right\|^2 \quad , \quad 1 \leq m < \infty$$

where m is any real number greater than 1, $u_{ij}$ is the degree of membership of $x_i$ in the cluster j, $x_i$ is the i$^{th}$ of d-dimensional measured data, $c_j$ is the d-dimension center of the cluster, and ||*|| is any norm expressing the similarity between any measured data and the center. Fuzzy partitioning is carried out through an iterative optimization of the objective function shown above, with the update of membership $u_{ij}$ and the cluster centers $c_j$ by

$$U_{ij} = \frac{1}{\sum_{k=1}^{c} \left[ \frac{\left\| x_i - c_j \right\|}{\left\| x_i - c_k \right\|} \right]^{\frac{2}{m-1}}} \qquad C_j = \frac{\sum_{i=1}^{N} U_{ij}^{m} x_i}{\sum_{j=1}^{N} U_{ij}^{m}}$$

This iteration will stop when $\max_{ij}\left\{\left|u_{ij}^{(k+1)} - u_{ij}^{(k)}\right|\right\} < \varepsilon$, where $\varepsilon$ is a termination criterion between 0 and 1, whereas k are the iteration steps. This procedure converges to a local minimum or a saddle point of $J_m$.

**ADVANTAGES**

1) FCM gives best result for overlapped data set.

2) It is comparatively better than k-means algorithm.

3) Data point is assigned membership to each cluster center as a result of which data point may belong to more than one cluster center whereas in the case of k-means algorithm data point must exclusively belong to one cluster center.

**DISADVANTAGES**

1) FCM requires a priori specification of the number of clusters.

2) Euclidean distance measures can unequally weight underlying factors.

3) We get the better result with lower value of β but at the expense of more number of iterations.

## 2.3.The Kernel Fuzzy C Means Clustering Algorithm(KFCM)

The KFCM algorithm adds kernel information to the traditional fuzzy c-means algorithm and it overcomes the disadvantage that FCM algorithm can't handle the small differences between clusters. . The kernel method maps nonlinearly the input data space into a high dimensional feature space. The essence of kernel-based methods involves performing an arbitrary non-linear mapping from the original d-dimensional feature space Rd to a space of higher dimensionality (kernel space). The kernel space could possibly be of infinite dimensionality. The rationale for going to higher dimensions is that it may be possible to apply a linear classifier in the kernel space while the original problem in the feature space could be highly non-linear and not separable linearly . The kernel method then takes advantage of the fact that dot products in the kernel space can be expressed by a Mercer kernel K. Thus the distance in the kernel space does not have to be explicitly computed because it can be replaced by a Mercer kernel function (typically referred to as a kernel trick). There are two major forms of kernel-based fuzzy clustering. The first one comes with prototypes constructed in the feature space. These clustering methods will be referred to as KFCM-F (with F standing for the feature space). In the second category, abbreviated as KFCM-K, the prototypes are retained in the kernel space and thus the prototypes must be approximated in the feature space by computing an inverse mapping from kernel space to feature space. The advantage of the KFCM-F clustering algorithm is that the prototypes reside in the feature space and are implicitly mapped to the kernel space through the use of the kernel function.

## 3. GKFCM

Given, $X = \{x_1, \dots x_n\} \subset R^p,$ the GKFCM partitions X into $c$ fuzzy subsets by minimizing the following objective function

**Equation 1**

$$J_m(U,V) = \sum_{i=1}^{c} \sum_{k=1}^{n} U_{ik}{}^{m} \left\| x_k - v_i \right\|^2$$

Where $c$ is the number of clusters and selected as a specified value in this paper, $n$ the number of data points, $u_{ik}$ the membership of $x_k$ in class $i$, satisfying $\sum_{i=1}^{c} u_{ik} = 1$, $m$ the quantity controlling clustering fuzziness, and $V$ the set of cluster centers or prototypes ($v_i \in R^p$). The function $J_m$ is minimized by a famous alternate iterative algorithm.

Now consider the proposed Gaussian kernel fuzzy c-means (GKFCM) algorithm. Define a nonlinear map as

$\Phi : x \rightarrow \Phi(x) \in F$

Where $x \in X$ . X denotes the data space, and F the transformed feature space with higher even infinite dimension. GKFCM minimizes the following objective function

**Equation 2**

$$J_m(U,V) = \sum_{i=1}^{c} \sum_{k=1}^{n} U_{ik}{}^{m} \left\| \phi\,(x_k) - \phi\,(v_i) \right\|^2$$

Where

**Equation 3**

$$\left\| \phi(x_k) - \phi(v_i) \right\|^2 = K(x_k, x_k) + K(v_i, v_i) - 2K(x_k, v_i)$$

Where $K(x, y) = \Phi(x)^T \Phi(y)$ is an inner product kernel function. If we adopt the Gaussian function as a kernel function, i.e.,

$K(x,y) = exp(-\|x - y\|^2 / \sigma^2)$, then $K(x,x) = 1$, according to Eqs. (3), Eqs. (2) Can be rewritten as

**Equation 4**

$$J_m(U,V) = 2\sum_{i=1}^{c}\sum_{k=1}^{n} U_{ik}{}^{m}\left(1-k(x_k,v_i)\right)$$

Minimizing Eqs. (4) under the constraint of $u_{ik}$ , we have

**Equation 5**

$$u_{ik} = \frac{\left(1/(1-k(x_k,v_i))\right)^{\frac{1}{m-1}}}{\sum_{j=1}^{c}\left(1/(1-k(x_k,v_i))\right)^{\frac{1}{m-1}}}$$

**Equation 6**

$$V_i = \frac{\sum_{k=1}^{n} U_{ik}^{m}\ K(x_k,v_i)x_k}{\sum_{k=1}^{A} U_{ik}^{m}\ K(x_k,v_i)}$$

Here we just use the Gaussian kernel function for simplicity. If we use other kernel functions, there will be corresponding modifications in Eqs. (5) and (6).

In fact, Eqs.(3) can be viewed as kernel-induced new metric in the data space, which is defined as the following

**Equation 7**

$$\mathrm{d(x,y)} = \left\|\phi(\mathrm{x_k}) - \phi\ (\mathrm{v_i})\right\| = \sqrt{2(1-\mathrm{k(x,y)})}$$

And it can be proven that d(x, y) defined in Eqs. (7) is a metric in the original space in case that $K(x,y)$ takes as the Gaussian kernel function. According to Eqs. (6), the data point $x_k$ is endowed with an additional weight $K(x_k, v_i)$ , which measures the similarity between $x_k$ and $v_i$ , and when $x_k$ is an outlier, i.e., $x_k$ is far from the other data points, then $K(x_k, vi)$ will be very small, so the weighted sum of data points shall be more robust

## <u>CLUSTERING ALGORITHM APPLICATIONS</u>

- Clustering Algorithm can be used in Identifying the Cancerous Data Set.
- Clustering Algorithm can be used in Search Engines.
- Clustering Algorithm can be used in Academics.
- Clustering Algorithm can be used in Wireless Sensor Network 's Based Application.
- Clustering Algorithm can be used in Drug Activity Prediction.

## 4. RESULTS

The experiments and performance evaluation were performed on medical images including a CT image of the MR image of brain The GKFCM clustering and the pro-posed kernel based fuzzy level set method were implemented with Matlab R2013a (MathWorks, Natick, MA, USA) in a Windows 7 System Ultimate. All the experiments were run on a VAIO Precision 340 computer with Intel i3 and 4GB RAM.

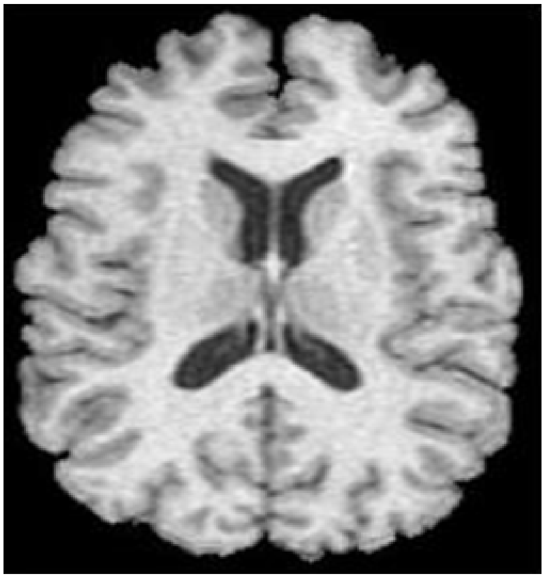


Figure 1 : Original Image

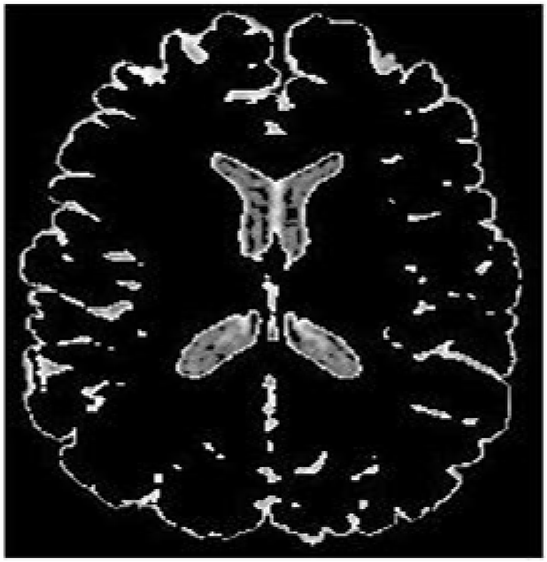


Figure 2 : Cluster 1

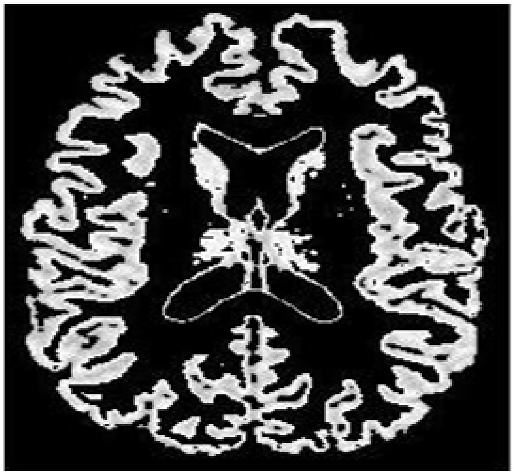


Figure 3 : Cluster 2

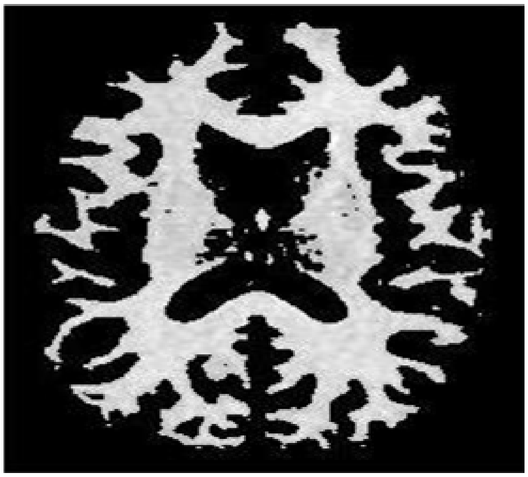


Figure 4 : Cluster 3

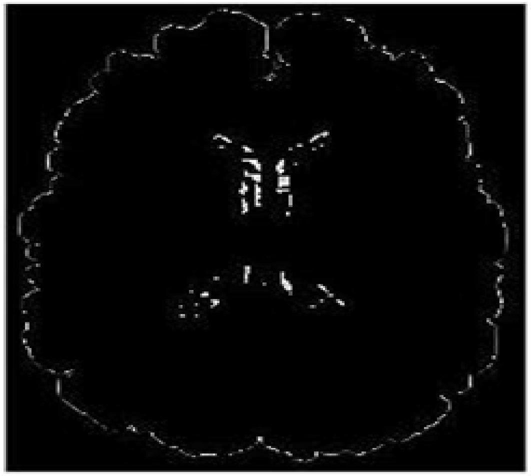


Figure 5 : Cluster 4

## 5. CONCLUSION

Clustering is one of the efficient techniques in medical and other image segmentation. The primary advantage of the research work is that it includes the kernel method, the effect of neighbour pixel information to improve the clustering accuracy of an image, and to overcome the disadvantages of the known FCM algorithm which is sensitive to the type of noises. The aim of this paper is to propose a new kernel-based fuzzy level set algorithm for automatic segmentation of medical images with intensity in homogeneity. It employs Gaussian kernel-based fuzzy clustering as the initial level set function. It can approximate the boundaries of ROI with parameter estimation simultaneously well. It provides noise-immunity and preserves image details. It can be useful in various fields like medical image analysis, such as tumor detection, study of anatomical structure, and treatment planning

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# SELECTION OF BEST ALTERNATIVE IN MANUFACTURING AND SERVICE SECTOR USING MULTI GRADE DECISION APPROACH - A REVIEW

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## *ABSTRACT*

*Modern manufacturing organizations tend to face versatile challenges due to globalization, modern lifestyle trends and rapid market requirements from both locally and globally placed competitors. The organizations faces high stress from dual perspective namely enhancement in science and technology and development of modern strategies. In such an instance, organizations were in a need of using an effective decision making tool that chooses out optimal alternative that reduces time, complexity and highly simplified. This paper explores a usage of new multi criteria decision making tool known as MOORA for selecting the best alternatives by examining various case study. The study was covered up in two fold manner by comparing MOORA with other MCDM and MADM approaches to identify its advantage for selecting optimal alternative, followed by highlighting the scope and gap of using MOORA approach. Examination on various case study reveals an existence of huge scope in using MOORA for numerous manufacturing and service applications.*

## *KEYWORDS*

*MADM, MCDM, MOORA, optimization, manufacturing sector, service sector*

## 1. INTRODUCTION

In modern trend, manufacturing organizations tend to face versatile challenges due to globalization, modern lifestyle trends and rapid market requirements from both locally and globally placed competitors [30] [34]. Modern organizations were in a need to improve their overall performance in market and build up a competitive advantage [32]. To improve the overall performance, organization had to deliver enhanced quality products for pacifying the customers [17]. The delivery of embarked quality products was commonly differentiated into three index values such as customer expected level, satisfaction level and achieved level of quality [12]. The improvement in satisfaction level of quality was declined, since many conventional manufacturing units faces high stress from dual perspectives namely enhancement in science and

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technology that consequence towards developing of modern strategies and versatile customer requirements [36] [24]. There exist numerous theories, models and approaches that reveal the change in a paradigm shift from craft manufacturing towards mass manufacturing, lean manufacturing and agile manufacturing [36] [35] that reduces the stress from conventional manufacturing units. The change up in a paradigm shift internally had made managers in conventional units to reconsider their decision making ability for selecting the best production system [24]. The concept selection through decision making was an imperative approach that nurtures creative and innovative ideas by thriving towards choosing of optimal alternative [33], based on values, beliefs and perceptions [7] [11]. Decision makers in manufacturing and service sector select an optimal alternative with a set of conflicting objectives through dynamic mind set [15]. All the aforementioned statements reveals, manufacturing and service organization faces a stressful task on decision making due to dynamic decision makers ability for choosing the best alternative.

In present days, organizations were in a need of using an effective decision making tool that gives out optimized results from discrete inputs within a shorter period of time with effective decision making ability. The ameliorating emphasize on decision making purely depends on decision makers mantling of onerous circumstances in versatile competitive environment [23] to choose the optimal alternative with conflicting criteria's. Optimal selection of alternatives based on set of conflicting criteria's involves optimization a tool that deals with a kind of problem which either maximizes or minimizes the single or multi objectives was a numerical functions of real or integer variables [3]. The optimization in general was broadly classified into single objective optimization (SOO) and multi objective optimization (MOO) problem. The main goal of SOO was to find the best value of objective function for making up an optimal solution by satisfying set of feasible solution [3]. The SOO selects the best alternative by using approaches such as calculus based techniques, enumerative and random techniques involving genetic algorithm (GA) and simulation annealing (SA) [3]. The numerical methods or calculus based methods uses necessary and sufficient conditions for satisfying solution in optimization problem. Numerical methods were further classified into direct and indirect search methods for selecting optimal solution. Enumerative techniques involve each and every point of finite and infinite search space to attain an optimal solution [3]. In many real life problem, we face a circumstance were improvement in one objective leads to impact on another objective basically known as MOO that perform parallel optimizing of two or more conflicting objectives that leads to automation, semi automation in industrial applications [3] [17]. The MOO were applicable in numerous applications such as product and process design, network analysis, finance, aircraft design [3] [17]. The usage of MOO in above said fields along with maintenance optimization was to choose the best responses through nature of information that can be either qualitative or quantitative [1]. The qualitative measurements of input information to quantitative assessment of output falls upon using multi-criteria decision making (MCDM) method like analytical hierarchy process (AHP), game theory and fuzzy sets that are used for identifying the imperative criteria's and alternatives [26] [7].There exists approaches like elimination and choice translation reality (ELECTRE), preference ranking organization method for enrichment and evaluation (PROMTHEE) that uses quantitative assessment of data by comparing little criteria. The method like decision making trial and evaluation laboratory (DEMATEL) evaluates and creates the casual relationship within the criteria's [29]. There are also approaches like verbal decision analysis (VDA) that deals with qualitative data assessment to provide qualitative results [7]. In literature's their avail usage of other approaches for solving MOO problem they are such as aggregating, population based pareto and non pareto approach, vector evaluated genetic algorithm (VEGA), multi objective GA (MOGA), non-dominated GA (MSGA) and niched pareto GA (PGA) [3].

During the second part of twenty century, MCDM method proves to be an emerging area in operational research for identifying the optimal options that impacts multiple of conflicting criteria's [31]. The MCDM method was broadly classified into multi attribute decision making (MADM) and multi objective decision making (MODM) approach [31]. The MADM approach was the ranking of best alternative with most attractive attributes [8]. Unlike MADM approaches, MODM method designs the best alternative with multiple objectives that depends on continuous decision variables subject to certain constraints [9]. The endemically used MADM approaches for identifying the optimal solutions with discrete alternatives were namely taguchi method, desirability function, response surface methodology (RSM), inner/outer orthogonal array (I/O OA), technique for order preference by similarity to ideal solution(TOPSIS), VIseKriterijumska Optimizacijai kompromisno Resenje in Serbian (VIKOR), complex proportional assessment(COPRAS), grey relational analysis(GRA),multi objective optimization on the basis of ratio analysis (MOORA) that converts MOO problem into SOO [17]. This paper exposes a use of quantitative assessment method namely MOORA that proves to be a foreseen MADM approach over other approaches with high stability, robustness and less computational time for selecting optimal alternative by satisfying set of conflicting criteria. The study on MOORA is explored in two fold manner, initially the MOORA have been compared with aforesaid MCDM and MADM approaches to identify its usability and advantage for selecting optimal alternative. On other side, paper highlights scope and gap of using MOORA approach through intensify examining of case studies in manufacturing and service sector that propel the empirical benefits of MOORA.

The hierarchical nomenclature of the study starts with methodology in part-2,literature review on usage of MOORA in manufacturing and servicing sector in part-3,gap assessment in part-4 and conclusion in part-5.

## 2. METHODOLOGY

An endemic theory and pragmatic evaluation on optimization, SOO and MOO approaches were said to be available in different web of knowledge portals and conference proceedings. There avail accessibility of articles related on applicability of optimization, SOO and MOO in manufacturing and service sector on leading elite citation databases namely Taylor and Francis (www.tandfonline.com), Science direct (www.sciencedirect.com), Springer link (www.springerlink.com), control and cybernetics (http://control.ibspan.waw.pl:3000/mainpage), journal of military and information sciences (www.jmisci.com), engineering economics (www.inzeko.ktu.lt/index.php/EE).In the initial stages of surveying articles, the searching starts with journals titled on optimization, SOO and MOO in manufacturing and service sector from year 2000 to present in aforementioned web of knowledge portals. There exist myriad of articles to limit the search by making a shift from optimization, SOO and MOO towards empirical usage of MOORA that reduces the list to 38.In final list of 38 articles the 23 articles uses the MOORA concept by differentiating 11 cases on manufacturing sector and remaining 12 on service sector as shown in Figure 1.

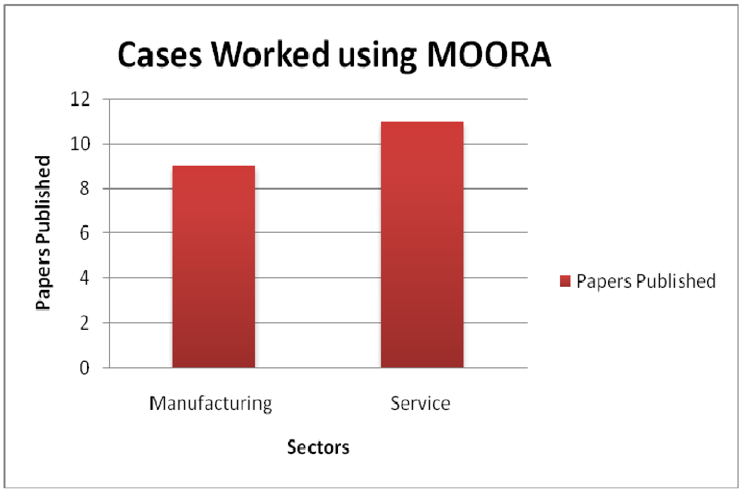

Figure-1. Papers on MOORA in manufacturing and service sector

Finalized list of articles are thoroughly overviewed to identify the intensify realization on using MOORA for achieving good manufacturing growth, profit with high stability, robustness and less computational time for selecting optimal alternative with set of conflicting criteria in discrete cases.

## 3. MULTI OBJECTIVE OPTIMIZATION ON THE BASIS OF RATIO ANALYSIS (MOORA)

In real time, making up of optimal decision to satisfy the customer proven to be a focal part in manufacturing sector [11]. MOORA a MADM approach was used to attain the best solution among given discrete alternatives with conflicting objectives [17]. In early stages multiplicative form of generating dimensionless numbers were elaborated by Scharling (1985) and Brauers (1997, 1999, 2002 and 2004) with later stages there evolve a usage of ratio analysis approach with respective to dimensionless measure known as MOORA [8]. MOORA a cardinal approach isolates extreme and non-convex points by providing insight to mid-way solution as per economical law of decreasing marginal utility [10]. MOORA was first introduced by Brauers and Zavadaskas in the year 2006[8] [10] [19]. MOORA was proven to be a robustic approach over minkowski, Euclidean distance metric, tchebycheff min max metric [10]. In MOORA, performing of Multi response optimization or MOO was done by satisfying constraints and feasible solution. The MOORA was viewed as a ratio and reference point system [2].

MOORA as an approach satisfies the seven conditions to be looked foreseen over other MADM or MODM techniques [8] [11]. MOORA proves to be a best MADM approach for attaining optimal decisions within less computational time and no usage of extra parameters like $v$ in VIKOR and $\xi$ in GRA method [11] [2]. The MOORA have merits over other MADM approaches as compared and revealed in Table 1. The comparisons illustrate, MOORA chooses best alternative with high simpleness, less computational time and with basic mathematical calculations [2]. The second phase of this review article will elaborately corroborate on empirical benefits of using MOORA with other MADM methods through various case studies in manufacturing and service sector as discussed briefly.

## 3.1.Literature Review on MOORA

Manufacturing sectors are those involving numerous activities from production of a pin to assembling of part types for making up a complex structure. Manufacturing covers mass production, job shop and batch production that are a real wealth for any country in terms of employment and constitute as the back bone for service sector [37].Service sector are those that pacify the daily commercial need of the human being by catering them with high loyalty. The numerous cases for choosing the best alternative from conflicting objectives by using MOORA in manufacturing and service sectors are discussed through intensify realization.

Table-1**.** Comparison of MOORA with MADM approaches

| **MADM method** | **Computational Time** | **Simplicity** | **Mathematical calculations required** |
|---|---|---|---|
| MOORA | very less | very simple | Minimum |
| AHP | very high | very critical | Maximum |
| ANP | Moderate | Moderately critical | Moderate |
| GRA | very high | very critical | Maximum |
| VIKOR | Less | Simple | Moderate |
| GTA | very high | very critical | Maximum |
| ELECTRE | High | Moderately critical | Moderate |
| DEA | very high | very critical | Maximum |
| TOPSIS | Moderate | Moderately critical | Moderate |
| PROMTHEE | High | Moderately critical | Moderate |

### 3.1.1.MOORA in manufacturing sector

[22] Espouses the study on using AHP and MOORA for choosing the best of wire electronic discharge machining (WEDM) process. The study was conducted by using taguchi OA for identifying the best value for multi objective responses material removal rate, kerb width and surface roughness, on other side AHP a best MCDM approach had been used for conducting the weight and consistency for the three aforesaid responses along with usage of multi criteria decision making approach known as MOORA for choosing the best WEDM. The experimentation using OA choses one among best input parameters such as pulse on time, pulse off time, wire feed rate, wire tension, servo voltage and flushing pressure. Evaluation through AHP reveals the subjective weight for the three criteria as w1 =0.5469, w2=0.3445, w3=0.1085 with consistency ratio (CR<0.1). Similarly the usage of MOORA with Taguchi OW reveals the optimal trial as 19 out of 27 trial to give the best of material removal rate, kerb width and surface roughness in WEDM process.

[25] Portrays as study on choosing the best non-traditional machining process for the laboratory in national institute of technology-agartala. The cross functional team had been formed that comprises of individuals from NIT for chosing the best non-traditional machine. The team had used two new multi criteria or attribute decision making approach such as MOORA and multi

objective optimization on the basis of simple ratio analysis(MOOSRA) for chosing the best among seven alternatives such as ultrasonic machining(USM), abrasive jet machining (AJM), electrochemical machining (ECM), EDM, WEDM, Electrical Beam Machining (EBM) and laser beam machining (LBM). The analysis, brainstorming session reveal the imperative criteria as tolerance, surface finish, power requirement, material removal rate, cost, tooling and fixture, tool consumption, safety, work material and shape feature. The team perform the analysis in two fold manner initially to calculate the weight of criteria using AHP followed by choosing the best among seven non-traditional machining process using MOORA and MOOSRA. Normalization, consistency and performance score reveal the ranking of EDM with first rank followed by ECM and EBM with USM at penultimate position concluded by ECM.

[27] Portrays that critical empowerment faced by purchasing managers was the performance evaluation and monitoring of suppliers that can provide high success for an organization. The choosing of best among four suppliers was covered in this study that makes up supplier selection a multi criteria problem that include both tangible and non-tangible factors. The four suppliers cater a chemical and bio technology concern in India. In Initial phase, data had been mined from chemical and biotechnological industries through a questionnaire and then performing evaluation through 1-5 likert scaling. The results obtained from likert scaling reveals four imperative criteria's in chemical and biotechnological concern namely total cost, quality service, on-time delivery and pollution causing factors. In next phase, fuzzy along with MOORA approach had been applied to choose the best among four suppliers who satisfies aforesaid criteria's by generating decision matrix. Evaluation through MOORA and fuzzy illustrate supplier 1 as best over other three of them to cater chemical and biotechnology concern. In future, fuzzy MOORA a simplified approach for engineers\managers will find a very easy way in suitable applications.

[17] Espouses on pragmatic usage of MOORA for converting MOO to SOO. The problem had been looked after effectively by taking up a case in washing machine manufacturing concern in turkey. By prolong instigation on shop floor in washing machine manufacturing concern reveals the controllable factors in washing machine as depth of washing machine body side panel (A), washing machine's body panel thickness (B), insulation type of washing machine motor (C) and belt thickness of washing machine motor (D) that impacts dual responses namely noise level of the washing machine in dB with lower the better (LB) quality characteristics and spin revolution of entered resonate with higher the better (HB) quality characteristics by varying all at two levels. The experimental study had been conducted using taguchi level-8 orthogonal array (OA) with ten replications for each treatment combination in washing machine and selection of optimal alternative was done using MOORA. Result Analysis through MOORA based taguchi design reveals input optimal condition as washing machine body panel to be new, washing machine body thickness as 0.9, insulation type of washing machine motor as type-A and belt thickness at nominal range. The results derived through taguchi MOORA are compared with taguchi GRA, taguchi TOPSIS and taguchi VIKOR that shows out MOORA as a best optimization tool for modelling in industrial application. In the verge of future, MOORA can be used in similar applications with dependence.

[15] Investigated a study on applying MOORA for solving MOO problem in six various welding processes such as submerged arc welding, gas tungsten arc welding, gas metal arc welding, $CO_2$ laser welding and friction stir welding. The study corroborate an insight on comparing results of GA, taguchi method(TM), GRA, support vector regression (SVR),generalized reduced gradient method (GRG) and neural network (NN) with MOORA in six various welding process. In submerged arc welding, the TM with GRA was hybridized for monitoring heat affecting zone,

bed width, penetration and reinforcement using process input such as slog mix, basicity index and current. The results reveal MOORA gives alike ranking as TM with GRA. Similarly, an experimental study on monitoring front height, front width, back height and back width in gas tungsten arc welding was taken up using TM for getting best weld bead geometry. The optimal condition obtained using TM provide comparable results with MOORA. Study on monitoring ultimate tensile strength (UTS) was done using SVR in gas metal arc welding that provides a reasonable comparable ranking with MOORA. Monitoring of best optimal welding parameters in $CO_2$ laser welding was done using GA and performing generations by NN provides the worthy comparison on ranking with MOORA. Dual studies were done in friction stir welding for monitoring UTS using GRA, whose results were better with MOORA evaluation. The comparison of other MODM approach with MOORA reveals MOORA as a highly flexible, applicable and potential approach in solving complex decision making problems. In future, MOORA method can be used for solving various selection problems in real time manufacturing environment.

[2] Illustrate that making up of decision for flexible manufacturing system (FMS) proves to be an intrication of satisfying numerous criteria's with conflicting attributes. This paper studies out usage of MOORA for performing decision making through sceptical amalgamation of various stratum in production system. The problem on choosing appropriate product design for power electronic device was taken as a case to choose best of ten alternatives by satisfying three different attributes namely manufacturing cost, junction temperature and thermal cycles. The optimal decision on choosing best of ten was done using MOORA. The evaluation through MOORA reveals design 5 and 1 as best that gets correlated with alternative selection already performed using AHP. In similar way, problem on choosing four alternative plant layouts was studied up by considering five performance attributes. The study also makes up a comparison between MOORA and weighed Euclidean distance based approach (WEDBA) that reveals layout design 2 as best and 1 as worst using both approaches. In similar way, choosing of best FMS was studied up by comparing MOORA result with AHP that reveals FMS2 as best with FMS 4 occupies least in performance ranking in both cases. The ranking of best method for performing welding process to join mild steel(0.2% of C) of 6mm thickness was done by considering three welding process namely shield metal arc welding(SMAW), gas tungsten arc welding(GTAW) and gas metal arc welding (GMAW) with six attributes. Optimization analysis through MOORA reveals SMAW as best among three processes with GMAW occupying last position. The study on using MOORA to choose best among twenty suppliers was done by performing evaluation through DEA in agricultural and construction equipment by satisfying five criteria's. The evaluation illustrate supplier 10 as best among others. In future, MOORA a simple ratio analysis approach with less mathematical calculations have a wide scope of developing using software like C++ language.

[18] Conducted a study on selection of material that plays a focal part in design and functioning of products. The study reveals that selection of material can be done in least complicated manner with high applicability, simplicity and accuracy using MOORA, reference point theory and full multiplicative from of MOORA (MULTIMOORA) by looking out four various case studies. In initial case, the choosing of appropriate material for designing a flywheel was done using four criteria's with ten different materials that was already analyzed through TOPSIS. Analyization reveals material 9 as imperative and 10 as menial. Results obtained through TOPSIS were compared with MOORA, MULTIMOORA and reference point approach that gives out same ranking. In second case, material selection was done for building up a cryogenic storage tank by choosing seven different materials along with seven performance criteria's for storing nitrogen.

The evaluation made-up through MOORA, reference point and MULTIMOORA reveals material 3 as best and material 2 as worst ranked for building up a cryogenic tank. Third case study chooses a material for a product that was to be operated at high temperature in oxygen rich environment using six various materials and four criteria's. Analysis through MOORA was compared with MULTIMOORA and reference point approach reveals material 5 as best with material 1 in last position. The final case study uses up a simplified fuzzy logic to choose the best material for sailing boat mast. The study chooses fifteen different materials with five performance criteria's. Data analysis through fuzzy logic reveals same results as MOORA, MULTIMOORA and reference point by ranking material 15 as best suited material for sailing boat mast. In later days, MOORA, MULTIMOORA and reference point approaches can be applied with other decision making scenario with more criteria's and alternatives.

[28] Espouses that MCDM method provides an opportunity for choosing frequently acceptable alternatives based on conditions that are stated using criteria. There exist numerous MCDM methods such as compromise programming, AHP, TOPSIS, ELECTRE, PROMTHEE, COPRAS, VIKOR and additive ratio assessment (ARAS). This article explores an extension of MOORA method to be used along with triangular fuzzy numbers by integrating with ratio system and reference point system in fuzzy environment. The case was taken up in a mining company that scheduled to start up exploitation of new mine in serbia. The problem faced by mining company was the transportation distance to new mine from existing location for performing grinding that was expensive. To avoid from these problem experts like's to consider three alternatives of grinding circuit design such as A1,A2 and A3 that should pacify five criteria's namely grinding efficiency, economic efficiency, technological reliability, capital investment costs and environmental impact. Choosing of best grinding circuit design was done in two fold manner initially by using fuzzy ratio system with MOORA by determining overall fuzzy performance index, de-fuzzyfication and selection of desirable alternatives that reveals grinding circuit design A3 as dominating over A1 and A2.On other side, fuzzy reference point system with MOORA was done for choosing the best design by calculating the distance between fuzzy ratings and reference point that reveals grinding circuit design A3 as dominating in Serbian mining company. In future, MOORA method can be used as a basis for research and authors depending on the problem solved by choosing relevant one.

[14] Diligently erudite that decision making process prove to be highly arduous especially in assessing the appropriateness of a project from engineering standpoint. The case covers selecting best of five profitable investment projects that can levy high growth and prosperity for an organization. Selection of projects involves complications that was overcome through newly proposed MOORA method along with standard deviation (SDV) . MOORA a MCDM method was used for choosing the best alternative with conflicting criteria's whose difference in significance among objectives can be evaluated using SDV. The four important criteria's chosen for study were net present value (NPV),rate of return(ROR),payback Period(PB) and project risk (PR) in manufacturing organization that can provide profitable investments. Evaluation made-up through MOORA and SDV identifies project 3 as best that provides highest NPV, ROR with lowest PB and PR followed by project 2 and quelled by project 5.In future, MOORA can be combined with other MCDM methods.

[11] Illustrate an accustom challenges of global competitiveness in manufacturing organization makes them to spurt over effective decision making ability for identifying and choosing the best alternative. This study acclimatise a new MODM approach namely MOORA for evaluating and choosing six decision making problems in advance manufacturing system (AMS). The initial

selection was made on industrial robot by comparing six various criteria's. The comparison reveals robot 2 (cybo tech V15) as best and robot 5(PUMA 500/600) occupying the worst ranking. In same implication, the setting up of FMS was done by comparing seven different alternatives such as FMS1 to FMS7 and judging using MOORA reveals alternative FMS7 as best with alternative FMS8 occupying last position. In similar way, MOORA had been used for selecting best machine tool, non traditional machining (NTM) process, rapid prototyping (RP) process, computerized numerical control (CNC) and automated inspection system to obtain the best AMS. In future, MOORA has a huge scope of applying with wide range of problems in real time manufacturing environment.

[16] Espouses milling operation was a pure metal cutting process done using a rotary cutter. The productivity and competitiveness of economical usage in machining operations plays a salient role by selecting best cutting parameters in process planning of metal parts. The six different decision making problems in milling process was chosen as a case by using a potential, flexible and applicable MOORA method. The first case uses MOORA evaluation in side milling process to identify the optimal process parameters such as cutting speed, feed rate, axial depth of cut, radial depth of cut for controlling material removal rate (MRR). The evaluation was already done using grey-fuzzy and graph theory matrix analysis (GTMA) that makes up a comparable ranking with MOORA method. Similarly, MOORA was used along with grey-taguchi, TM to evaluate the best process parameters for controlling average surface roughness, average tool life in end milling, side milling, end milling, face milling and milling process. The comparability study on six various decision making problems tangibly illustrate MOORA as highly stable, simple and easy to implement decision making approach with less mathematical calculations. Thus provides the applicability, potentiality and flexibility of using MOORA in milling process.

### 3.1.2. MOORA in service sector

[13] Concentrate on assessing the performance of Indian technical education system. In modern era, the technical education system faces an onerous task due to liberalization and globalization of Indian economy. The study had been conducted to assess the performance of seven Indian institute of technology (IIT) such as Kharagpur, Bombay, Madras, Kanpur, Delhi, Guwahati and Roorkee. Evaluation parameters to assess the performance of aforesaid IIT had been chosen as faculty strength, student intake, number of Ph.D. awarded, number of patents applied, campus area in acres and tuition fees per semester. Evaluation was done using a nuance multi criteria analysis based performance evaluation known as subjective and objective weight integrated approach (SOWIA) and MOORA, the SOWIA approach had been used for calculating integrated, objective and subjective weights of each criteria for assessing the IIT with MOORA used for ranking the optimal OOT with effective criterion ranking. Usage of SOWIA and MOORA reveals IIT- Kharagpur as best among other six IIT in India. The robustness of obtained output had been assessed using sensitivity analysis and comparison was made with AHP-COPRAS using non parametric spearman test of relationship (rs) and Kendall's Tau Test (Z) reveals the result as alike obtained from SOWIA-MOORA approach.

[21] Espouses a study in special education and rehabilitation centre that were introduced for individuals to create a cosy living environment for nurturing their skills by achieving self reliance. The case was taken up by tapping three different special education and rehabilitation centre namely nida, parilti and ilgim in turkey. The best of choosing mentioned three rehabilitation centres was done by satisfying six various criteria's such as education, ergonomics, compliance of corporation building, cost, publication with prestige and assessment of personal

prestige. Initially, the weights of criteria were evaluated using triangular fuzzy numbers with AHP followed by choosing a best rehabilitation centre out of three was evaluated using MOORA and MULTIMOORA. Calculation results through MOORA and MULTIMOORA reveals nida as best special education and rehabilitation centre followed by ilgim and parilti. In future, same case can be analysed using grey numbers with subsequent comparison over other MCDM method.

[38] Erudite, alternative design solutions for building can be successful by applying MCDM methods with number of quantitative and qualitative criteria's. The main objective of current research work was to test the reliability of previously proposed methods such as weighed aggregated sum product assessment (WASPAS), orthogonal experimental design (OED), ARAS and multi objective particle swarm optimization algorithm (MOPSO).The case covers the selection of best design for facades in public or commercial buildings. The four building facades were chosen namely cellular concrete masonry covered by Rockwell plates and decorative plaster surface, sandwich facade panels, gas silicate masonry with Rockwell, minerit façade plates and aluminium gazing facades. Evaluation was done initially through WASPAS by varying λ value from 0 to 1 for monitoring the robustness of chosen optimal facade in building design that reveals sandwich facade panels as best in the range of varying λ from 0 to 0.4 and aluminium gazing facade being good with varying λ from 0.5 to 1.Comparable manipulation through MOORA's ratio, reference point and MULTIMOORA approach reveals "sandwich" panel as best for public façade.

[31] Espouses decision making was the searching of optimal alternatives from available feasible solutions. In real time, findings of optimal alternative effects the versatile conflicting criteria's for judging the decisions which are commonly known as MCDM approach. This paper explores an extension of MOORA, reference point and ratio analysis approach by integrating with interval grey number. Initially, MOORA had been used along with interval grey numbers followed by simultaneous usage of crisp and interval grey numbers and finally with interval grey numbers and whitening coefficient. MOORA also had been compared with simple additive weightage (SAW), TOPSIS, VIKOR and COPRAS. In first case, the optimal alternatives were evaluated using COPRAS compared with MOORA and interval grey numbers that show up both the rankings are alike. The second case takes up a comparison of MOORA with crisp and interval grey numbers along with SAW Grey analysis (SAW-G) by performing normalization, optimization that reveals par in ranking. In third case, MOORA was applied with interval grey numbers to eliminate the uncertainty by comparing with COPRAS Grey analysis (COPRAS-G) that gives out comparable ranking in decision makers pessimistic, optimistic and moderate mind set. The conclusion made up overall is, usage of MOORA with extensive measures provide simple and effective solution for real world problems.

[5] Portrays, a country is a group of regions that contributes towards GDP by producing a value added products. The Vilnius gediminas technical university takes up a study on mapping out multiple criteria's for sustainable development in cities and countries of Lithuania .The study on regional sustainable development in Lithuania cities were done by selecting ten Lithuania cities such as vilinus,klaipeda,Kaunas,telsiai,utena,alytus,panevezys,siauliai,marijampole and taurage. Regional development through GDP contribution on each region's was identified by selecting sixteen various attributes that rove to be focal. Study uses MOORA over other MADM and MODM approaches, since MOORA was a well-being, cardinal approach that puts up customer sovereignty as an emphasize goal. MOORA chooses best of Ten Lithuania Cities through effective contribution for well-being economy that can provide good material wealth, health, education, all kind of security and concerning the environment. The evaluation through

normalization, optimization and importance leaves Vilnius, Klaipeda and Kaunas as good wellbeing districts with telsiai, taurage and Siauliai occupies poorer position. The paper also shows out an effective project that can be tapped in industrialization and construction, commerce and tourism, labour drain to improve the GDP in Lithuanian country. In future, commercialization and industrialization on Lithuanian cities with decline labour drain over abroad would isolate vulnerability in well-being of inhabitants.

[19] Illustrate that pragmatic usage of building design was to acclimatize towards ameliorated and embody living environment conditions with a cosy surrounding by controlling energy losses in building. Heat energy losses in building can be controlled to a large extent by properly selecting external wall and window. This study investigate the selection of six various wall and window for building design such as A1, A2, A3, A4, A5 and A6 on four directions by satisfying seven various criteria such as heat loss through building wall, building windows, bearer thermal bridges, above rated air infiltration, external heat inflows in the building, total heat consumption with external walls and window price ratio. The criteria's representing heat losses were non-beneficial with heat flow and price ratio being beneficial. Mathematical manipulation through MOORA, MULTIMOORA and reference point theory reveals A2 reduces heat energy losses in building followed by A6 or A3 with A1, A4 and A5 was isolated by decision makers. The MOORA and MULTIMOORA theoretical model proven to be effective in real life situation can be successfully applied in solving utility problem in other sectors.

[4] Portrays in a broader sense that transition economies are making up of transition from plan to market. In 1990, countries of Soviet Union and central with Eastern Europe eradicate central planning, liberalized taxation, banking, customers and independent central banking. This study espouse on project management that are commonly used in a market economy. Project management predicts project for analyization that will make up a new economic activity by renovating existing economic activity. Project management involves combination of both micro and macro-economic objectives by selecting a case with multiple objectives in Wuhan, Hubei provenance, china. The empirical problem with Wuhan was to set up an inland seaport, since Wuhan was proximally located 1000 km inland. Choosing a best of three projects for setting up an inland port in Wuhan was a MOO problem that was verified using MOORA ratio system, reference point system, multiplicative form and MULTIMOORA. The chosen micro and macro-economic criteria's for project selection in this case were such as NPV, internal rate of return (IRR),PB, government income, Employment, value added (VA), risk, balance payment and investment. Technical evaluation through MOORA, multiplicative form and MULTIMOORA reveals project A as good for earning government income with project C increasing employment and project B occupies penultimate position.

[6] Reveal definition of robustness in econometrics was an error term in a linear equation that was broadened from a cardinal to qualitative one. The error term in linear equation was initiated by origin for robustness in econometrics. On other side, robustness was connected with residual terms, slack, dummy variables and outliers. The significance of robustness were explained in three fold ways first by considering robustness in cardinal scales, second by indicating the robustness as either vogue or arbitrary and finally by completeness in statistical universe with events and opinions. These interpretations are experimented by taking up a case in facility sector in Lithuania. Facility sectors are those performing servicing operations like acquisition, leasing, renting, managing, supervision, maintenance and repairing of existing buildings in private dwellings of Vilnius, capital of Lithuania. The study was done by selecting 15 largest maintenance contractors for performing facility operation in private dwellings of Vilnius by

having intensified discussion with a panel of 30 random dwelling owners in Vilnius. The panel suggests twenty criteria's for maintaining and choosing contractors in which eleven were expressed with rejection by choosing other nine criteria for study. Evaluation through MOORA and reference point approach ranks contractor 6 as first for size and experience with second for effectiveness followed by contractor 10 in second position for effectiveness and size succeeded by contractor 1 and contractor 4.A newer research based on newer data, larger samples and large number of quantifiable objective will increase the robustness of outcome.

[8] Illustrate that construction projects were reliable venture with peculiar features such as long period, tedious process and changing environment.The study narrowly focus on choosing best contractor, who plays a focal part in customer sovereignty of construction in building's. The choosing of best contractor was a multi criteria problem that should satisfy eligible criteria in dwellings of Vilnius, capital of Lithuania. This study chooses up the best contractor by using a new MODM approach namely MOORA in two fold manner initially through ratio and then using reference point analysis by making up a decision matrix for selecting best among fifteen contractors who satisfy aforementioned eligible criteria's. Manipulation through MOORA ratio analysis and reference point theory reveals contractor six as first for size, experience and second on effectiveness followed by contractor ten ranked first for effectiveness and second for size. Ranking on contractors reveals that neither of chosen contractors was cost effective. In later days, a newer research can be done with newer data, large samples and large number of quantified objectives using MOORA.

[7] Erudite that decision making proves to be an imperative part of human brain were values, belief and perceptions urge it to be successful. The case study maps out choosing of best road design in expanding a highway of Thuringia, Germany from 4 to 6 lanes using a MODM approach namely MOORA. The MOORA a MODM technique was used for making up the comparison between six various types of road design such as concrete surfacing with changing axis and gradient, asphalt concrete surfacing by changing axis and retaining gradient, concrete surfacing with changing axis and retaining gradient, asphalt concrete surfacing by changing axis and gradient, concrete surfacing with retaining axis and gradient and asphalt concrete surface with axis and retaining radiant. The five performance criteria's chosen for road selection were such as longevity, cost price, environment protection, economic validity and construction duration. Numerical manipulation, optimization and imperativeness through MOORA identifies the auspicious condition for laying road can be done by changing the axis and retaining the gradient of highway with concrete surfacing in Thuringia, Germany. The proposed model leaves a path to apply the MOORA a sceptical ratio analysis approach for solving similar utility problems in construction sector.

[20] Espouse that demand for purchasing newly build houses or apartments are growing high day in day out. During purchasing of houses, customers do pay high attention towards price, maintenance cost, living space, location Etc., by ignoring inner climate in houses. A cosy inner climate will eradicate propagating of bacteria's within the room along with controlling of vapour condensing and moulding. This article takes up a study to analyse the inner climate in five storied house in naujoji, Vilnia. The assessment of inner climate in ten living rooms of a five storied house was done by looking out six important criteria's such as air turnover ratio, air humidity, air temperature, illumination intensity, air flow rate and dew point. The data on each afore said criteria's for ten living rooms were obtained using metrel equipment MJ6201EU with calibrated certificate. Calculations were performed using MOORA, initially by making up decision matrix followed by normalizing, determining complex rationality and ranking that leaves out living room

7 as best with good air turnover ratio, air humidity, air temperature, illumination intensity with less air flow rate and dew point in five storied building. In future, the data obtained using MOORA method may be used in determining the market value of flats or apartments.

[10] Identifies a transition economy as previous accumulated economies of central and eastern Europe or Asia that were transpired into controlled market economies. This paper narrowly tailors on privatization in transition economy were the government or state enterprises are turned over into private owners. The salient goal of the study was to optimize privatization process in transition economy to increase the effectiveness of internal return rate (IRR), productivity and declining of payback period from management side. On other side, a study contribute on increasing macro economical attributes namely maximum of investments, employment and influence of current balance payment for assessing the privatization in transition economy. The article initially covers the comparison of MOORA with other reference point approaches like rank correlation, minkowski metric (1986), tchebycheff metric (1821-1894), Euclidean distance metric with additive weightage, TOPSIS. The comparison reveals MOORA gives priority to the mid way solutions by ranking it first within the convex zone over other approaches. The mentioned context urges to use MOORA with well being economy of transition in Lithuania, which gives customer sovereignty as highest preference attributes over productivity. The study was conducted by selecting three various projects such as project A,B and C to reveal the difference in ranking between MOORA and reference point approach that selects project A and B as first. The conclusion was made-up with contradicted results from two approaches by having Project A and C first rank for four objectives with no first rank for project B. The herewith comparison on three projects culminate that project A and C would dominate B at four dominating positions to give preference for obtaining better mid way solutions as per economic law of decreasing marginal utility. In later days, a newer research can be done with newer data, large samples and large number of quantified objectives.

## 4. GAP ASSESSMENT

The study conducted by various scholars in manufacturing and service sector illustrate, organization faces accustom challenges due to ineffective decision making that deteriorates priority and worthiness of decision makers. To overcome such a situation, organizations needs an aid of effective decision making tool that involves creative development and identification of options, clarity in judgement, firmness of decision and effective implementation that all can be done using MOORA. MOORA a pure cardinal approach was used effectively for solving real-time complex decision making problem in eleven cases of manufacturing and twelve cases of service sector as shown in Table 2 and Table 3.MOORA with such an empirical benefit have a wide scope of applicability in other manufacturing and service sector such as product and process design, network analysis, aircraft design, automobile design, thermal power plant, nuclear power plant, chemical industry, cement industry, hospitals, banks, schools, finance Etc. The usage of MOORA will allow decision makers to choose the best alternative within less computational time, high stability and reduce cost.

## 5. CONCLUSIONS

In this article, analysis on MOORA a MADM approach was done through various case studies in manufacturing and service sector that corroborate a usage of MOORA in two fold manner

- MOORA was compared with other endemically used MADM approaches that reveal, MOORA chooses best alternative with high simpleness, less computational time and basic mathematical calculations along with no usage of extra parameters like $v$ in VIKOR and $\xi$ in GRA method.

- In the second phase, intensified realization through sparse cases available in using MOORA was studied out to illustrate the imperative benefits and scope of applicability for solving real time empirical problems.

In future span, providing extension for MOORA,MOOSRA and MULTIMOORA (Multiplicative form of MOORA) using interval grey numbers and fuzzy have an wide scope in manufacturing and service sectors to eradicate vagueness, imprecision in decision maker subjectivity for choosing the best alternative with conflicting criteria.

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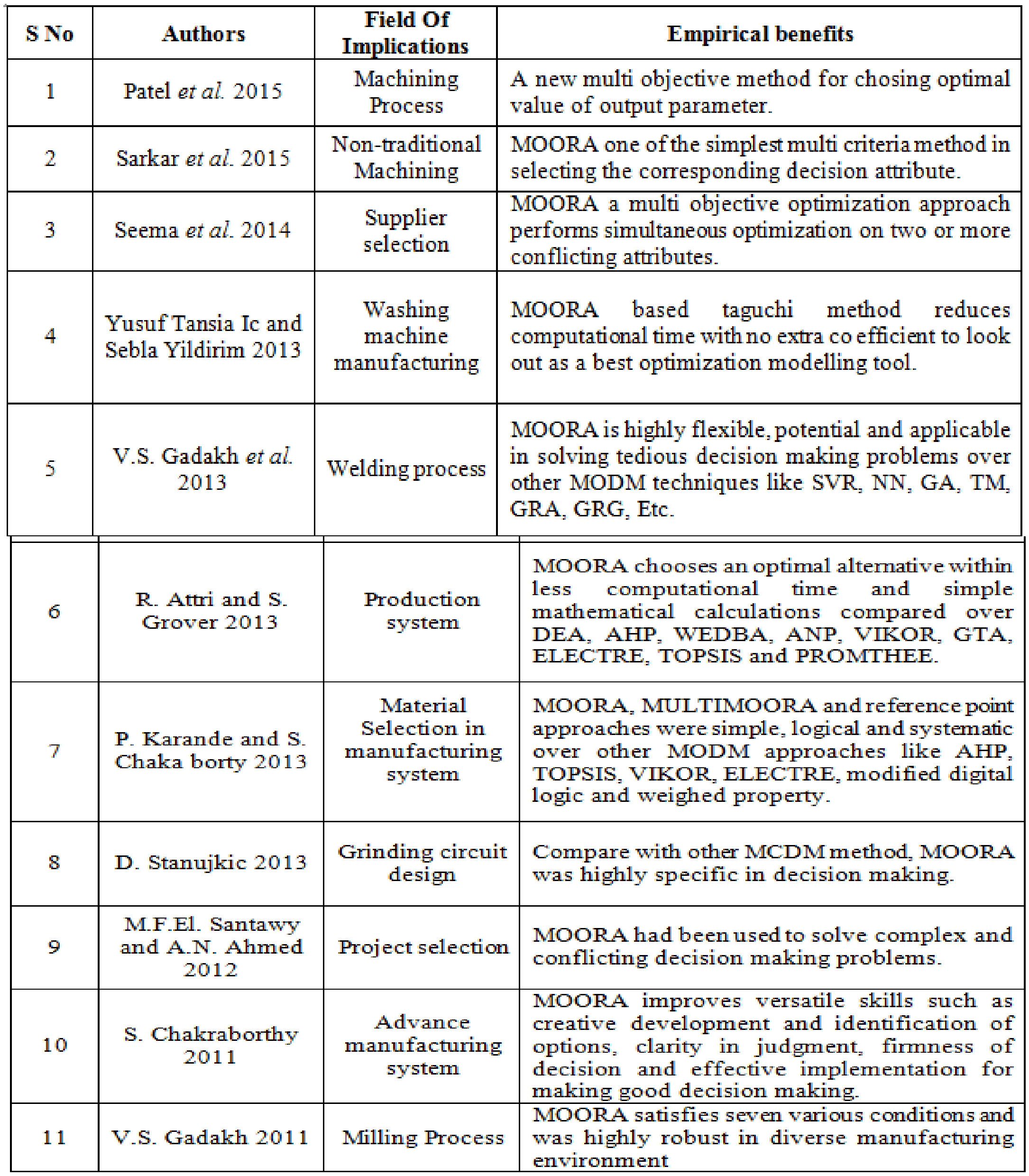
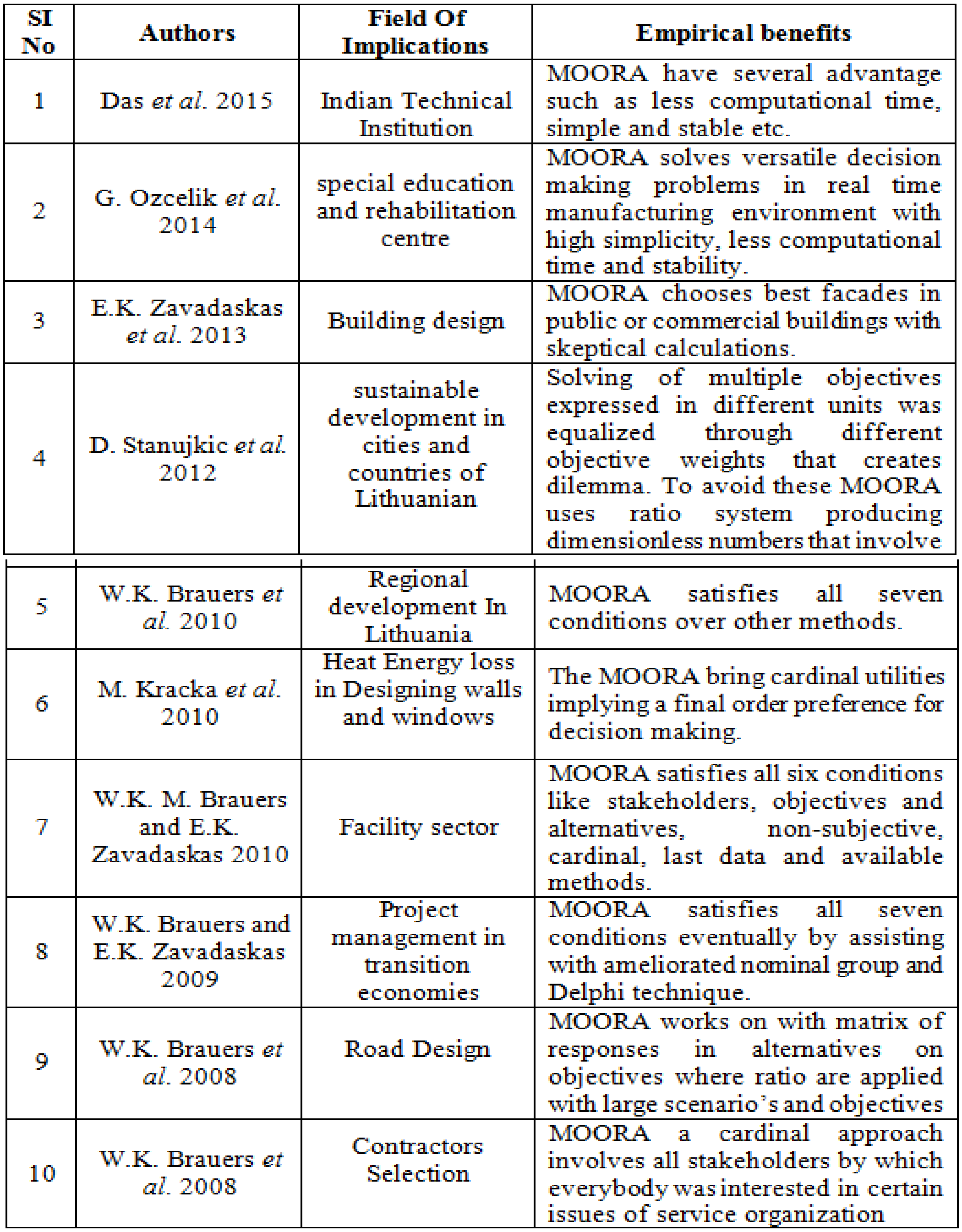
**Table-2.** MOORA applications in manufacturing sector.



| S No | Authors | Field Of Implications | Empirical benefits |
|---|---|---|---|
| 1 | Patel *et al.* 2015 | Machining Process | A new multi objective method for chosing optimal value of output parameter. |
| 2 | Sarkar *et al.* 2015 | Non-traditional Machining | MOORA one of the simplest multi criteria method in selecting the corresponding decision attribute. |
| 3 | Seema *et al.* 2014 | Supplier selection | MOORA a multi objective optimization approach performs simultaneous optimization on two or more conflicting attributes. |
| 4 | Yusuf Tansia Ic and Sebla Yildirim 2013 | Washing machine manufacturing | MOORA based taguchi method reduces computational time with no extra co efficient to look out as a best optimization modelling tool. |
| 5 | V.S. Gadakh *et al.* 2013 | Welding process | MOORA is highly flexible, potential and applicable in solving tedious decision making problems over other MODM techniques like SVR, NN, GA, TM, GRA, GRG, Etc. |
| 6 | R. Attri and S. Grover 2013 | Production system | MOORA chooses an optimal alternative within less computational time and simple mathematical calculations compared over DEA, AHP, WEDBA, ANP, VIKOR, GTA, ELECTRE, TOPSIS and PROMTHEE. |
| 7 | P. Karande and S. Chaka borty 2013 | Material Selection in manufacturing system | MOORA, MULTIMOORA and reference point approaches were simple, logical and systematic over other MODM approaches like AHP, TOPSIS, VIKOR, ELECTRE, modified digital logic and weighed property. |
| 8 | D. Stanujkic 2013 | Grinding circuit design | Compare with other MCDM method, MOORA was highly specific in decision making. |
| 9 | M.F.El. Santawy and A.N. Ahmed 2012 | Project selection | MOORA had been used to solve complex and conflicting decision making problems. |
| 10 | S. Chakraborthy 2011 | Advance manufacturing system | MOORA improves versatile skills such as creative development and identification of options, clarity in judgment, firmness of decision and effective implementation for making good decision making. |
| 11 | V.S. Gadakh 2011 | Milling Process | MOORA satisfies seven various conditions and was highly robust in diverse manufacturing environment |

Table-3. MOORA applications in service sector.



| SI No | Authors | Field Of Implications | Empirical benefits |
|---|---|---|---|
| 1 | Das *et al.* 2015 | Indian Technical Institution | MOORA have several advantage such as less computational time, simple and stable etc. |
| 2 | G. Ozcelik *et al.* 2014 | special education and rehabilitation centre | MOORA solves versatile decision making problems in real time manufacturing environment with high simplicity, less computational time and stability. |
| 3 | E.K. Zavadaskas *et al.* 2013 | Building design | MOORA chooses best facades in public or commercial buildings with skeptical calculations. |
| 4 | D. Stanujkic *et al.* 2012 | sustainable development in cities and countries of Lithuanian | Solving of multiple objectives expressed in different units was equalized through different objective weights that creates dilemma. To avoid these MOORA uses ratio system producing dimensionless numbers that involve |
| 5 | W.K. Brauers *et al.* 2010 | Regional development In Lithuania | MOORA satisfies all seven conditions over other methods. |
| 6 | M. Kracka *et al.* 2010 | Heat Energy loss in Designing walls and windows | The MOORA bring cardinal utilities implying a final order preference for decision making. |
| 7 | W.K. M. Brauers and E.K. Zavadaskas 2010 | Facility sector | MOORA satisfies all six conditions like stakeholders, objectives and alternatives, non-subjective, cardinal, last data and available methods. |
| 8 | W.K. Brauers and E.K. Zavadaskas 2009 | Project management in transition economies | MOORA satisfies all seven conditions eventually by assisting with ameliorated nominal group and Delphi technique. |
| 9 | W.K. Brauers *et al.* 2008 | Road Design | MOORA works on with matrix of responses in alternatives on objectives where ratio are applied with large scenario's and objectives |
| 10 | W.K. Brauers *et al.* 2008 | Contractors Selection | MOORA a cardinal approach involves all stakeholders by which everybody was interested in certain issues of service organization |

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# OCR-The 3 Layered Approach For Classification and Identification of Telugu Hand Written Mixed Consonants and Conjunct Consonants By Using Advanced Fuzzy Logic Controller

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## ABSTRACT

*Optical Character recognition is the method of digitalization of hand and type written or printed text into machine-encoded form and is superfluity of the various applications of envision of human's life. In present human life OCR has been successfully using in finance, legal, banking, health care and home need appliances. India is a multi cultural, literature and traditional scripted country. Telugu is the southern Indian language, it is a syllabic language, symbol script represents a complete syllable and formed with the conjunct mixed consonants in their representation. Recognition of mixed conjunct consonants is critical than the normal consonants, because of their variation in written strokes, conjunct maxing with pre and post level of consonants. This paper proposes the layered approach methodology to recognize the characters, conjunct consonants, mixed- conjunct consonants and expressed the efficient classification of the hand written and printed conjunct consonants. This paper implements the Advanced Fuzzy Logic system controller to take the text in the form of written or printed, collected the text images from the scanned file, digital camera, Processing the Image with Examine the high intensity of images based on the quality ration, Extract the image characters depends on the quality then check the character orientation and alignment then to check the character thickness, base and print ration. The input image characters can classify into the two ways, first way represents the normal consonants and the second way represents conjunct consonants. Digitalized image text divided into three layers, the middle layer represents normal consonants and the top and bottom layer represents mixed conjunct consonants. Here recognition process starts from middle layer, and then it continues to check the top and bottom layers. The recognition process treat as conjunct consonants when it can detect any symbolic characters in top and bottom layers of present base character otherwise treats as normal consonants. The post processing technique applied to all three layered characters. Post processing of the image: concentrated on the image text readability and compatibility, if the readability is not process then repeat the process again. In this recognition process includes slant correction, thinning, normalization, segmentation, feature extraction and classification. In the process of development of the algorithm the pre-processing, segmentation, character recognition and post-processing modules were discussed. The main objectives to the development of this paper are: To develop the classification, identification of deference prototyping for written and printed consonants, conjunct consonants and symbols based on 3 layered approaches with different measurable area by using fuzzy logic and to determine suitable features for handwritten character recognition.*

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***KEYWORDS***

*Optical Character Recognition (OCR), TopMiddleBottom Layer (TMBL) layer, BottomMiddleTop Layer (BMTL), Hand written and printed character recognition (HWPCR), Artificial Neural Network (ANN).*

## 1. INTRODUCTION

Optical Character Recognition is the method of digitalization of hand and type written or printed text into machine-encoded form. OCR is the most active invention research area in the field of image processing, character and pattern recognition. In present life OCR has been successfully using in finance, legal, banking, health care and home need appliances. Character Recognition classified into two ways, online and offline. Online character and pattern recognition method is finer to their off mode counterparts in recognition of hand written characters due to the temporal information available with the formal information. In Off-Line mode character recognition, the written or printed document can be scanned as an image then it can be digitized then converted it into machine readable form with different character reorganization algorithmic methodology. Off-Line mode character recognition process is an active and effective research area towards to development of new innovations, ideas and techniques that would improve recognition accuracy. The OCR consists the different levels of processing methods like as Image Pre Acquisition, Acquisition, Pre-processing, Segmentation, Post processing, Feature Extraction and Classification. India is a multi cultural, literature and traditional scripted country. 18 official scripted languages are formed and have many local regional languages in India. Telugu is the official language of the southern Indian states of Telangana and Andhra Pradesh. Telugu is also spoken in all over in Malaysia, Bahrain, Oman, Singapore, Fiji, UAE and Mauritius. Officially, there are 10 numerals, 18 vowels, 36 consonants, and three dual symbols. Telugu is the Dravidian composed language and it is the third most popular script in India. The Telugu script is closely related to the Kannada script. In OCR, captured or scanned input image is active from number of stages like Image Acquisition, pre-processing, processing, post-processing, segmentation, feature extraction and classification to perform Optical Character Recognition. Scanned Images or captured photographs taken as input for the OCR system in Image Acquisition stage. Pre-processing is important and necessary to convert the raw data to correct deficiencies in the data acquisition process due to limitations of the capturing device sensor. Pre-processing stage step involves detect text stroke rate, binarization, normalization, noise removal and so on. Segmentation is the process of dividing the individual cum grouped characters, separating line spaces, words and mixed characters from scanned image. Feature extraction explores the exact identification of the characters, can be considered as finding a set of features that define the shape of the underlying character as precisely and uniquely as possible.

## 2. EARLIER WORK WITH OPTICAL CHARACTER RECOGNITION ALGORITHMS

In the past and present invasion of OCR, many algorithms are designed for different ways of character recognition processes such as Template Matching, Statistical Algorithm, Structural Algorithm, Neural Network Algorithm and Support Vector Machine. Template Matching Algorithm proposed only for the recognition of the typewritten characters. The Statistical Algorithm, Structural Algorithm, Neural Network Algorithm and Support Vector Machine proposed for recognition of both type and handwritten characters. Each algorithmic methodology carries both advantages and disadvantages.

## 2.1 Neural Network Algorithm

An Artificial Neural Network is an innovative methodology for information processing. ANN is inspired by the biological nervous system, such as the main system act like as brain and its inter-connected nerve process data. ANN composes huge number of inter-connected neurons for processing data cum elements working in harmony to solve the problems [25]. A neural network is a powerful data modelling tool that is able to capture and represent complex input/output relationships. Neural network algorithm activated and identifies the characters by boosting and worm-up of trained neuron of the neural network. Feed forward Neural Network, Feedback neural network and Self Organizing Map are the types of neural network. Neural network algorithm especially works for new characters can be found when it can middle of recognition process, and also it is a suitable.

## 2.2 Support Vector Machine

The Support Vector Machine (SVM) is a related to support vector networks and set of supervised learning methods used for classification. Support vector machine algorithm activated and discover the characters by scrutinise and mapping the given input information on with high priority dimensional future apace and it can be determine a dividing hyper plane with maximum and minimum margin data. SVM is robust, accurate and very effective even though when the training samples and models are less and it can perform good result without adding prior data sets and feed information.

## 2.3 Structural Algorithm

The initial idea behind the creation of structural algorithms is the recursive description of a complex pattern in terms of simpler patterns based on the size and shape of the object [23]. This structural algorithm activated and identifies by recognize compound component of the character. Structural algorithm classifies the input patterns on the basis of components of the characters and the relationship among these components. Firstly the primitives of the character are identified and then strings of the primitives are checked on the basis of pre-decided rules [00]. Structural pattern recognition is intuitively appealing because in addition to classification, this approach also provides a description of how the given path constructed from the primitives: [24]. Generally a character is represented as a production rules structure, whose left-hand side represents character labels and whose right-hand side represents string of primitives. The right-hand side of rules is compared to the string of primitives extracted from a word. So classifying a character means finding a path to a leaf: [22]. This algorithm mainly uses the structural shape pattern of the objects.

## 2.4 Statistical Algorithm

The purpose of the Statistical Algorithm is to determine and categorize the given pattern based on the statistical approach like as pre planned made observations, measurement approaches and a set of numbers prepared which is used to prepare a measurement vector [22]. Statistical algorithm uses the statistical decision functions and a set of optimality criteria which to maximizes the probability of the observed pattern given the model of a certain class.

Statistical algorithms activated and identifies by making the measurement and assumptions. Statistical algorithm is based on three assumptions. Such as distribution of present cum future set, sufficient statistics presented in each class and collection of pre-images to extract a set of features which represents each distinct class of image pattern. The major advantage is, it works even when prior data or information is not available about the characters in the training data.

### 2.5 Template Matching Algorithm

Template Matching Algorithm known as pattern matching algorithm. All basic characters and symbols are pre-stored in the system, and it is system prototype that useful to classify, identifies the characters by comparing two pattern matching symbols or images. Template matching is the process of finding the location of sub image called a template inside an image. Template matching algorithm activated and identifies by Comparing derived image features and templates: [21]. It is easy to implements but it only works on the pre-stored fonts and templates.

## 3. General Points of Classification of The Consonants And Mixed Conjunct Consonants

General points might be concentrated during the process of handwritten character recognition when digitized input image is, such as handwritten characters.

- Image clarity, quality and range of the pen ink plotted.
- Written text stroke, clarity, and thickness of the text.
- Pen or pencil ink injecting ratio on the paper.
- Local variations, rounded corners, and improper extrusions
- Unreflective and relative size of the character.
- Some characters represents different shapes
- In the translation point of view, it can be entirely or partly and it represents relative shift of the character.
- Individual and irrelative line pixels, segments and curves.

## 4. General Telugu Characters, Numbers and Symbols

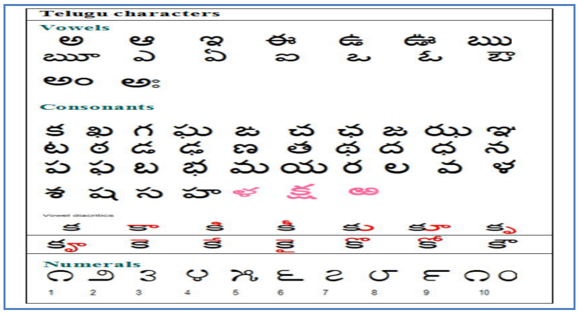
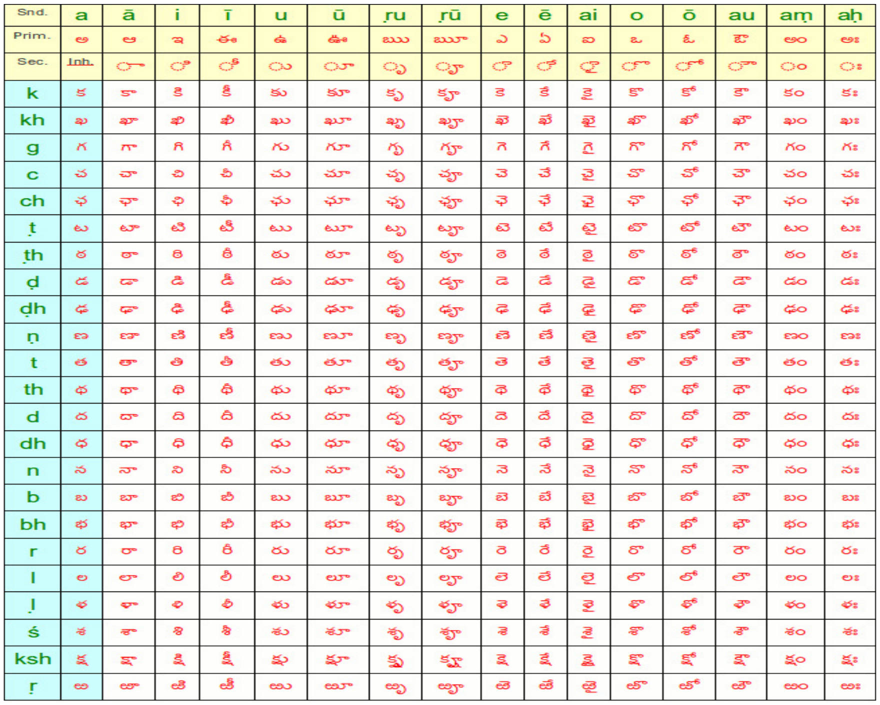

Telugu characters
Vowels
అ ఆ ఇ ఈ ఉ ఊ ఋ
ౠ ఎ ఏ ఐ ఒ ఓ ఔ
అం అః
Consonants
క ఖ గ ఘ ఙ చ ఛ జ ఝ ఞ
ట ఠ డ ఢ ణ త థ ద ధ న
ప ఫ బ భ మ య ర ల వ ళ
శ ష స హ ళ క్ష ఱ
Vowel diacritics
క కా కి కీ కు కూ కృ
కౄ కె కే కై కొ కో కౌ
Numerals
౧ ౨ ౩ ౪ ౫ ౬ ౭ ౮ ౯ ౧౦
1 2 3 4 5 6 7 8 9 10

Figure 1. Telugu characters and numbers



| Snd. | a | ā | i | ī | u | ū | ṛu | ṛū | e | ē | ai | o | ō | au | aṃ | aḥ |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Prim. | అ | ఆ | ఇ | ఈ | ఉ | ఊ | ఋ | ౠ | ఎ | ఏ | ఐ | ఒ | ఓ | ఔ | అం | అః |
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| k | క | కా | కి | కీ | కు | కూ | కృ | కౄ | కె | కే | కై | కొ | కో | కౌ | కం | కః |
| kh | ఖ | ఖా | ఖి | ఖీ | ఖు | ఖూ | ఖృ | ఖౄ | ఖె | ఖే | ఖై | ఖొ | ఖో | ఖౌ | ఖం | ఖః |
| g | గ | గా | గి | గీ | గు | గూ | గృ | గౄ | గె | గే | గై | గొ | గో | గౌ | గం | గః |
| c | చ | చా | చి | చీ | చు | చూ | చృ | చౄ | చె | చే | చై | చొ | చో | చౌ | చం | చః |
| ch | ఛ | ఛా | ఛి | ఛీ | ఛు | ఛూ | ఛృ | ఛౄ | ఛె | ఛే | ఛై | ఛొ | ఛో | ఛౌ | ఛం | ఛః |
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| ḍ | డ | డా | డి | డీ | డు | డూ | డృ | డౄ | డె | డే | డై | డొ | డో | డౌ | డం | డః |
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| t | త | తా | తి | తీ | తు | తూ | తృ | తౄ | తె | తే | తై | తొ | తో | తౌ | తం | తః |
| th | థ | థా | థి | థీ | థు | థూ | థృ | థౄ | థె | థే | థై | థొ | థో | థౌ | థం | థః |
| d | ద | దా | ది | దీ | దు | దూ | దృ | దౄ | దె | దే | దై | దొ | దో | దౌ | దం | దః |
| dh | ధ | ధా | ధి | ధీ | ధు | ధూ | ధృ | ధౄ | ధె | ధే | ధై | ధొ | ధో | ధౌ | ధం | ధః |
| n | న | నా | ని | నీ | ను | నూ | నృ | నౄ | నె | నే | నై | నొ | నో | నౌ | నం | నః |
| b | బ | బా | బి | బీ | బు | బూ | బృ | బౄ | బె | బే | బై | బొ | బో | బౌ | బం | బః |
| bh | భ | భా | భి | భీ | భు | భూ | భృ | భౄ | భె | భే | భై | భొ | భో | భౌ | భం | భః |
| r | ర | రా | రి | రీ | రు | రూ | రృ | రౄ | రె | రే | రై | రొ | రో | రౌ | రం | రః |
| l | ల | లా | లి | లీ | లు | లూ | లృ | లౄ | లె | లే | లై | లొ | లో | లౌ | లం | లః |
| ḷ | ళ | ళా | ళి | ళీ | ళు | ళూ | ళృ | ళౄ | ళె | ళే | ళై | ళొ | ళో | ళౌ | ళం | ళః |
| ś | శ | శా | శి | శీ | శు | శూ | శృ | శౄ | శె | శే | శై | శొ | శో | శౌ | శం | శః |
| ksh | క్ష | క్షా | క్షి | క్షీ | క్షు | క్షూ | క్షృ | క్షౄ | క్షె | క్షే | క్షై | క్షొ | క్షో | క్షౌ | క్షం | క్షః |
| ṛ | ఱ | ఱా | ఱి | ఱీ | ఱు | ఱూ | ఱృ | ఱౄ | ఱె | ఱే | ఱై | ఱొ | ఱో | ఱౌ | ఱం | ఱః |

Figure 2. Combinational vowels with consonants

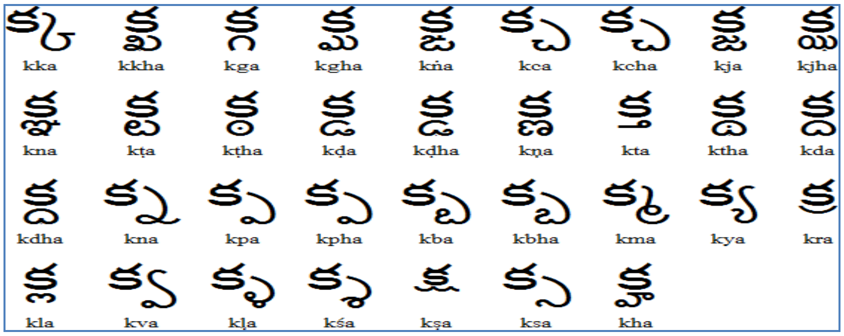

Figure 3. Conjunct consonants

## 5. PAPER OBJECTIVES

The main objectives of this paper is To determine suitable features for decision making state and identification of Telugu Written and Printed Consonants and Conjunct Consonants based on 3 layer approach with their orientation, alignment method. And also to develop the identification, classification and deference prototyping for written and printed mixed and conjunct Consonants characters with their orientation, alignment method by using fuzzy logic system.

## 6. WORKING METHODOLOGY

The scanned image page contains the different stroke levels of consonants, normal and mixed conjunct consonants. In this research paper we are concentrated on different stroke levels of consonants and mixed conjunct consonants. The scanned image has been processed under the following processes.

- Hand written Text in image identification and detection.
- Hand written Text layout or orientation identification.
- Text classification of the text based on the orientation of the text
- Segmentation.
- Character processing applying the Gaussian Fuzzy process
- Post Processing Analysis.

In this implementation Fuzzy logic based neural network having the four methods (input, fuzzification, inference and defuzzification) have been used. Fuzzification is the scaling of input data to the universe of discourse (the range of possible values assigned to fuzzy sets). Rule application is the evaluation of fuzzified input data against the fuzzy rules written specifically for the system. Defuzzification is the generation of a specific output value based on the rule strengths that emerge from the rule application. The Fuzzy based neural network rules can be applied for the paper front and back side layered written and printed characters.

This paper implements the aadvanced ffuzzy llogic system controller collected the text in the form of written or printed, collected the text images from the scanned file, digital camera, Processing the Image with examine the high intensity of images based on the quality ration, extract the image characters depends on the quality then check the character orientation and alignment then to check the character thickness, base and print ration. The input image characters can classify into the two ways, first as normal consonants and second as conjunct consonants, first way represents the normal consonants and the second way represents conjunct consonants. In this research, we classify input image written and printed as normal consonants and second as conjunct consonants based on the 3 layer approach. The middle layer represents normal consonants and the top and bottom layer represents conjunct consonants. Here recognition process starts from middle layer, and then it will check the top and bottom layers, the recognition process treat as conjunct consonants when it can detect any symbolic characters in top and bottom layers of present base character otherwise treats as normal consonants as shown in the fig.5.
Capture the entire consonant or conjunct consonant characters from 3 layers Middle, Top, Bottom(MTB) into single character or symbol. After conversion it into single symbolic character, then the concern algorithmic methodology can be applied to identify the realistic name of the character. In this methodology to classify the consonants and conjunct consonants proposed concern algorithmic methodology can be applied in second level.

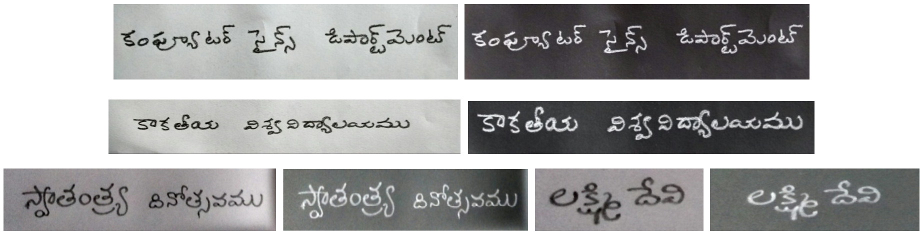

Figure 4. Examples and Tested Samples of handwritten Telugu characters with different modes.

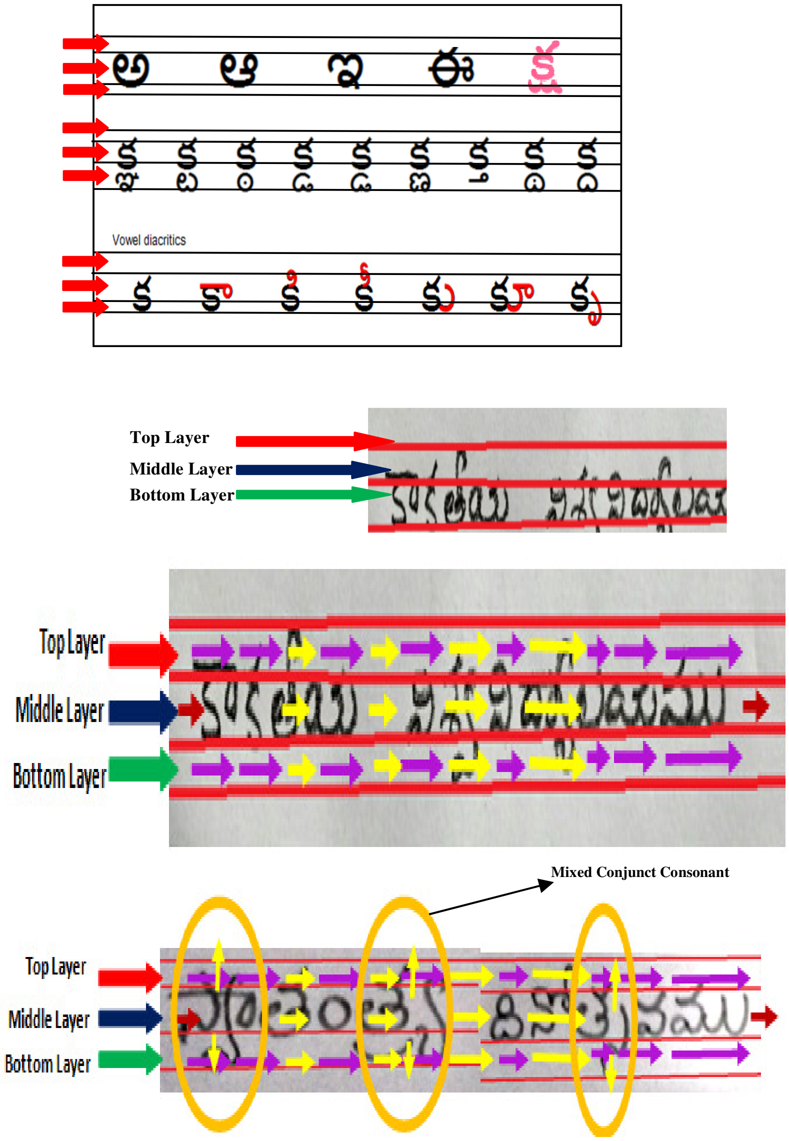

Figure 5. Tested Samples of handwritten Telugu characters with layers to help the sensor to detect variation of the written character type.

We are applied the post processing technique to all 3 layer characters. Then after in Post processing of the image, we are concentrated on the Image text readability and compatibility. If the readability is not process then repeat the process again as shown data flow structure fig.6. In this recognition process includes slant correction, thinning, normalization, segmentation, feature extraction and classification.

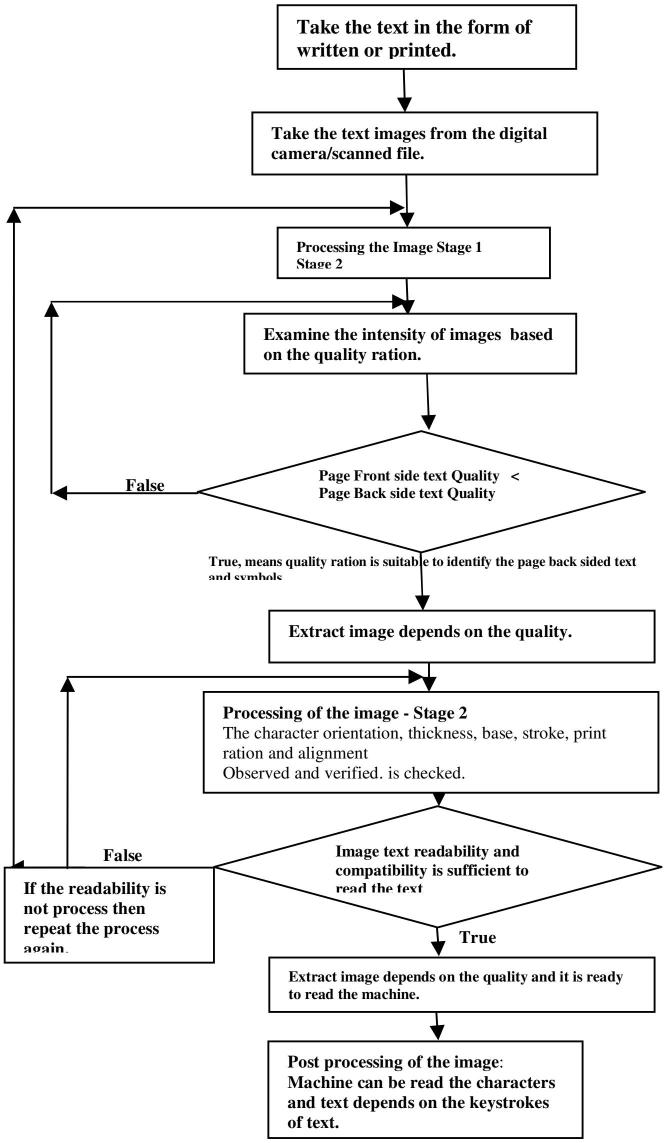
Take the text in the form of written or printed.
Take the text images from the digital camera/scanned file.
Processing the Image Stage 1
Stage 2
Examine the intensity of images based on the quality ration.
Page Front side text Quality < Page Back side text Quality
False
True, means quality ration is suitable to identify the page back sided text and symbols
Extract image depends on the quality.
Processing of the image - Stage 2
The character orientation, thickness, base, stroke, print ration and alignment
Observed and verified. is checked.
Image text readability and compatibility is sufficient to read the text
False
If the readability is not process then repeat the process again.
True
Extract image depends on the quality and it is ready to read the machine.
Post processing of the image: Machine can be read the characters and text depends on the keystrokes of text.

Figure 6. Data Process and next level flow diagram in OCR process.

In the process of development of the algorithm the pre-processing, segmentation, character recognition and post-processing modules were discussed. The main objectives to the development of this paper are: To develop the classification, identification of deference prototyping for Written and Printed Consonants, Conjunct Consonants and symbols based on 3 layer approach with different measurable area by using fuzzy logic and to determine suitable features for handwritten character recognition.

## 7. IMPLEMENTATION

The Fuzzy logic was for the most part an object of skepticism and derision, in part because the word ‘‘fuzzy” is generally used in a pejorative sense. Fuzzy logic is not fuzzy. Basically, fuzzy logic is a precise logic of imprecision and approximate reasoning. More specifically, fuzzy logic may be viewed as an attempt at formalization/mechanization of two remarkable human capabilities. First, the capability to converse, reason and make rational decisions in an environment of imprecision, uncertainty, incompleteness of information, conflicting information, partiality of truth and partiality of possibility – in short, in an environment of imperfect information. And second, the capability to perform a wide variety of physical and mental tasks without any measurements and any computations [1].

The three elements required to realize a fuzzy system are fuzzification, rule application, and defuzzification. Fuzzification is the scaling of input data to the universe of discourse (the range of possible values assigned to fuzzy sets). Rule application is the evaluation of fuzzified input data against the fuzzy rules written specifically for the system. Defuzzification is the generation of a specific output value based on the rule strengths that emerge from the rule application.

In a realized fuzzy system, a microcontroller or other engine runs a linked section of object code that consists of two segments. One segment implements the fuzzy logic algorithm, performing fuzzification, rule evaluation, and defuzzification, and thus can be thought of as a generic fuzzy logic inference engine. The other segment ties the expected fuzzy logic inputs and outputs, as well as application-specific fuzzy rules, to the fuzzy logic inference engine[1] as shown in the Figure 7.

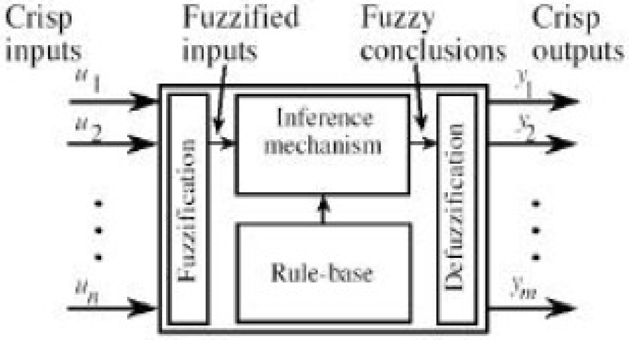

Figure 7. Basic block diagram of Fuzzy System Crisp inputs and Outputs.

One may ask where and how fuzzy logic is implemented. here with the layer quadrants location and three layered quadrants differentiation method for consonants and conjunct consonants with the set of rules are known and which are the feeds for fuzzy logic controller [8 - 9] fuzzification rules, these cases and conditions would be implemented as the if cases and for each individual quadrant the processing action is to be done is written as the then-corresponding action Fuzzy-neural network having the four layers (input, fuzzification, inference and defuzzification) have been used.

## 7.1 Basic Configuration of a Fuzzy System

Fuzzy controller in a closed-loop configuration (top panel) consists of dynamic filters and a static map (middle panel). The static map is formed by the knowledge base, inference mechanism and fuzzification and defuzzification interfaces.

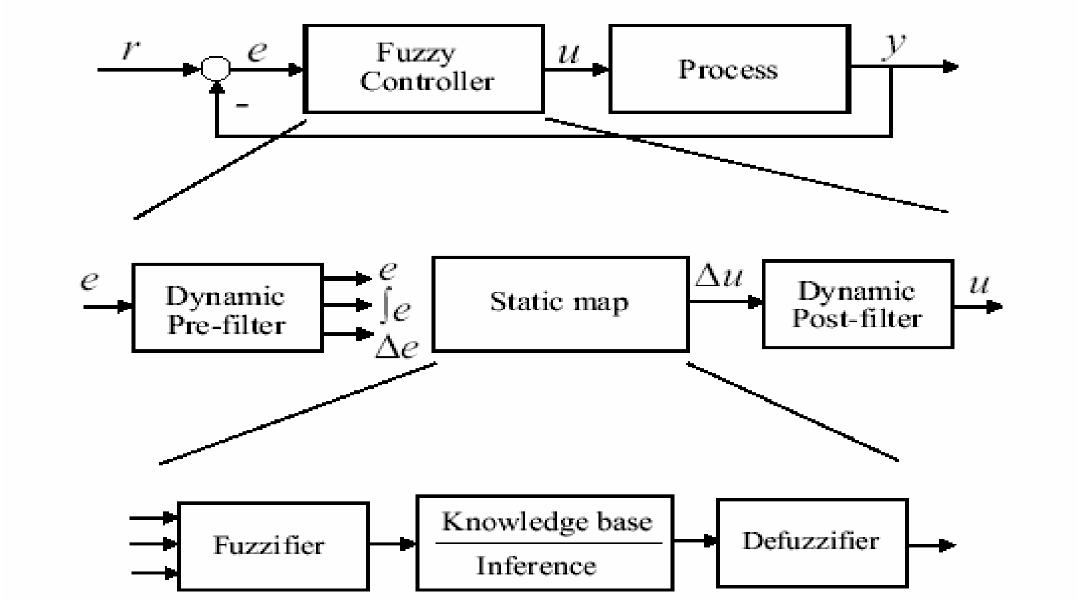

Figure 8. Fuzzy controller in a closed-loop configuration (top panel) consists of dynamic filters and a static map (middle panel). The static map is formed by the knowledge base, inference mechanism and fuzzification and defuzzification interfaces.

### 7.2 Fuzzy Sets

Fuzzy sets can be effectively used to represent linguistic values, such as low, young, and complex. A fuzzy set can be defined mathematically by assigning to each possible individual in the universe of discourse a value representing its grade of membership in the fuzzy set to a greater or lesser degree as indicated by a larger or smaller membership grade. The fuzzy set is represented as where x is an element in X and µA(x) is a membership function of set A which defines the membership of fuzzy set A in the universe of discourse, X.

### 7.3 Fuzzy Membership Functions

A fuzzy set is characterized by a membership function which associates with each point in the fuzzy set a real number in the interval [0, 1], called degree or grade of membership. The membership function may be triangular, trapezoidal, Gaussian etc. A triangular membership is described by a triplet (a, m, b), where „m" is the modal value, „a" and „b" are the right and left boundary respectively. The trapezoidal membership function (shown in Figure. 9) is defined as follows.

$$\mu_Z(x_k,\gamma_k)=\begin{cases}1 & x_k\in[u_k,U_k]\\ 1-\max(0,\min(1,\gamma_k(u_k-x_k))) & x_k\prec u_k\\ 1-\max(0,\min(1,\gamma_k(x_k-U_k))) & x_k\succ U_k\end{cases}$$

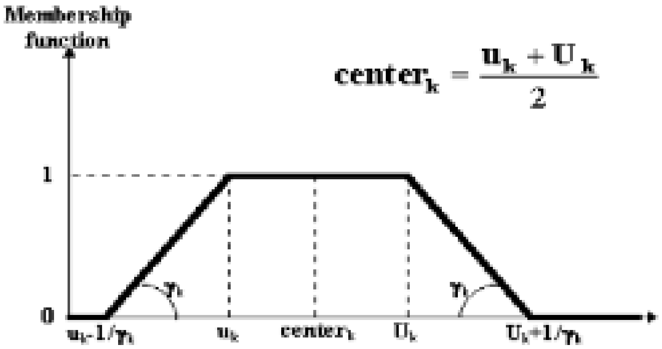

Figure 9. Trapezoidal Membership

Function for µ Z (xk, $\gamma$ k)

Another fuzzy membership function that is often used to represent vague, linguistic terms is the Gaussian which is called Gaussian membership function (shown in figure 10) is defined as follows.

$$\mu_Z(x_k,\gamma_k)=\exp\left(-\frac{1}{2}\cdot\frac{(x_k-\mathrm{center}_k)^2}{\gamma_k^{\,2}}\right)$$

$$\mathrm{center}_k=\frac{u_k+U_k}{2}$$

with $\gamma_k > 0$ for any $k\in\{1, 2, \ldots, n\}$

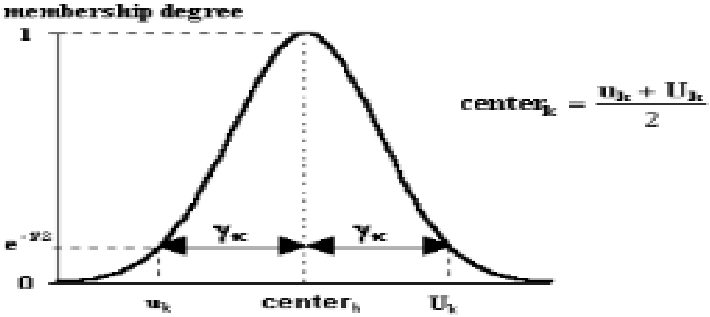

Figure 10. Gaussian Membership Function for µ Z(xk, $\gamma$ k)

## 7.4 Gaussian Bell curve sets

Give richer fuzzy system with simple learning laws that tune the bell curve variance. The Gaussian Function is represented by “(equation 1),”

$$\mu_{A_i}\langle x\rangle = Gaussian\langle x, c_i, \sigma_i\rangle = e^{-(x-c_i)^2/2\sigma_i^2}$$

Where Ci is the center of the $i^{th}$ fuzzy set and $\sigma_i$ is the width of the $i^{th}$ fuzzy set.

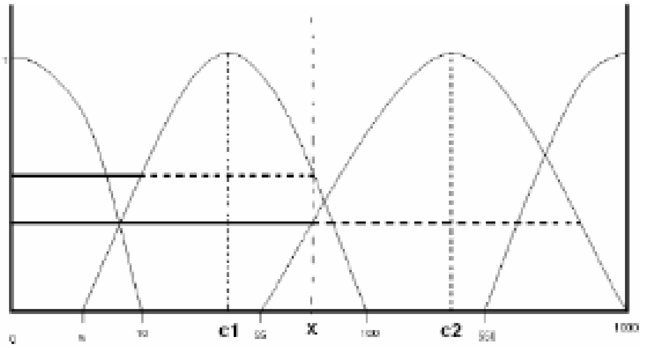

Figure 11. Representation of DATA Cost driver using Gaussian Membership Function

We define a fuzzy set for each linguistic value with a Gaussian shaped membership function μ is shown in Figure 10. We have defined the fuzzy sets corresponding to the various associated linguistic values for each variable / parameter of interest it may be character intensity, orientation, layout or anything.

In this research, a new fuzzy effort estimation model is proposed by using Gaussian function to deal with linguistic data or text image with three layered quadrant position analysis, and to generate fuzzy membership functions and rules for further processing the membership functions Primitives have been added to find form a character, which is part of the lexicon. The word is not said to be recognized till it is tested with lexicon containing root words with an efficient algorithm [7]. The system working model is designed as shown in the flowchart figure 6, and the process the recognition the consonants and conjunct consonants based the figure 8, figure 9, figure.10 and figure.11 is repeated till the whole text is reached to get the clarity and in readable and understandable.

## 8. DISCUSSION

The proposed algorithmic data flow presented to get the versatility in implementation while constructing an OCR system; our proposal system can scan the text in different layered approach with their different directions and orientation. There are many advantages of the proposed system. First, when there are some feature parts which are related to knowing the decision making stages and identification of mixed hand written letters and consonant character and the Second, identification of low rate and low quality written mixed conjunct consonant text.

## 9. FUTURE SCOPE

The proposed 3 layered methodology approach planning to test and it can be implementing either using the math tool or the LabVIEW VI GUI and MathLab. Our future work aims to improve the classifier of the mixed and non-mixed conjunct consonants to achieve still better recognition rate with our future proposal algorithmic methodology and also to improve the better recognition procedure for low quality readable imaged Telugu mixed-conjunct-consonants.

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# MINING FUZZY ASSOCIATION RULES FROM WEB USAGE QUANTITATIVE DATA

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## ABSTRACT

*Web usage mining is the method of extracting interesting patterns from Web usage log file. Web usage mining is subfield of data mining uses various data mining techniques to produce association rules. Data mining techniques are used to generate association rules from transaction data. Most of the time transactions are boolean transactions, whereas Web usage data consists of quantitative values. To handle these real world quantitative data we used fuzzy data mining algorithm for extraction of association rules from quantitative Web log file. To generate fuzzy association rules first we designed membership function. This membership function is used to transform quantitative values into fuzzy terms. Experiments are carried out on different support and confidence. Experimental results show the performance of the algorithm with varied supports and confidence.*

## KEYWORDS

*Web Usage mining, Data mining, Fuzzy association rules, Web log file, Fuzzy term.*

## 1. INTRODUCTION

With the continued increase in the usage of the World Wide Web (WWW), Web mining has been established as an important area of research. The WWW is a vast repository of unstructured information, in the form of interrelated files; those are distributed on several Web servers over wide geographical regions. Web mining deals with the discovering and analyzing the valuable information from the WWW. Web usage mining focuses on discovery of the potential knowledge from the browsing patterns of users to find the correlation between the pages on analysis.

Mining is of three types: Data Mining, Text Mining and Web Mining. There are many challenging problems in Data, Text, and Web Mining Research. The mining data may be either structured or unstructured. Data Mining deals with structured data organized in a database whereas text mining deals with unstructured data. Web mining data handles the combination of structured and unstructured data. Web Mining uses data mining as well as text mining techniques and its distinctive approaches. Web data mining is the application of data mining techniques to discover interesting and potentially useful knowledge from Web data. Web hyperlink structure or Web log data or both are used by Web data mining process.

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There are many types of data that can be used in Web Mining [1, 2].

## 1.1 Web Content

The data actually present in the Web pages which conveys information to the users. The contents of a Web page may be varied e.g. text, HTML, audio, video, images, etc.

## 1.2 Web Structure

The organization of the Web pages connected through hyperlinks i.e. various HTML tags used to link one page to another and one Web site to another Web site.

## 1.3 Web Usage

The data that reflect the usage of Web collected on Web servers, proxy server, and client browser with IP address, date, time etc.

## 1.4 Web User Profile

The data that provides demographic information about users of the Web sites, i.e. user registration data and customers profile information.

World-wide-Web applications have grown very fast and have made a significant impact on computer systems. Among them, Web browsing for useful information may be most commonly seen. Due to its incredible amounts of use, efficient and effective Web retrieval has thus become a very important research topic in this field.

Figure 1 shows the step wise procedure for Web usage mining process.

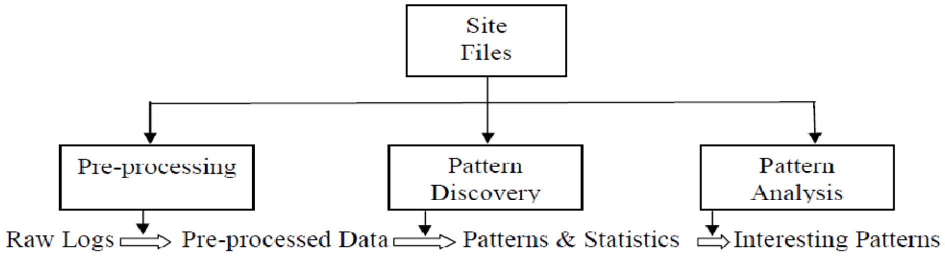

Figure 1. Web Usage Mining Process

The general process of Web usage mining includes [3]

1. Resource collection: Process of extracting the task relevant data (e.g. access logs of HTTP servers),
2. Information pre-processing: Process of Cleaning, Integrating and Transforming of the result of resource collection,
3. Pattern discovery: Process of uncovered general patterns in the pre-process data and
4. Pattern analysis: Process of validating the discovered patterns.

There are different Web mining techniques [1], used for efficient and effective Web retrieval. Web usage mining is one of the ways for the same. Web-usage mining emphasizes on the automatic discovery of user access patterns from Web servers [1, 2]. In the past, several Web-mining approaches for finding sequential patterns and user interesting information from the World Wide Web were proposed [1, 2, 4].

Real world transactions are commonly seen with quantitative values known as boolean transactions [5]. A boolean association involves binary attributes; a *generalized* association involves attributes that are hierarchically related and a *quantitative* association involves attributes that can take on quantitative or categorical values. For example, assume whenever customers in a supermarket buy bread and butter, they will also buy milk. From the transaction of the supermarkets, an association rule can be mined out as "Bread and Butter →Milk". Most of the previous study focused on such type of boolean transaction data. Transaction data in real-world applications usually consist of quantitative values. Designing a sophisticated data-mining algorithm which will handle real-world applications data presents a challenge to data mining researchers.

Exhaustive research has been done in Web mining. There are many more techniques used to find association between Web pages. But instead of only page sequence if we consider page view time while accessing the Web page then the Web log sequence can be seen as quantitative data.

Fuzzy logic, which may be viewed as an extension of traditional logical systems, provides an effective conceptual framework for dealing with the problem of knowledge representation in an environment of uncertainty and imprecision [6, 7, 8, 9].

Fuzzy set theory was first introduced by Zadeh in 1965 [6].

Fuzzy set theory is being used more and more frequently in intelligent systems because of its simplicity and similarity to human reasoning [5, 6, 7, 8, 9]. The theory has been applied in fields such as manufacturing, engineering, control, diagnosis, and economics, among others [6, 8].

Here first, we applied fuzzy concept to Web usage log data to find fuzzy labels and then applied Apriori algorithm to find interesting association rules.

The remaining parts of this paper are organized as follows: Basic Apriori algorithm is reviewed in Section 2. Fuzzy set concepts are reviewed in Section 3. Proposed algorithm is described in Section 4. Experimental results are shown in Section 5. Conclusions and future work is described in the last Section 6.

## 2. REVIEW OF BASIC APRIORI ALGORITHM

Agrawal et.al developed several mining algorithms based on the concept of large itemsets to find association rules between transaction data [4]. Sequential mining process is based on two phases a, phase one is used to generate number of candidate itemsets and then its frequency is counted by scanning the transaction data. The qualifying itemsets i.e. which are equal to or above predefined threshold value called as min support are called as large itemsets. Initially large-1 itemsets are generated; these large-1 itemsets are combined to form large-2 itemsets and so on. This process is repeated until all large itemsets are had been found. In second phase, all association rules are formed against large itemsets. Then each association rule is checked with min confidence. Qualifying association rules were output as set of association rules.

```
Input- $L_1$= {large-1 sequences}
Output- maximal sequences in $\cup_k L_k$
    For ($k$=2;$L_{k-1}$;k++) do
    begin
        $C_k$=New candidates generated from $L_{k-1}$
        For each user-sequence c in the database do
            Increment the count of all candidates in $C_k$ that are contained in c.
        $L_k$ = Candidates in $C_k$ with minimum support.
    end
```

## 3. Review of Fuzzy Set Concepts

Formally, the process by which individuals from a universal set X are determined to be either members or non-members of crisp set can be defined by a characteristic or discrimination function [5, 6]. For a given crisp set A, this function assigns a value $\mu_A$(x) to every x ∊ X such that

$$\mu_A(x)=\begin{cases} 1 \; if \; and \; only \; if \; x \in A \\ 0 \; if \; and \; only \; if \; x \notin A \end{cases}$$

Thus, this function maps elements of the universal set to the set containing 0 and 1. This kind of function can be generalized such that the values assigned to the elements of the universal set fall within specified ranges, referred to as the membership grades of these elements in the set. Higher the value denotes better degrees of the set membership. Such a function is called membership function $\mu_A$(x), by which fuzzy set A is usually defined. This function is represented by

$$\mu_A: X \rightarrow [0, 1],$$

Where [0, 1] denotes the interval of real numbers from 0 to 1, inclusive.

A special notation is often used in the literature to represent fuzzy sets, Assume that $x_1$ to $x_n$ are the elements in fuzzy set A, and $\mu_1$ to $\mu_n$ are their grades of membership in A, A is usually represented as follows:

$$A= \mu_1/x_1 \; +\mu_2/x_2 \; +.....+\mu_n/x_n$$

### 3.1 Operations on Fuzzy Sets

Following are the basic and commonly used operations on fuzzy sets as proposed by Zadeh [5].

#### 3.1.1 Complementation

The complementation of a fuzzy set A is denoted by ¬A, and the membership function of ¬A is given by:

$$\mu_{\neg A}(x)= 1 - \; \mu_A(x), \; \forall x \in X$$

### 3.1.2 Union

The union of fuzzy sets A and B is denoted by A∪B, and the membership function of A∪B is given by:

$$\mu_{A\cup B}(\mathrm{x}) = \max\{\,\mu_A(\mathrm{x}), \mu_B(\mathrm{x})\} \quad \forall x \in X$$

### 3.1.3 Intersection

The union of fuzzy sets A and B is denoted by A∩B, and the membership function of A∩B is given by:

$$\mu_{A\cap B}(\mathrm{x}) = \min\{\,\mu_A(\mathrm{x}), \mu_B(\mathrm{x})\} \quad \forall x \in X$$

## 4. PROPOSED ALGORITHM

```
Input: Pre-processed dataset
Output: Set of fuzzy association rules
Get initial membership functions, support value and confidence value
Divide dataset into partitions
Set n to number of partitions to be processed
repeat
    Transfer quantitative values into fuzzy terms with fuzzy values
    Calculate the counts of fuzzy terms
    repeat
        for each fuzzy term
            Generate the candidate set by counting of each fuzzy term
        end for
        for each fuzzy term
            if count ≥ min support
                generate large itemsets
            end if
        end for
        join the large itemsets
    until large itemsets = = NULL
until n=0
repeat
for each large itemsets
    if confidence ≥ min confidence
        Construct association rule
    end if
end for
merge all association rules
until n=0
```

## 5. EXPERIMENTAL RESULTS

The experimental results are derived from United States Environmental Protection Agency (EPA). The EPA dataset contains a 24-hour period of Hypertext Transfer Protocol (HTTP) requests to a Web server [11]. The EPA dataset has HTTP request from 23:53:25 EDT 29th August 1995 to 23:53:07 30th August 1995. The EPA dataset has total 47748 requests: 46014 GET requests, 1622 POST requests, 107 HEAD requests and 6 invalid requests. Table 1 shows a sample of records from the EPA dataset after cleaning and preprocessing.

Table 1. Input Transactions

| TID | Pages with view time in seconds |
|---|---|
| 0 | (1,26); (2,260); (3,120); (4,430) |
| 1 | (6,220); (7,86); (8,9); (9,101); (10,320) |
| 2 | (6,22);(7,520);(8,17) |
| 3 | (13,190);(14,74) |
| 4 | (15,6);(16,140);(17,133);(18,261) |
| 5 | (6,136);(20,880) |

The quantitative value of each transaction is transformed into fuzzy set according to the membership functions defined in figure 2.

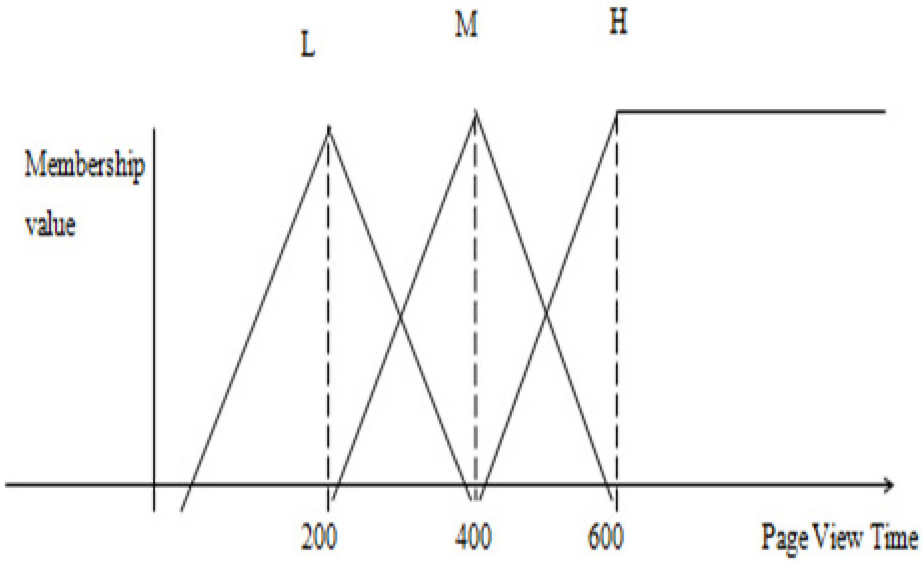

Figure 2. A Triangular Membership Functions for Page View Time

All the transactions from table 1 are converted in fuzzy terms (shown in table 2) using the membership functions defined in figure 2.

Table 2. Input Transactions transformed into the fuzzy sets

| TID | Fuzzy set |
|---|---|
| 0 | $(\frac{1.0}{1.low}); (\frac{0.7}{2.low}+\frac{0.3}{2.medium}); (\frac{1.0}{3.low}); (\frac{0.85}{4.medium}+\frac{0.15}{4.high});$ |
| 1 | $(\frac{0.9}{6.low}+\frac{0.1}{6.medium}); (\frac{1.0}{7.low}); (\frac{1.0}{8.low}); (\frac{1.0}{9.low}); (\frac{0.4}{10.low}+\frac{0.6}{10.medium})$ |
| 2 | $(\frac{1.0}{6.low});(\frac{0.4}{7.medium}+\frac{0.6}{7.high});(\frac{1.0}{8.low})$ |
| 3 | $(\frac{1.0}{13.low});(\frac{1.0}{14.low})$ |
| 4 | $(\frac{1.0}{15.low});(\frac{1.0}{16.low});(\frac{1.0}{17.low});(\frac{0.7}{18.low}+\frac{0.3}{18.medium})$ |
| 5 | $(\frac{1.0}{6.low});(\frac{1.0}{20.high})$ |

Calculate the scalar cardinality of each fuzzy term in given transactions as the count value. The counts for all fuzzy terms are shown in table 3. This fuzzy terms set is called candidate -1 fuzzy term set.

Table 3. Counts for all fuzzy terms

| Fuzzy term | Count | Fuzzy term | Count |
|---|---|---|---|
| 1.low | 1.0 | 10.medium | 0.6 |
| 2.low | 0.7 | 7.medium | 0.4 |
| 2.medium | 0.3 | 7.high | 0.6 |
| 3.low | 1.0 | 13.low | 1.0 |
| 4.medium | 0.85 | 14.low | 1.0 |
| 4.high | 0.15 | 15.low | 1.0 |
| 6.low | 2.9 | 16.low | 1.0 |
| 6.medium | 0.1 | 17.low | 1.0 |
| 7.low | 1.0 | 18.low | 0.7 |
| 8.low | 2.0 | 18.medium | 0.3 |
| 9.low | 1.0 | 20.high | 1.0 |
| 10.low | 0.4 | | |

The candidate-1 fuzzy term set is checked against predefined minimum support value assume that the support value is 1.0. The qualified fuzzy terms are called as large-1 fuzzy terms shown in table 4.

Table 4. The set of large-1 fuzzy terms

| Fuzzy term | count | Fuzzy term | count |
|---|---|---|---|
| 1.low | 1.0 | 13.low | 1.0 |
| 3.low | 1.0 | 14.low | 1.0 |
| 6.low | 2.9 | 15.low | 1.0 |
| 7.low | 1.0 | 16.low | 1.0 |
| 8.low | 2.0 | 17.low | 1.0 |
| 9.low | 1.0 | 20.high | 1.0 |

As large-1 fuzzy term set is not null, join large-1 fuzzy terms to generate candidate-2 fuzzy terms. Then we check candidate-2 fuzzy terms with minimum support to find large-2 fuzzy term set. Hence we repeat the process of join and generate till we get the largest fuzzy term set null. Finally we combined all partitions largest fuzzy term sets to form association rules. Then each association rule is checked with min confidence. Qualifying association rules were output as set of association rules. For example visitors who viewed page 7 for low amount time also viewed page 8 for low amount of time.

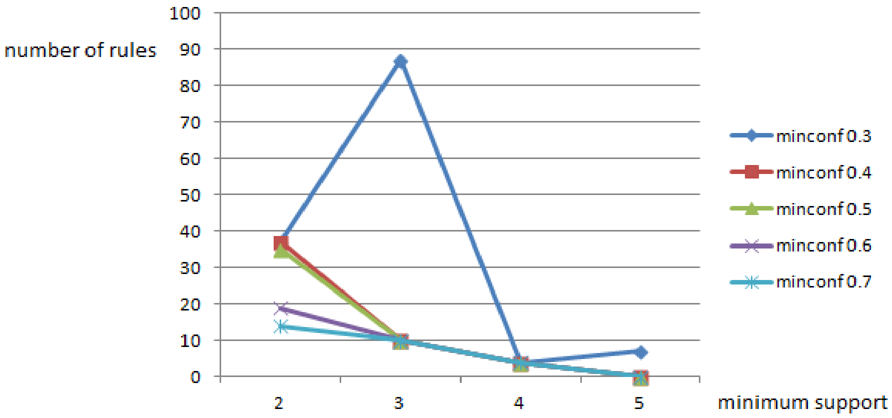

Figure 3. The relationship between numbers of association rules and minimum support values.

Experiments were conducted with varied support and confidence. From figure 3, it is clear that the number of association rules decreased along with the increase in minimum support values.

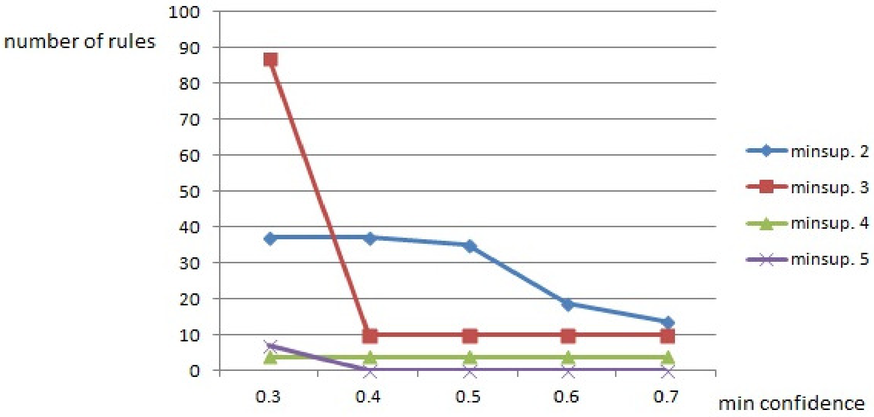

Figure 4. The relationship between numbers of association rules and minimum confidence values.

From figure 4, it is easily seen that the number of association rules decreased as the increase in minimum confidence values. When we observe the curves of figure 3 and figure 4, it is clear that the curves for larger minimum support values were smoother than smaller minimum support values; it means that minimum confidence value had a larger effect on number of association rules when smaller minimum support values were used.

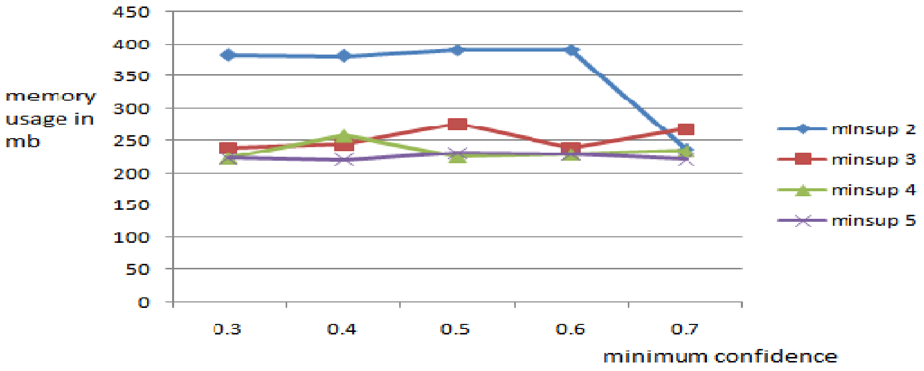

Figure 5. The Memory Usage Statistics with varied minimum support and confidence.

From figure 5, it is observed that the memory utilization is high when the minimum support is low and memory utilization gets decreased as minimum support values get increased.

## 6. Conclusions And Future Work

In this paper, we have proposed a generalized fuzzy data mining algorithm to extract interesting patterns. The proposed algorithm uses static membership functions to fuzzify the quantitative Web usage data along with predefined membership function. We also use predefined support and confidence. In this paper we divided whole database into different partitions based on hours. Each hour partition, we apply separately fuzzy mining algorithm to extract association rules. Finally all hours association rules combined to declare total number of rules for given database. There is possibility to lose some association rules, but in future, we will try to attempt to discover some interesting temporal association rules based on this partition.

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# SEGMENTATION AND LABELLING OF HUMAN SPINE MR IMAGES USING FUZZY CLUSTERING

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## ABSTRACT

*Computerized medical image segmentation is a challenging area because of poor resolution and weak contrast. The predominantly used conventional clustering techniques and the thresholding methods suffer from limitations owing to their heavy dependence on user interactions. Uncertainties prevalent in an image cannot be captured by these techniques. The performance further deteriorates when the images are corrupted by noise, outliers and other artifacts. The objective of this paper is to develop an effective robust fuzzy C- means clustering for segmenting vertebral body from magnetic resonance images. The motivation for this work is that spine appearance, shape and geometry measurements are necessary for abnormality detection and thus proper localisation and labelling will enhance the diagnostic output of a physician. The method is compared with Otsu thresholding and K-means clustering to illustrate the robustness. The reference standard for validation was the annotated images from the radiologist, and the Dice coefficient and Hausdorff distance measures were used to evaluate the segmentation.*

## KEYWORDS

*Vertebra segmentation, fuzzy clustering, MRI, labelling*

## 1. INTRODUCTION

Image segmentation is a fundamental building block in an image analysis tool kit. Segmentation of medical images is in itself an arduous process where the images are prone to be affected by noise and artifacts. Automatic segmentation of medical images is a difficult task as medical images are complex in nature and rarely posses simple linear feature characteristic. Further, the output of segmentation algorithm is affected due to partial volume effect, intensity inhomogeneity in case of MR images.

Spine is the most complex load bearing structure in our entire human body. It is made up of 26 irregular bones connected in such a way that flexible curved structure results. The vertebral column is about 70cm long in an average adult and has 5 major divisions. Seven vertebrae found in the neck region, constitute the cervical part, the next 12 are the thoracic vertebrae and 5 supporting the lower back are the lumbar vertebrae. Inferior to these, is the sacrum which articulates with the hip bones of pelvis. The entire column is terminated by the tiny coccyx. Intervertebral disc acts as a shock absorber and allow the spine to extend. These are thickest in the lumbar and cervical regions, enhancing the flexibility in these regions. Its degeneration is relatively a common phenomena with aging due to wear and tear and is the major cause for back pain [1]. Herniated disc, spinal stenosis and degenerative discs are a few of the types, to mention. These can be imaged and studied from MRI scans. Also it is prescribed most commonly for

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patients with excruciating back pain. MR imaging of spine is formally identified with IR (Inversion Recovery), T1 and T2 weighted images. While water content appears bright in T2 (in medical lingo, its hyper intense which is clearly seen in the spinal canal), the same appears dark (hypo intense) in T1 images. MR can detect early signs of bone marrow degeneration with high spatial resolution where fat and water protons are found in abundance.

Degenerative lumbar spine disease (DLSD) includes spondylotic (arthritic) and degenerative disc disease of the lumbar spine with or without neuronal compression or spinal instability. Accurate diagnosis remains a challenge without manual intervention in segmenting the vertebral features. It can be seen from fig 1. the degenerated state of L5 vertebrae and the associated intensity changes prevalent. These are primarily due to the end plate degeneration.

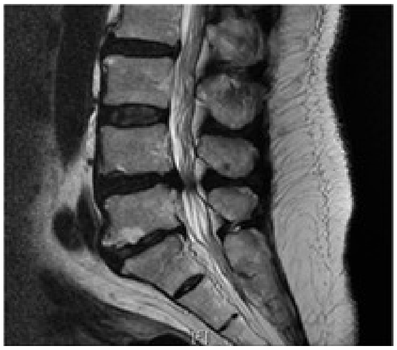


Figure 1. Degenerated L5 vertebra in MR sagittal plane

While degenerative changes are a biological phenomena occurring in spinal structure that are imaged using radiological equipments, certain irrelevant processes are also captured. These constitute the artifacts caused due to intensity inhomogenities shown in fig 2. The segmentation process is highly affected by these complexities present in MR images.

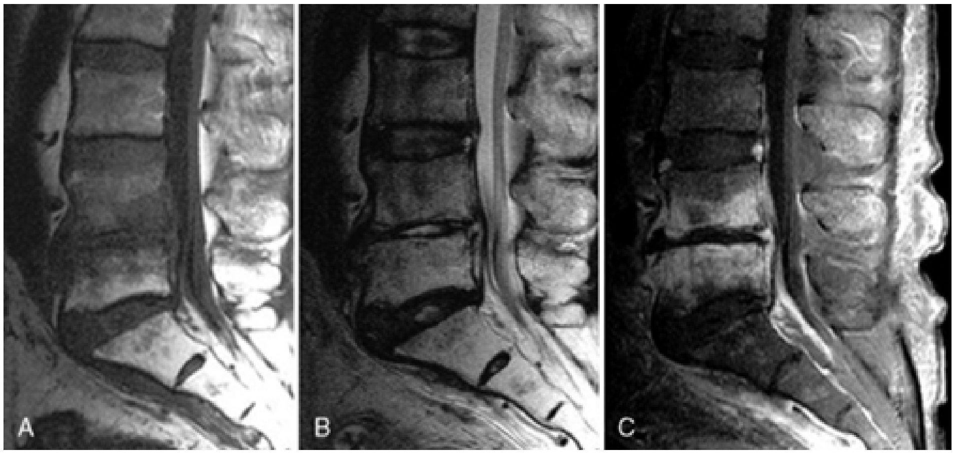


Figure 2. Intensity inhomogenity captured in lumbar vertebrae

The current work deals with segmentation of spinal column from MR image using fuzzy means clustering for identification and labelling of individual vertebral structures. The segmented output can be refined further and used for classification of degenerative state as well as to diagnose deformities.

## 2. LITERATURE

The commonly used segmentation methods are global thresholding, multilevel thresholding and supervised clustering techniques. In intensity thresholding, the level determined from the grey-level histogram of the image. The distribution of intensities in medical images, especially in MRI images is random, and hence global thresholding methods fail due to lack of determining optimal threshold. In addition, intensity thresholding methods have disadvantage of spatial uncertainty as the pixel location information is ignored[2]. An edge detection scheme can be used for identifying contour boundaries of the region of interest(ROI). The guarantee of these lines being contiguous is very sleek. Also, these methods usually require computationally expensive post-processing to obtain hole free representation of the objects.

The region growing methods extend the thresholding by integrating it with connectivity by means of an intensity similarity measure. These methods assume an initial seed position and using connected neighbourhood, expand the intensity column over surrounding regions. However, they are highly sensitive to initial seeds and noise. In classification-based segmentation method, the fuzzy C-means (FCM) clustering algorithm [3], is more effective with considerable amount of benefits. Unlike hard clustering methods, like k-means algorithm, which assign pixels exclusively to one cluster, the FCM algorithm allows pixels to have dependence with multiple clusters with varying degree of memberships and thus more reasonable in real applications. Using intuitionistic fuzzy clustering(IFC), where apart from membership functions(MF), non membership values are also defined, [4]have segmented MR images of brain. The heuristic based segmentation also considers the hesitation degree for each pixel. A similar study on generic gray scale images is put forth in [5] where the IFC combines several MF's and the uncertainty in choosing the best MF.

The article deals with elementary fuzzy C-means clustering, attempting to segment vertebral bodies(VB) with morphological post processing. Also the VB's are labelled accordingly which can reduce the burden of radiologist while classifying the degenerations involved.

## 3. METHODS

The proposed method is schematically depicted in fig.3. The input image(s) have been collected from Apollo Speciality Hospitals, Chennai after going through a formal ethical clearance process. The T1 weighted images, served as the initial dataset for the proposed algorithm.

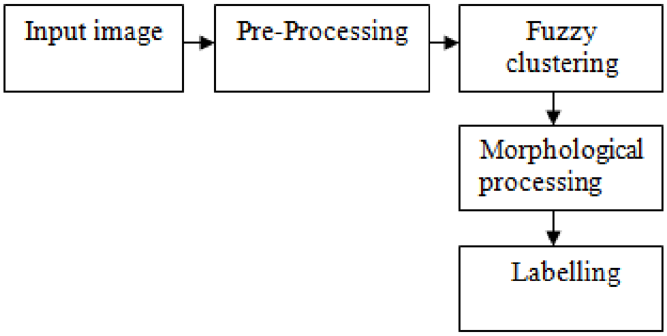


Figure 3. Schematic of the proposed segmentation method

### 3.1. Pre-Processing

The method first smooths the image using the edge preserving anisotropic diffusion filter presented in. It serves the dual purpose of removing inhomogenities and as an enhancer as well.

### 3.2. Fuzzy C-Means Clustering

The fuzzy c-means algorithm [2]has been broadly used in various pattern and image processing studies [6]–[8]. According to fuzzy c-means algorithm, the clustering of a dataset can be obtained by minimizing an objective function for a known number of clusters. Fuzzy C-means is based on minimization of the following objective function:

$$J = \sum_{i=1}^{N} \sum_{j=1}^{M} u_{ij}^{k} \; \left\| x_i - v_j \right\|^2, \qquad 1 \le k < \infty$$

where ;

*k* is any real number known as the weighting factor,

$u_{ij}$ is degree of membership of $x_i$ in the cluster *j*

$x_i$ is the $i^{th}$ of *p*-dimensional measured intensity data

$v_j$ is the *p*-dimensional center of the $j^{th}$ cluster

$\|*\|$ is any norm expressing the similarity between measured intensity data and center

N represents number of pixels while M represents the number of cluster centers

Fuzzy clustering is performed through an iterative optimisation of objective function shown above with update of membership function $u_{ij}$ and cluster centers $v_j$ by

$$u_{ij} = \frac{1}{\sum_{l=1}^{M} \left( \left\| \frac{x_i - v_j}{x_i - v_l} \right\| \right)^{\frac{2}{(k-1)}}}$$

$$v_j = \frac{\sum_{i=1}^{N} u_{ij}^{k} x_i}{\sum_{i=1}^{N} u_{ij}^{k}}$$

The algorithm is terminated when $\max_{ij}\{u_{ij}$ at $t+1$ - $u_{ij}$ at $t\} \le \epsilon$ which is between 0 and 1.

### 3.3. Post Processing

A series of morphological operations are executed for extracting the vertebral bodies (VB) from the clustered output. Hole filling is the preliminary step followed by an erosion to remove islands. An area metric is used to extract only Vertebrae from surrounding muscular region Shape analysis [9] reveals that the aspect ratio of VB varies between 1.5 and 2. This helps in isolating the ligaments and spinal muscles associated with the spine in the region of interest.

### 3.4. Labelling

The segmented vertebrae are labelled using the connected component entity. Each VB is identified with a group number. Starting from L5(Lumbar), the vertebrae are labelled successively till L1 and then, the thoracic region begin. If the sacrum remains due to improper segmentation, it can be eliminated based on aspect ration or area criteria. A colored schematic is also presented for visual calibration.

### 3.5. Validation

The proposed method was validated using Dice coefficient (DC) and Hausdorff distance (HD) . The reference standard for comparison was the annotated images from the radiologist. DC measures the set agreement as described in following equations, where the images constitute the two sets. The generalized HD provides a means of determining the similarity between two binary images. The two parameters used for matching the resemblance between the given images are,

- Maximum distance of separation between points, yet that can still be considered close.
- The fraction that determines how much one point set is far apart from the other.

$$D(A,B) = \frac{2|A \cap B|}{|A|+|B|} \text{ (Dice Coefficient)}$$

$$D(A,B) = \underbrace{Max}_{a \in A} \{\underbrace{Min}_{b \in B} \{d(a,b)\}\} \text{ (Hausdorff Distance)}$$

where, *a, b* are points from the images *A,B* respectively.

## 4. Results and Discussion

The method is tested on sagittal cross-section of T1-weighted MR images of spine.The goal is to segment the vertebral bodies from the muscular background.

### 4.1 Fuzzy segmentation

The input MR sagittal slice of spine considered for the current study is shown in fig 4. After the pre-processing stage, the enhanced input is clustered using the Fuzzy C-means technique and the final output derived is shown in fig 5(d).

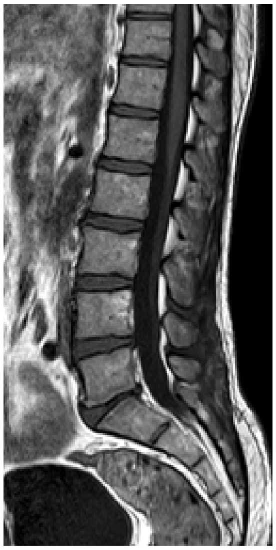
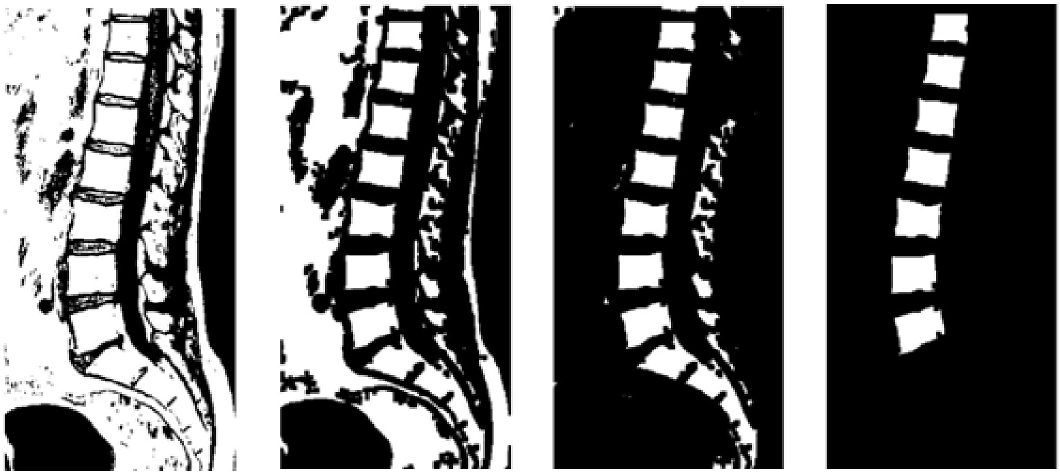


Figure 4. Sagittal plane MR T1 image

The intermediate steps involving the morphological operations are depicted in fig 4. It can be seen that, the fuzzy clustering provides a closer disjoint VB's owing to which we can erode the muscular region and thus arrive at delineating the same.



(a) fuzzy c-means (b) Erosion (c) Filtering using area criteria (d) Aspect ratio based elimination

Figure 5. Post processed output using morphological operations

### 4.2 Labeling of VB

Automatic labeling of vertebrae is usually performed to reduce the manual effort put in by the radiologist. It can be seen from fig 6, the labeled vertebrae and its color scheme can help in better diagnosis given that geometric attributes are also extracted.

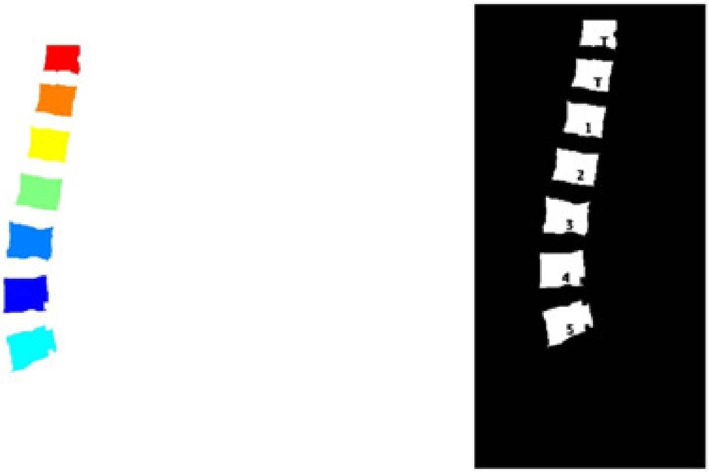
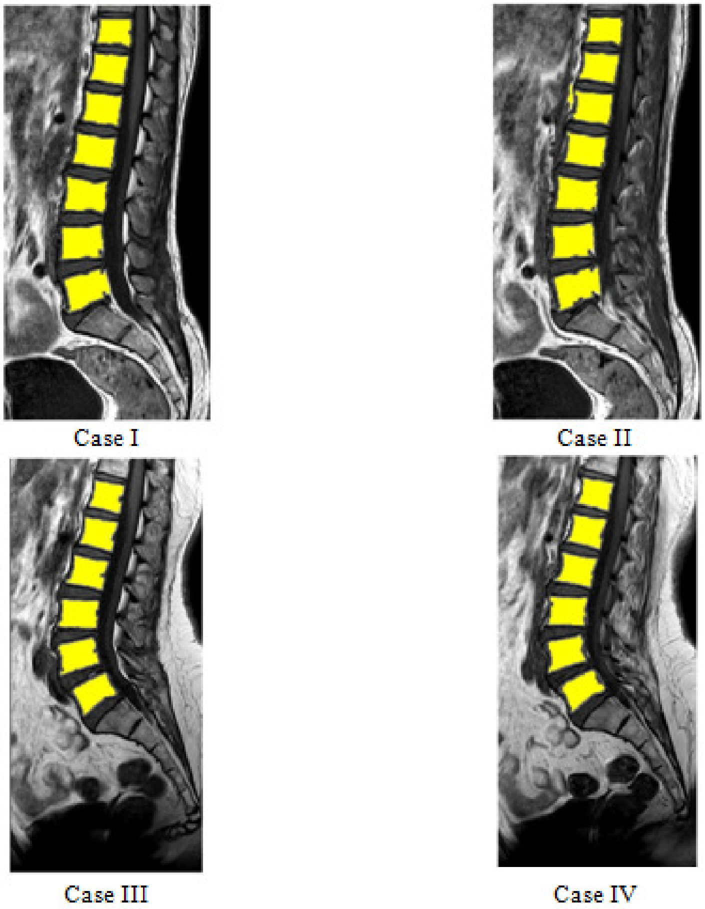


Figure 6. Labeling of VB after segmentation

### 4.3 Case study

Around 4 cases were used for the entire study. The patients complained of mild lower back pain and are in the age group between 45-60. The population included 2 female and 2 male. An image overlay of the input and segmented output for various cases is presented in fig 7.



Case I

Case II

Case III

Case IV

Figure 7. Overlay of segmented image with input for various case studies

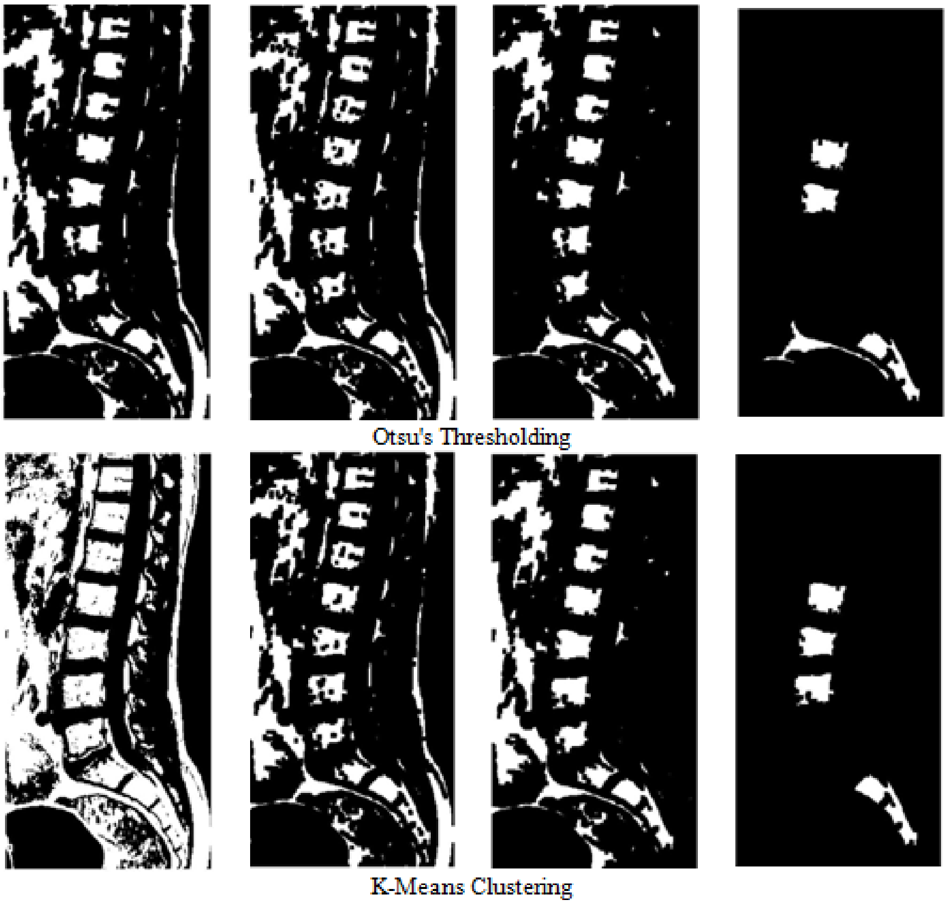
### 4.4 Comparative Analysis

A comparative tabulation amongst the global thresholding, a simple clustering and the Fuzzy clustering is illustrated in Table 1.

Table 1. Comparison of segmentation methods

| Cases | SI | Segmentation methods | | |
|---|---|---|---|---|
| | | Otsu thresholding | K- Means Clustering | Fuzzy C Means Clustering |
| Case I | DC | 0.36 | 0.622 | 0.835 |
| | HD | 10.23 | 7.338 | 3.97 |
| Case II | DC | 0.43 | 0.618 | 0.90 |
| | HD | 16.9 | 6.142 | 4.03 |
| Case III | DC | 0.57 | 0.714 | 0.852 |
| | HD | 15.8 | 5.48 | 3.62 |
| Case IV | DC | 0.437 | 0.773 | 0.83 |
| | HD | 15.2 | 5.7 | 3.95 |

The ground truth image was manually segmented by the radiologist and is used as the gold standard for validation. It can be observed that the Fuzzy method provides better DC value (closer to 1) and HD value (closer to 0) than compared to the rest thus affirming the robustness in segmentation. Images obtained using Otsu's thresholding and K-means is shown in fig 8.



(a) fuzzy c means (b) Erosion (c) Filtering using area criteria (d) Aspect ratio based elimination

Figure 8. Comparative analysis using Otsu and K-means

## 4.5 Failure Case

The method was tested on several images and in some images the segmentation failed to provide quality results. The transverse and spinous processes are a part of vertebral bodies. Thus, when they start emerging, with disruption in intensity as well as structure, the fuzzy clustering method fails to adapt to the complex topology. Apart from this, the presence of anterior and posterior ligaments also significantly affects the results of the segmentation. fig 9. shows the results of segmentation of one such case where the ROI has not been delineated clearly.

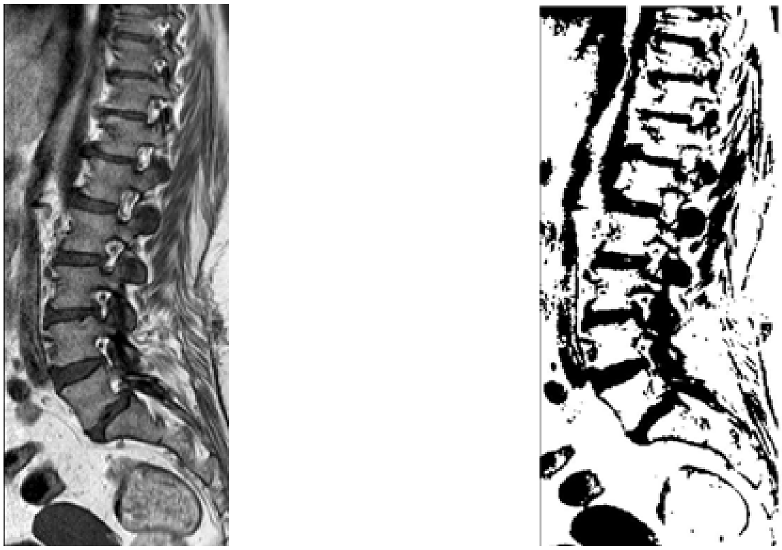


Figure 9. Failure case of proposed segmentation

## 5. CONCLUSIONS

In this paper, a fuzzy C-means clustering algorithm followed by morphological operations and labelling has been presented for segmentation of spine MR images. It is compared with the simple K-means clustering and Otsu thresholding scheme. Upon validation, it is observed that the fuzzy C-means gives improved segmentation results as compared to the counterparts.As a part of future work, we would like to incorporate intuitionistic fuzzy clustering to check if it can enhance the accuracy. Also extract features from the segmented VB for classifying various deformity.

## ACKNOWLEDGEMENTS

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# A CROSS-LAYER BASED SCALABLE CHANNEL SLOT RE-UTILIZATION TECHNIQUE FOR WIRELESS MESH NETWORK

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## *ABSTRACT*

*Due to tremendous growth of the wireless based application services are increasing the demand for wireless communication techniques that use bandwidth more effectively. Channel slot re-utilization in multi-radio wireless mesh networks is a very challenging problem. WMNs have been adopted as back haul to connect various networks such as Wi-Fi (802.11), WI-MAX (802.16e) etc. to the internet. The slot re-utilization technique proposed so far suffer due to high collision due to improper channel slot usage approximation error. To overcome this here the author propose the cross layer optimization technique by designing a device classification based channel slot re-utilization routing strategy which considers the channel slot and node information from various layers and use some of these parameters to approximate the risk involve in channel slot re-utilization in order to improve the QoS of the network. The simulation and analytical results show the effectiveness of our proposed approach in term of channel slot re-utilization efficiency and thus helps in reducing latency for data transmission and reduce channel slot collision.*

## *KEYWORDS*

*Multi-radio WMN, Radio channel measurement, Scheduling, Routing, Medium access control (MAC)*

## 1. INTRODUCTION

In current era wireless network gain much attention; research is ongoing day-by-day to improve more and more wireless technologies. Wireless Mesh Network (WMN) s is a part of this technologies growth. IEEE 802.15.5 MAC standard for mesh communication in wireless personal area network. WMN has a quality of dynamically self-organized and it can self-configure which make it more popular than other wireless network. Multi-hop transmission is one more

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characteristic of WMN. In a wireless Mesh network, there is fixed infrastructure over fixed wireless network which is used by wireless host. Every wireless host is connected with any of the mesh node; some mesh node may have direct association with internet. Channel quality in WMN fluctuated due to Doppler Effect, fading and interference [1]. MAC provides the actual benefit of mesh network. MAC- layer protocol by default chooses the minimum available transmission rate and it does not protect from error. Mesh network based on CSMA/CA MAC protocol which has single hop transmission characteristics, cannot provide the quality of service for the application which is streaming in real time like voice calling, video calling, etc. CSMA/CA has some limitation due to which we need a new MAC protocol which gives better throughput, capacity and reduce delay. To achieve better QoS it is needed to use the Time division multiple access (TDMA) based approach in MAC layer. Total channel (frequency channel or single band) is split into time-frame slot in TDMA scheduling and assignment of transmitting slot to the node is done. Power drop, collision, data overhead is prevented by every time slot [2]. TDMA with distributed approach consist of two different procedures. In first procedure it based on Bellman ford algorithm [3], each node find a nearest feasible link, which are taken from two-hop routing information updated by neighbour node. In second approach nearest feasible schedule is used to analyze the global feasible schedule and it inform the availability of a new schedule to the entire node.

## 2. RELATED WORK

Number of MAC-layer multicast mechanism was purposed for mesh network to overcome the inefficiency of the network. Hop-by-hop recovery on loss of packet is provided by researchers in various ways. Here [4] author gives the analysis of maximized output for a wireless mesh network over CSMA/CA in MAC layer protocol. Random access is not accounted in CSMA due to which collision overhead is increased. New development for optimal capacity analysis of network done in CSMA/CA with multi commodity flow (MCF), author analyze throughput based on upper and lower bound of the network capacity over CSMA/CA. the drawback of CSMA/CA is that it is not suitable for real time data transfer like video calling. In [5] if physical rate is increases efficiency of the MAC layer is decreases. More efficient MAC layer protocol in terms of scalability still has issues. Proposed scheme by author is MAC protocol based on dual channel token called (DT-MAC). This protocol is suitable for large number of user in terms of scalability and efficiency. Token management is extra overhead for network and it is not suitable for upper layer. In [6] wireless mesh network high throughput need a TDMA based approach. TDMA support multichannel transmission, schedule dissemination and routing integration. TDMA based on routing metrics and stability of routing metrics. Experiment shows that it control the network overhead and it not affected by external interference. It is not useful for large network. In [3] TDMA each frame is associated with some slot, and non –conflicting link is transmitted through these slots. Iterative procedure is used to find the nearest feasible schedule by exchanging the link information between nodes. Another part is work on wave based termination which is used to detect the scheduled nearest node and if any new node is scheduled which is activated. Spatial-TDMA [9] used for reduced the energy consumption and improve the throughput author formulate offline energy –throughput by the tradeoff curve. Physical interference involved where node used for controlling the power. Author work is based on single channel or single node, it is not feasible for multi-channel or multiple node scenario. Here [7] author works for high throughput and reliable mesh network in multi-hop transmission. Reduce network bandwidth in multicast tree. Author presents a distributed and centralized algorithm for tackle the problem of multicasting. Obtained result from expected multicast transmission count (EMTX) method, shows the effectiveness it reduces the number of hop-by-hop transmission per packet, but it not considerable for real life or realistic scenario. A hierarchical mesh tree protocol given in [10] which achieve efficient routing at the MAC layer. Optimal route is chosen by the using of mesh tree topology. The used new HMTP also used for maintaining the update of new route formed. The HMTP topology overcomes the drawback cluster-tree. In[8] improvement of QoS by avoiding the network congestion, an algorithm is designed for that prediction of congestion is done before it really happen by using different data, analysis of network and used the historical data of traffic to generate idea of future network traffic. Through network traffic data, load balancing is done to avoid congestion in wireless mesh network. But author proposed algorithm is inefficient to response network congestion properly.

### 2.1 Issues and Challenges Faced in Multi Radio Wireless Mesh Network

Using IEEE 802.15.5 standard WMN in free frequency bands for wireless communications traffic has the following issue the need to be addressed as in [12]:

Speed of mobile devices. Physical and transport levels of IEEE 802.15.5 developed for fixed stations, where high speed can lead to large and rapid changes in channel conditions, which in turn increases the probability of frame error (FER). This occurrence is due to the Rayleigh fading channel [11].

Distance: IEEE 802.15.5 is used for communications over short distances of several hundred meters. Together with this limitation there is a necessity in a large number of access points/roadside stations (remote control) to cover the entire route. Usually 802.15.5 transmits a plurality of control frames and messages for the association and/or network authentication before transmitting useful information.

Handover is also difficult to implement due to the high speed of vehicles on the road, where the handoff occurs very frequently between the remote control for the entire route.
When designing a Mesh network appear the following difficulties:

Difficult to predict the number of subscribers on the network at different intervals. Difficulties in predicting the amount of traffic generated by nodes, hence the total system capacity. The wireless channel is stochastic and time-varying according to different parameters.

It is seen from literature that the existing mac based mesh network suffer improper channel slot re-utilization. To overcome the short coming here the author propose an efficient cross layer based channel slot re-utilization optimization based on node classification technique to improve the QoS of WMNs.

The paper organization is as follows: The proposed channel slot re-utilization models are presented in Section two. The results and the experimental study are presented in the section three. The concluding remark is discussed in the last section.

## 3. PROPOSED MODEL

Here the author proposes an adaptive cross layer based slot channel re-utilization optimization to improve the QoS of WMNs. The slot re-utilization helps in reducing latency of data delivery LP

LP but there is a chance or risk of beacon collision to some other devices that may join late to the wireless mesh network. To address this here the author proposes a node classification based slot re-utilization technique to reduce latency and propose robust wireless mess tree architecture.

## 3.1 Proposed Node Classification for Slot Re-utilization for WMN

Here the author classifies the device pair based on the information of parenthood and neighbourhood relationship. The classified device pair (x, y) is as follows

### 3.1.1 Connected Inner Relay Node Pair (CIRP):

Here x and y are adjacent device that exist physically in the WMN, and either x and y are not adjacent device; or, either x or y has a child, but xand y have a conjoint adjacent device which is a child of either x or y.

### 3.1.2 Connected Leaf Relay Node Pair (CLRP):

Here x and y are adjacent devices that exist physically in the WMN, but neither x nor y has any child.

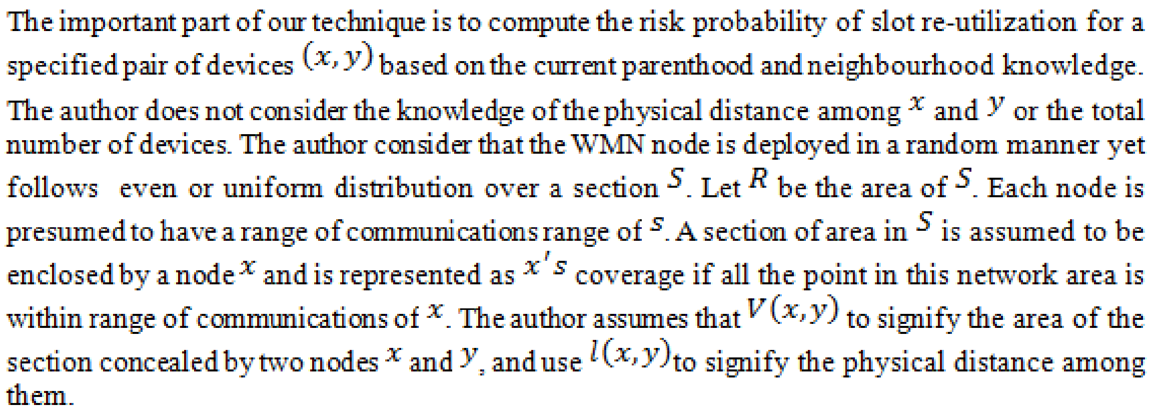
### 3.1.3 Distant Inner Relay Node Pair (DIRP):

Here x and y are not adjacent devices physically but have a conjoint adjacent physical devices in common, although all these adjacent physical devices are neither x's nor y's children.

### 3.1.4 Non-connected leaf node pair (NCLRP):

Here x and y are not adjacent physical devices, neither do they have adjacent physical devices in common. Now the author propose channel slot reutilization by CLRP, DIRP and NCLRP when the probability of is risk is small which is explained in below section.

## 3.2 Proposed Slot Re-Utilization for WMN



The important part of our technique is to compute the risk probability of slot re-utilization for a specified pair of devices $(x, y)$ based on the current parenthood and neighbourhood knowledge. The author does not consider the knowledge of the physical distance among $x$ and $y$ or the total number of devices. The author consider that the WMN node is deployed in a random manner yet follows even or uniform distribution over a section $S$. Let $R$ be the area of $S$. Each node is presumed to have a range of communications range of $s$. A section of area in $S$ is assumed to be enclosed by a node $x$ and is represented as $x's$ coverage if all the point in this network area is within range of communications of $x$. The author assumes that $V(x, y)$ to signify the area of the section concealed by two nodes $x$ and $y$, and use $l(x, y)$to signify the physical distance among them.

It is known fact that the radio coverage of a wireless transmitter suffer from path loss phenomenon. A practical radio propagation model may consider random variations in path loss at different direction and location [13] and [14], [16] respectively. Subsequently the packet transmission among pair of devices becomes a probabilistic task with probability distribution utility considering direction or distance among the transmitter and the receiver as a parameter. The proposed node or device-pair classification and communication evaluation are based on the perception of adjacent physical devices, which represent a binary association considering that the two nodes are either adjacent physical devices or are not. Such an association needs a setup of a thresholding on packet or data reception probability for the decision of adjacent physical devices in accordance to a source or transmitter. Subsequently the sources or transmitter operative range of communications would be uneven. However, we can estimate the lower bound of the range of transmission within which any nodes can have an association with the source or transmitter, or a higher of the range, outside which no nodes will be able to receive the data from sources or transmitter successfully.

The symbolization $s$ is represented as the lower bound, the upper bound, or the average bound of range of communication, in which case it is essentially the worst case, best case or the mean case risk parameters of the analytical result presented in the following sturdy.

### 3.2.1. Scheme 1:

The predictable mesh area of the particular region mutually covered by two devices $x$ and $y$ is

$$G|V(x,y)| = \left\{\left(\pi - \frac{3\sqrt{3}}{4}\right) \quad if\ p(x,y) \leq s.\right.$$

$$G|V(x,y)| = \left\{\frac{\sqrt{3}}{4} s^2 \quad if\ s < p(x,y) \leq 2s.\right.$$

A device that is positioned at the edge of $S$ is expected to cover less area than as part of its coverage in beyond or outside $S$. This effect is known as the border effect. To overcome the impact by the border effect the author presents the following analysis considering that the region covered by any device is within $S$. If $S$ represents a rectangle area, the probability can be evaluated by adopting the torus convention methodology [15], which turns a flat rectangle into a torus. With this theory, the link occurrence probability [17] is formulated as $p = \pi s^2/R$. Our fundamental outcome consists of following three Propositions which is presented below.

### 3.2.2. Proposition 1:

Consider that the device are distributed uniformly over a region $S$ of $R$ size, and $R \gg \pi s^2$. Assume a device pair $(x,y) \in YP$ are using same channel slot when a new device $n$ join a network which is represented by $P_Y(x,y)$. The predictable probability of $n$ suffer from the risk involved in channel slot re-utilization among device $x$ and $y$ is $P_Y(x,y) = \left(1 - \frac{3\sqrt{3}}{4\pi p}\right)$ where $p = \pi s^2/R$.

Proposition 1 is verified based on the inclusion exclusion principle and the outcome of Scheme 1. It shows that $P_Y = (x,y) \approx 1.41p$, therefore increase in range of communication involves high probability of collision among devices in $YP$.

### 3.2.3. Proposition 2:

Proposition 2 represented as $P_Z = (x,y)\ (resp. P_X(x,y))$ is the probability expected when a device $n$ joining a network becomes a victim of slot re-utilization among $x$and $y$ when $(x,y) \in ZP\ (resp. (x,y) \in XP)$. Moreover the predictable probability $P_X^*(x,y)$ that a device $n$ joining a network become a fatality or victim of channel slot re-utilization among $x$ and $y$ when $(x,y) \in XP$ considering that $s < d(x,y) \leq 2s$. Let $a$ represent the number of adjacent device of $y$, then $P_Z(x,y)$and $P_X(x,y)$are correlated to $P_X^*(x,y)$ by

$$P_Z(x,y) = \frac{\sqrt{3}}{4\pi\big(1-\varphi(a)\big)}p - \frac{\varphi(a)}{1-\varphi(a)}P_X^*(x,y), \quad (1)$$

$$P_X(x,y) = 3pP_X^*(x,y),$$

Where $p = \pi s^2/R$ and

$$\varphi(a) = \frac{2}{3}\int_{\theta=0}^{2\pi/3}\left[1-\frac{\theta-\sin\theta}{\pi}\right]^a \sin\theta\, d\theta.$$

Function $\varphi(a)$ is the predictable probability of all $y's\ a$ adjacent devices not residing in the region covered by $x$ and $y$ considering that $s < d(x,y) \leq 2s$. Subsequently $\varphi(a)$ is reducing in accordance to value of $a$, $\varphi(a) \leq \varphi(1) = 1 - \frac{\sqrt{3}}{4\pi}$ and $1-\varphi(a) \geq 1-\varphi(1) = \frac{\sqrt{3}}{4\pi}$ for all $a \geq 1$. It follows the first term of (1) is lesser than $1p$ and $P_Z(x,y)$ hence it is upper bounded by $p$for the case of $a = 1$.

$$P_Z(x,y) = p - \frac{1-\frac{\sqrt{3}}{4\pi}}{\frac{\sqrt{3}}{4\pi}}P_X^*(x,y) \geq 0.$$

It follows that

$$P_X^*(x,y) \leq \frac{\sqrt{3}}{4\pi-\sqrt{3}}p \approx 0.16p.$$

Therefore $P_X(x,y) = 3pP_X^*(x,y) = 0.48p^2$

For a general $a$, the integration task of $\varphi(a)$ requires an intensive computation procedure. Luckily the value of $\varphi(a)$ corresponding to practical value os $a$ are pre-calculated and kept in the devices before deployment. These assessment can be checked when $\varphi(a)$ need to be computed. More notably based on Proposition 2 we can evaluate $P_X^*(x,y)$, then we can predict the precise value of $P_Z = (x,y)$ and $P_X(x,y)$. Next based on Proposition 3 we evaluate the $P_X^*(x,y)$.

### 3.2.4. Proposition 3:

Based on the definition of Proposition 2,

$$P_X^*(x,y) = \int_s^{2s} V(b) \left\{ \frac{\left[1 - \frac{V(x)}{\pi s^2}\right]^a \frac{2s}{3s^2}}{\int_s^{2s} \left[1 - \frac{V(x)}{\pi s^2}\right]^a \frac{2s}{3s^2}} \right\} dx$$

Where

$$V(b) = s^2 \left[ 2arc\cos\frac{b}{2s} - 2\sqrt{1 - \left(\frac{b}{2s}\right)^2} \left(\frac{b}{2s}\right) \right]$$

From Figure 1 and Figure 2 Compares the values of $P_Z(x,y)$and $P_X(x,y)$ respectively are the simulation value obtained based on Proposition 2 and Proposition 3. The simulation effective range of communication is set and the areas are fixed as $\sqrt{aR/c\pi}$, and devices are added to the simulation bed until an average degree $a$ of a device is reached. Our analytical or mathematical result gives a high precision of accuracy. Proposition 3 requires an intensive computation for increase in $a$. For a device to compute $P_X^*(x,y)$ effectively here the author propose the following approximation

$P_Z(x,y) \approx 0.17p.$ (2)

The value of $P_X(x,y)$ are largely so low and are considered to be zero i.e.... $P_Y(x,y) \geq P_Z(x,y) \geq P_X(x,y)$ or $P_X(x,y) \geq P_Z(x,y) \geq P_X \geq P_Y(x,y)$.

The simulation sturdy of our proposed approach is evaluated in the below section of this paper.

## 4. Simulation Result and Analysis

The system environment used is windows 10 enterprises 64-bit operating system with 16GB of RAM. The author have used visual studio Dot net framework 4.0, 2010 and used VC++ programming language. The author has conducted simulation study for probability analysis for channel slot re-utilization by varying the node size and node degree.

In Fig. 1, the author computes the probability of P_Z (x,y) by varying number of node or devices and node degree value. In figure we can see that when we increase the node degree a value the probability of collision also increases for all node sizes (50, 100, and 150). The probability of collision is high for smaller mesh network size (50) when compared to larger network size (150).

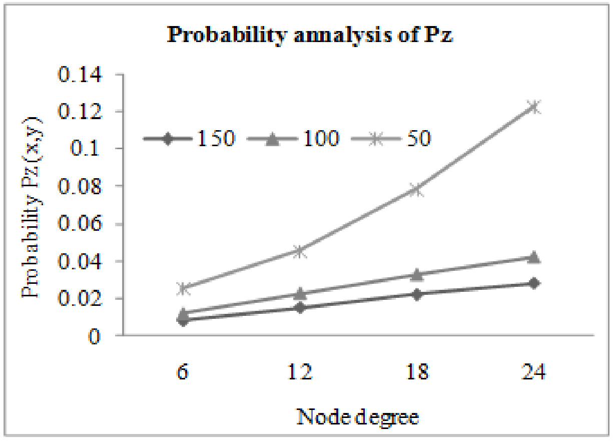


Figure 1. Probability analysis for $P_Z(x, y)$

In Fig. 2, the author computes the probability of P_X (x,y)by varying number of node or devices and node degree value. In figure we can see that when we increase the node degree a value the probability of collision also increases for all node sizes (50, 100, and 150). The probability of collision is high for smaller mesh network size (50) when compared to larger network size (150).

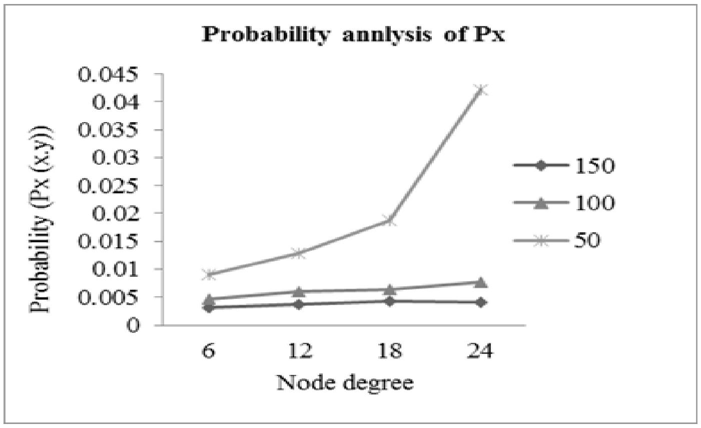


Figure 2. Probability analysis for $P_X(x, y)$

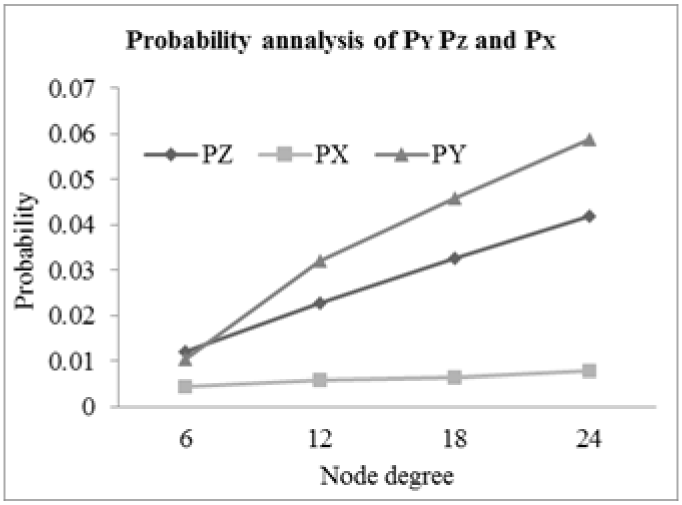


Figure 3. Probability analysis

In Fig. 3, the author computes the probability of $P_X(x,y)$, $P_Z(x,y)$, $P_Y(x,y)$ by node degree value for 150 nodes or devices. In figure we can see that when we increase the node degree $a$ value the probability of collision also increases. The probability of collision is high for $P_Y(x,y)$, the probability of collision is low for $P_X(x,y)$ and the probability of collision for $P_Z(x,y)$lies between $P_X$ and $P_Y$. Thus proving proposition 3 $P_Y(x,y) \geq P_Z(x,y) \geq P_X(x,y)$.

## 6. CONCLUSIONS

The paper presents a model that help in the design of MWNs that meets the QoS necessities of the end user. Here in this work we have presented a cross-layer based channel slot reutilization model based on node classification technique that minimizes the collision for channel slot re-utilization and thus helps in reducing latency for data transmission in WMN. The experimental result shows the impact of proposed model on channel slot re-utilization. In future we would conduct simulation sturdy for latency and compare our proposed model with other distributed, centralized or MAC based scheduling algorithm.

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# ASSOCIATIVE REGRESSIVE DECISION RULE MINING FOR PREDICTING CUSTOMER SATISFACTORY PATTERNS

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## ABSTRACT

*Opinion mining also known as sentiment analysis, involves customer satisfactory patterns, sentiments and attitudes toward entities, products, services and their attributes. With the rapid development in the field of Internet, potential customer's provides a satisfactory level of product/service reviews. The high volume of customer reviews were developed for product/review through taxonomy-aware processing but, it was difficult to identify the best reviews. In this paper, an Associative Regression Decision Rule Mining (ARDRM) technique is developed to predict the pattern for service provider and to improve customer satisfaction based on the review comments. Associative Regression based Decision Rule Mining performs two-steps for improving the customer satisfactory level. Initially, the Machine Learning Bayes Sentiment Classifier (MLBSC) is used to classify the class labels for each service reviews. After that, Regressive factor of the opinion words and Class labels were checked for Association between the words by using various probabilistic rules. Based on the probabilistic rules, the opinion and sentiments effect on customer reviews, are analyzed to arrive at specific set of service preferred by the customers with their review comments. The Associative Regressive Decision Rule helps the service provider to take decision on improving the customer satisfactory level. The experimental results reveal that the Associative Regression Decision Rule Mining (ARDRM) technique improved the performance in terms of true positive rate, Associative Regression factor, Regressive Decision Rule Generation time and Review Detection Accuracy of similar pattern.*

## KEYWORDS

*Associative Regression, Decision Rule Mining, Machine Learning, Bayes Sentiment Classification, Probabilistic rules.*

## 1. INTRODUCTION

Recently, novel method enriching semantic knowledge bases for opinion mining in big data applications has been evolved. In Opinion mining, sentiment analysis is very difficult to discover like and dislike of people. Hence by learning matrices for words, model can handle unseen word compositions.

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In order to estimate their helpfulness, text mining and predictive modeling techniques toward a more complete analysis of the information captured by user-generated online reviews has been presented by many researchers. Taxonomy Aware Catalog Integration (TACI) [1] integrated products coming from multiple providers by making use of provider taxonomy information ensuring scalability that are typical on the web. However, tuning parameters does not update unless significant improvement in accuracy to avoid over fitting and it does not use any target or source taxonomy during training or application of classifier.

Tweet Analysis for Real-Time Event Detection and Earthquake (TA-RTED) [2] designed a classifier based on the keywords in order to improve the earthquake detection extracted through tweets. However, the registered location might not be current location of a tweet and it might not hold for other events such as traffic jams, accidents, and rainbows.

Many researchers have published their study of machine learning approach. Machine learning approach was developed using naïve Bayes [3] for identifying and distributing healthcare information. However, the syntactic rule-based relation extraction systems are complex based on additional tools.

Sara Hajian and Josep Domingo-Ferrer et al., [4] handles discrimination prevention in data mining and it also used for direct or indirect discrimination prevention. However, it failed to address the data distribution. An efficient algorithm was designed in [5] for detecting the top-k totally and partially unsolved sequences. This algorithm also used for reducing the running time and improving the accuracy while preserving data quality. However, it does not increase the detection accuracy of similar pattern at a required level.

Opinion mining analyzed people’s opinions, sentiments, and attitudes toward entities products, services, and their attributes. Characterization of event and prediction based on temporal patterns are detected using multivariate reconstructed phase space (MRPS) [6] using fuzzy clustering unsupervised method. However, the MRPS method provides more difficult event function for different applications.

Intrinsic and extrinsic domain relevance criterion was developed in [7] aimed at improving the feasibility and effectiveness of the approach. However, it difficult to detect opinion features, including non-noun features, infrequent features, and implicit features collectively.

Probabilistic Generative Classifiers [8] used two or more classifiers resulting in the improvement of similarity measure. However, it does not address the various prior distribution investigations. The classification of trajectories on road networks was analyzed in [9] using frequent pattern-based classification which improves the accuracy. However, it does not address the pattern-based classification. The multi-class sentiment classification using that Extreme Learning Machine (ELM) methods were described in [21] for detecting their respective performance in multi-class sentiment classification of tweets. However, but it does not increases the classification accuracy effectively.

The contribution of the paper is organized as follows. Associative Regression Decision Rule Mining (ARDRM) technique is presented to predict the pattern for service owner and increasing their customer satisfaction based on their review comments. The Machine Learning Bayes Sentiment Classifier is subjected in ARDRM technique to classify the class labels for each service reviews. By applying the various probabilistic rules, the regressive factor of the opinion words and Class labels are verified between the words. This helps to increase the review detection accuracy.

The rest of the paper is organized as follows. Section 2 introduces several data mining models. Section 3 introduces our Associative Regression Decision Rule Mining technique based on the customer review comments. Section 4 presents the experimental setting and Section 5 presents the results of performance evaluation. Finally, the concluding remark is presented in Section 6.

## 2. RELATED WORK

In [11], a predictive model using three classification algorithms called decision tree, Bayesian classifier and back propagation neural network was presented. This model improved the diagnosis and prediction of cerebrovascular disease. Another predictive model using gradient-boosted regression tree [12] to make prediction aiming at reducing the execution flow. However the prediction accuracy did not effectively increase.

Many research works were conducted to answer top-k queries using Pareto Based Dominant Graph (DG) [10] aiming at improving the search efficiency. However, the relationship analysis remained unaddressed. Fast Distributed Mining (FDM) algorithm was designed in [13] for mining of association rules in horizontally distributed databases in a secured manner aiming at minimizing the communication rounds, communication and computational cost.

With the emergence of social media, web users have opened with a venue for expressing and sharing their thoughts and opinions related to different topics and events. Twitter feeds classification based on a hybrid approach was presented in [14] to achieve higher accuracy. However, this approach does not increase the accuracy at a required level.

In [15], a unified framework called, HOCTracker presented a novel density-based approach to identify hierarchical structure of overlapping communities. Probabilistic neural network and general regression neural network (PNN/GRNN) data mining model was planned in [16] for detect and preventing the oral cancer at earlier stage and also provides higher accuracy.

An incremental classification algorithm in [17] with feature space heterogeneity efficiently removed the outliers and extracted the relevant features at an early time period. In [18], an extensible method to mine experiential patterns from increasing game-logs was designed by utilizing the growing patterns.

An enhanced k-means clustering was applied in [19] to reduce the coefficient of variation and execution time using greedy approach for efficient discovery of patterns in health care data. In [20], random forest predictions were made using random forest algorithm to display prediction uncertainty. However, the true positive rate was not addressed.

Based on the aforementioned issues such as lack of detection in classification accuracy and failure in detecting the specified event in customer reviews, Associative Regression Decision Rule Mining (ARDRM) technique is presented. The ARDRM technique helps the service provider for improving the hotel customer satisfactory level at different cities. The detailed explanation is presented in forthcoming section.

## 3. DESIGN OF ASSOCIATIVE REGRESSION DECISION RULE MINING

Our technique Associative Regression based Decision Rule Mining is been done in two step process. First, the Machine Learning Bayes Sentiment Classification use a base classifier where the class labels for each product/service reviews is classified. Then the opinion words and class labels are used to obtain the regressive factor using various probabilistic rules to produce a final decision on improving the customer satisfaction referred to as the Associative Regression Decision Rule model. These two steps are now discussed in detail.

Figure 1 shows the workflow of Associative Regression Decision Rule Mining technique. Given a domain-dependent review comments (i.e. opinion words) extracted from OpinRank dataset that includes the reviews of hotels in 15 different cities, we first extract a list of class labels from the Machine Learning Bayes Sentiment Classification via semantic equivalence of sentiments classification.

For each extracted class labels, we estimate its regression factor which represents the statistical association between opinion words and class labels. The resultant regressive sequence inferred is then applied with probabilistic rules to arrive at specific set of services preferred by the customers.

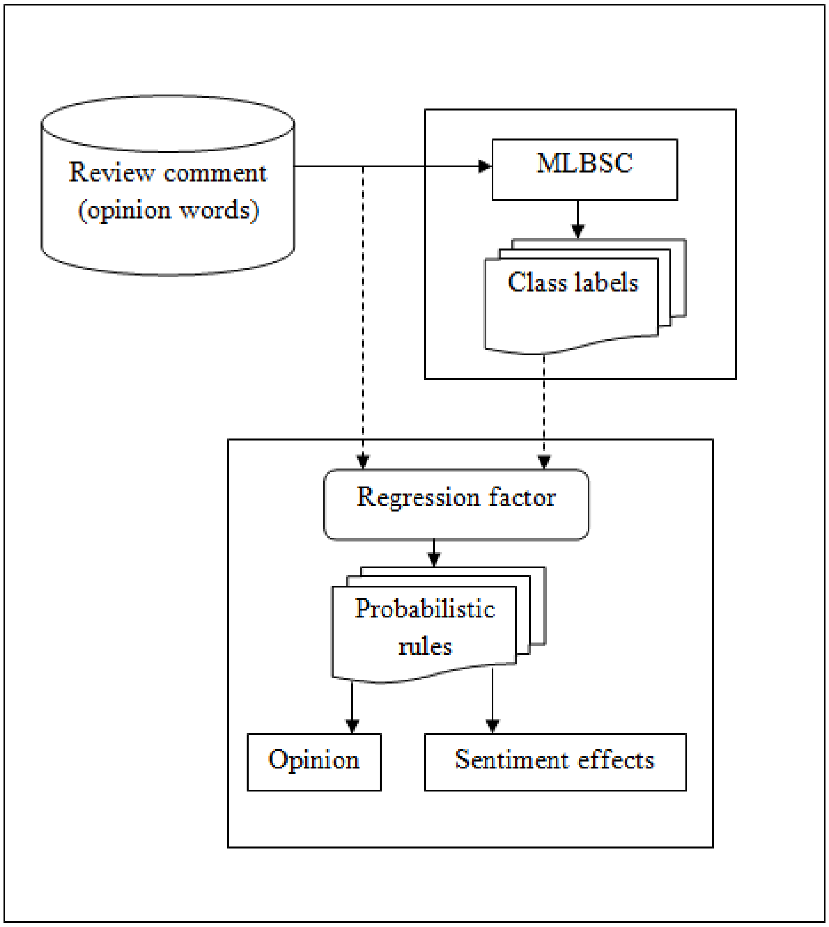

Figure 1. Workflow of Associative Regression Decision Rule Mining technique

### 3.1. Design of Regressive Sequencing Model

The first step in the design of ARDRM technique is to obtain the class labels generated from Machine Learning Bayes Sentiment Classification (MLBSC) techniques. Here the sentiment class labels are extracted using Probabilistic Bayes Classifier. In MLBSC, Probabilistic Bayes Classifier is applied on the semantic opinion words to evaluate sentiment class label using the maximum likelihood estimates (MLE). The MLE of a training list (i.e. bag of words extracted from OpinRank dataset) belonging to a specific class are mathematically evaluated as given below.

$$MLE\left(\frac{B_i}{C}\right) = \frac{Count\ of\ B_i\ in\ semantic\ opinion\ words\ of\ Class\ C}{Total\ number\ of\ words\ in\ semantic\ opinion\ words\ of\ Class\ C} \qquad (1)$$

From (1), the maximum likelihood estimates is the ratio of count of semantic opinion words of class '$C$' to the total number of words. Followed by this, the class labels generated from MLBSC are subjected to regressive sequencing to infer the sentiments reflected in the customer reviews. The regressive sequencing in ARDRM technique is produced with the aid of support and confidence value.

Let us assume that '$I = i_1, i_2, \dots, i_n$' represents a binary set consisting of opinion words with '$i_1, i_2, \dots, i_n$' referred to as items. Let us further assume that Transaction '$T$' (i.e. review comments) is the itemset with '$T \in I$'. Let '$P$' be the set containing items in '$I$' and transaction '$T$'contains '$P$' if '$P \in T$', then the support denotes the probability of frequent itemsets' occurrence. Smaller value of minsup results in larger number of rules whereas larger value of minsup results in smaller number of rules.

The support of rule '$P \rightarrow Q$' in the transaction database '$TD$' is the ratio between the transaction number including '$P$' and '$Q$' in the transaction sets and all the transaction number, which is then written as '$SUP\ (P \rightarrow Q)$'.

$$SUP\ (P \rightarrow Q) = \frac{Prob\ (PQ)}{N} \tag{2}$$

The confidence of the rule '$P \rightarrow Q$' in the transaction sets is the ratio between the transaction number including '$P$' and '$Q$' and those including '$P$', which is written as '$CONF\ (P \rightarrow Q)$'. Therefore,

$$CONF\ (P \rightarrow Q) = \frac{Prob\ (PQ)}{Prob\ (P)} \tag{3}$$

From (2) and (3), the sentiments reflected in customer reviews are obtained by using support and confidence value. This aids in achieving the true positive rate of customer reviews in an extensive manner. Once, the support and confidence value for customer reviews are generated, the regressive sequencing is designed. In MLBSC, the regressive sequencing model uses two variables '$y_1$' and '$y_2$' where '$y_1$' represents '$minsup$' and '$y_2$' represents '$minconf$' to infer the sentiments reflected in the customer reviews. The mathematical formulates for '$y_1$' and '$y_2$' is as given below.

$$x = \delta_0 + \delta_1 \left(\frac{1}{y_1^2}\right) + \delta_2 \left(\frac{1}{y_2^2}\right) \tag{4}$$

$$x = \delta_0 + \delta_1 \left(\frac{1}{y_1}\right) + \delta_2 \left(\frac{1}{y_2}\right) \tag{5}$$

$$x = \delta_0 + \delta_1\ (y_1) + \delta_2\ (y_2) \tag{6}$$

The regressive factor (i.e. '$y_1$' and '$y_2$') of the opinion words with class labels are checked for the association between the words. This in turn improves the associative regression factor in a significant manner. Figure 2 shows the algorithmic description of Regressive Sequencing algorithm.

```
Input: opinion words '$I = i_1, i_2, \ldots, i_n$', Transaction '$T$',
Output: Optimized true positive rate
Step 1: Begin
Step 2:     For each Transaction '$T$' with opinion words '$I$'
Step 3:         Measure the value for support using (2)
Step 4:         Measure the value for confidence using (3)
Step 5:         Measure '$minsup$' and '$minconf$' using (6)
Step 6:     End for
Step 7: End
```

Figure 2. Regressive Sequencing algorithm

From the above figure 2, the Regressive Sequencing algorithm performs three steps. For each transaction, customer reviews obtained from OpinRank dataset that includes hotel reviews is given as input. The first step evaluates the support value, followed by the measure of confidence value in order to identify the sentiments reflected in customer reviews. Finally, with the objective of improving the associative regression factor, sentiments reflected in customer reviews '$minsup$' and '$minconf$' are evaluated to check the association between the words.

## 3.2. Design of Associative Regressive Decision Rule

The second step in the design of ARDRM technique is to construct Associative Regressive Decision Rule. Various probabilistic rules are generated for the class objects in the corresponding classes with more similar patterns together. Based on the probabilistic rules, the opinion and sentiments effect on customer reviews are analyzed to arrive at specific set of services preferred by the customers with their review comments. The Associative Regressive Decision Rule helps the service providers to take decision on how to improve the hotel customer satisfactory level. Next, the frequent itemset generation algorithm is designed to the regressive sequenced dataset which is obtained through regressive sequencing model. Redundant regressive rules generated are eliminated using redundant regressive decision rule testing.

### 3.2.1. Redundant Regressive Decision Rule Testing

Redundant regressive decision rule testing is performed in ARDRM technique aiming at minimizing the regressive decision rule generation time and removes the redundancy involved. This is performed through elimination of redundant decision rule through regressive model.

$$P_a, P_{b,} P_c .., P_n \rightarrow \sum_{i=1}^{n} (y_1, \mu_i, \sigma_i) \qquad (7)$$

$$\text{First set of } variance\ (P_{ab}) = P_a - P_b \qquad (8)$$

$$\text{Second set of variance } (P_{bc}) = P_b - P_c \qquad (9)$$

From (7), '$\mu_i$' symbolizes the mean of the target review for the class objects and '$\sigma_i$' symbolizes the variance of the target review for the class objects. In (7), the mean and variance are evaluated. The variance of the association rules are calculated using (8), (9) where $P_a, P_{b,} P_c$ are the target reviews for class object. If the variance (first set) of the association rule is lower than the variance (second set) of the association rule, then redundancy is said to be occurred in the first set. On contrary, if the variance (first set) of the association rule is greater than the variance (second set) of the association rule, then redundancy is said to be occurred in the second set. By using specified threshold value, the redundant rules are eliminated. If the identified redundancy value is obtained within the threshold value, the redundant rules are eliminated. The Redundancy value is possibly occurred within the thresholding value. This in turn minimizes the regressive decision rule generation time.

### 3.2.2. Associative Regressive Decision Model

Once the redundant rules are eliminated using redundant regressive decision rule testing then, finally associative regressive decision model is designed to arrive at specific set of service preferred by the customers. Building an associative regressive decision model requires selection of a smaller, representative set of rules in order to provide an accurate representation of the training data.

The frequent itemset generation algorithm is shown in figure 3 to select the rule in an efficient manner by first sorting the rule, and then remove the occurrences covered by the rule. As shown in the algorithm, for each itemset, the algorithm starts with the elimination of redundant rule. Followed by this rule redundant removal, the occurrence of redundancy is observed and removed in specified threshold value. Then rule sorting is performed based on the pair of rules. Finally, Associative Regressive Decision model is applied to the generated rules that help the service provider to customer satisfactory level.

Let us consider a pair of rules, '$Rule_1$' and '$Rule_2$' where '$Rule_1 \gg Rule_2$'. This implies that '$Rule_1$ ' has higher preference over '$Rule_2$' and is formulated as given below.

$$if(Rule_1 \gg \ Rule_2) \rightarrow ARD = \ Rule_1, Rule_2 \tag{8}$$

$$if(Rule_2 \gg \ Rule_1) \rightarrow ARD = \ Rule_2, Rule_1 \tag{9}$$

**Input**: mean of the target review for the class objects '$\mu_i$', variance of the target review for the class objects '$\sigma_i$', first set $P_{ab}$, second set $P_{bc}$,

**Output**: Improved customer satisfactory level

```
Step 1:  Begin
Step 2:      For each set $P_i$
Step 3:          Perform redundant rule elimination through
Step 4:          If $\sigma_i(P_{ab}) < \sigma_i (P_{bc})$
Step 5:              Redundancy is found in said to be occurred in $(P_{ab})$
Step 6:          End if
Step 7:          If $\sigma_i(P_{ab}) > \sigma_i (P_{bc})$
Step 8:              Redundancy is found in said to be occurred in $(P_{bc})$
Step 9 :         End if
Step 10:         If ( $T_h \geq redundancy\ value$ )
Step 11:             The redundant rule is eliminated
Step 12:         End if
Step 13:     End for
Step 15:     Perform rule sorting
Step 16:     If $(Rule_1 \gg \ Rule_2)$
Step 17:         $ARD = \ Rule_1, Rule_2$
Step 18:     End if
Step 19:     If $(Rule_2 \gg \ Rule_1)$
Step 20:         $ARD = \ Rule_2, Rule_1$
Step 21:     End if
Step 22:     Perform Associative regressive decision model using (10)
Step 23:  End
```

Figure 3. Associative regressive decision-based frequent itemset generation algorithm

On contrary, if '$Rule_2 \ \gg \ Rule_1$', then '$Rule_2$ ' has higher preference over '$Rule_1$'. Once the sorted rules are obtained, the final step is to design Associative Regressive Decision model. The Associative Regressive Decision model is designed in such a way that, the rule has higher support value and has lower variance when '$Rule_1$' and '$Rule_2$' are applied. Then, the mathematical formulates

$$(Rule_1\ , Rule_2) \rightarrow (MaxSup\ (Rule_1, Rule_2), MinVar\ (Rule_1, Rule_2) \tag{10}$$

Based on (10), several probabilistic rules are generated for the class objects with more similar patterns together and also the rule the service preferred by the customers with their review comments. This in turn helps the service providers to take decision on improving the customer satisfactory level, thereby improving the review detection accuracy based on the review comments of the customers.

## 4. EXPERIMENTAL SETTINGS

Associative Regression Decision Rule Mining (ARDRM) technique uses JAVA platform with WEKA tool to predict a predictive pattern for service owner to improve their customer satisfaction based on their review comments. This method is widely used to perform efficient predictive pattern mining model with the tests and training samples. Hotel Customer Service Reviews (eg: OpinRank Dataset - Reviews from TripAdvisor) is taken to perform the experimental work. The training model for OpinRank dataset includes entire hotel reviews situated in 10 different cities (Dubai, Beijing, London, New York, New Delhi, San Francisco, Shanghai, Montreal, Last Vegas and Chicago) with the aid of Java platform and with WEKA tool. This dataset has been chosen because it gives a clear picture that helps in analyzing the comments made by tourists about hotel rooms and food provided. The total number of reviews included in OpinRank dataset is 250,000. For experimental purpose, we reviewed using 350 and the extracted field includes date of review, review title and full review made by the tourists.

The performance of Associative Regression Decision Rule Mining (ARDRM) technique is compared with Taxonomy-Aware Catalog Integration (TACI) [1], and Tweet Analysis for Real-Time Event Detection and Earthquake (TA-RTED) [2]. The tests on OpinRank dataset were conducted to evaluate four parameters: true positive rate, associative regression factor, regressive decision rule generation time and review detection accuracy of similar pattern.

## 5. DISCUSSION

The Associative Regression Decision Rule Mining (ARDRM) technique is compared against the existing Taxonomy-Aware Catalog Integration (TACI) [1] and Tweet Analysis for Real-Time Event Detection and Earthquake (TA-RTED) [2]. The experimental results using JAVA platform with WEKA are compared and analyzed with the aid of graph form as given below.

### 5.1. Impact of True positive rate

The true positive rate is the sentiments correctly identified as belonging to a specific class in customer reviews words correctly identified as belonging to a specific class. The true positive rate is mathematically formulated as given below.

$$TPR = \left(\frac{\text{sentiments correctly identified as belonging to a class}}{C}\right) * 100 \qquad (11)$$

From (11), the true positive rate '$TPR$' is obtained using the class '$C$' where each class consists of different number of sentiments extracted from user review. It is measured in terms of percentage (%). The convergence plot for 7 classes is depicted in table 1 and figure 4. From the figure 4 we can note that the proposed ARDRM technique achieved maximum true positive rate on sentiments being correctly identified as belonging to a specific class when compared to other methods.

Table 1. Tabulation for true positive rate

| **Class (C)** | **True Positive Rate (%)** | | |
|---|---|---|---|
| | **ARDRM** | **TACI** | **TA-RTED** |
| Class 1 | 84.32 | 73.15 | 68.21 |
| Class 2 | 88.15 | 77.12 | 71.08 |
| Class 3 | 91.35 | 80.32 | 74.28 |
| Class 4 | 85.21 | 74.18 | 68.10 |
| Class 5 | 87.57 | 76.54 | 70.46 |
| Class 6 | 89.32 | 78.29 | 72.22 |
| Class 7 | 92.14 | 81.11 | 75.04 |

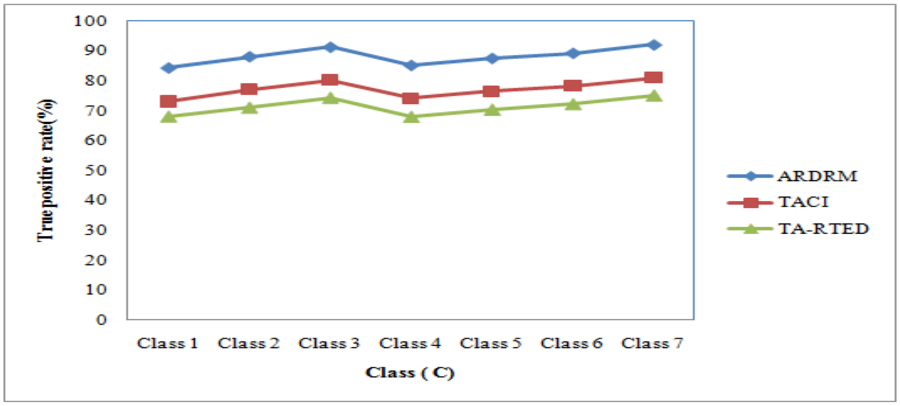

Figure 4 Measure of true positive rate

Figure 4 shows the true positive rate on sentiments being correctly identified as belonging to a specific class is increased with the application of maximum likelihood estimates when compared to the existing methods. The maximum likelihood estimates in ARDRM technique effectively constructs sentiment class label for the testing and training data extracted from OpinRank dataset. Therefore, the true positive rate is improved by 12.52% compared to TACI [1]. Moreover, by evaluating the support and confidence value, probability of frequent itemsets occurrence are made in a significant manner. As a result, the true positive rate is increased by 19.21% compared to TA-RTED [2].

## 5.2. Impact of associative regression factor

Table 2 shows the associative regression factor using the three methods, ARDRM, TACI [1] and TA-RTED [2] respectively. The associative regression factor in table 2 was measured with the aid of 7 classes and 35 rules generated from 350 customer review words extracted from the OpinRank dataset.

Table 2 Tabulation for associative regression factor

| METHODS | ASSOCIATIVE REGRESSION FACTOR (%) |
|---|---|
| ARDRM | 81.35 |
| TACI | 74.19 |
| TA-RTED | 65.18 |

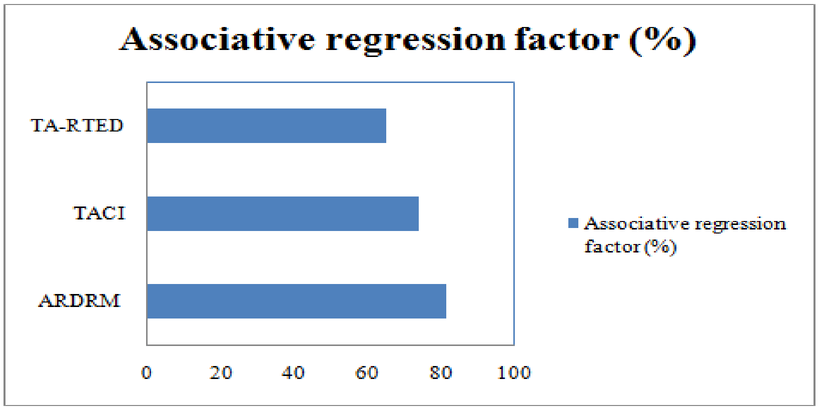

Figure 5. Measure of associative regression factor

Figure 5 shows the measure of associative regression factor with respect to 350 customer review words obtained from OpinRank dataset. The associative regression factor using ARDRM is improved when compared to two other methods [1] and [2]. This is due to the application of Regressive Sequencing algorithm. By applying Regressive Sequencing algorithm, the support and confidence value are evaluated according to the sentiments reflected in the customer review. This in turn improves the associative regression factor using ARDRM by 8.80% compared to TACI and 12.14% compared to TA-RTED respectively.

### 5.3. Impact of Regressive decision rule generation time

The regressive decision rule generation time is measured using the number of rules and the time to extract single rule. The mathematical formulation for regressive decision rule generation time is given as below.

$$DRGT = \sum_{i=1}^{n} Rule_i * Time\ (Rule_i) \qquad (12)$$

From (12), the execution time '$DRGT$' is measured using the number of rules '$Rule_i$' and measured in terms of milliseconds. Lower the regressive decision rule generation time more efficient the method is said to be. Convergence characteristics for the measure of Time to extract opinions from customer reviews for 35 rules extracted from different customers are considered and compared with two other methods and are shown in table 3.

Table 3. Tabulation for time to extract opinions from reviews

| Number of rules | Time to extract opinions from customer reviews (ms) | | |
|---|---|---|---|
| | ARDRM | TACI | TA-RTED |
| 5 | 1.31 | 1.68 | 1.85 |
| 10 | 2.51 | 2.81 | 3.05 |
| 15 | 3.79 | 4.02 | 4.22 |
| 20 | 4.96 | 5.26 | 5.48 |
| 25 | 5.85 | 6.15 | 6.35 |
| 30 | 6.3 | 6.60 | 6.80 |
| 35 | 8.32 | 8.62 | 8.82 |

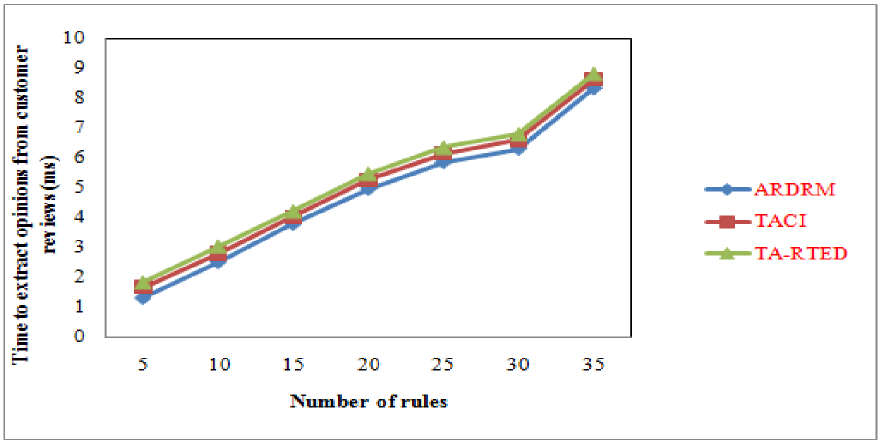

Figure 6 Measure of Regressive decision rule generation time

The targeting results of Regressive decision rule generation time for extracting predictive pattern using ARDRM technique is compared with two state-of-the-art methods [1], [2] in figure 6 is presented for visual comparison based on the number of rules. Our method differs from the FM-TACI [1] and TA-RTED [2] in that we have incorporated associative regressive decision rule. The associative regressive decision rule applies probabilistic rules using the mean and variance value for performing rule generation. As a result, the Regressive decision rule generation time generating decision rules using ARDRM technique is increased by 9.40 to TACI. Furthermore, by eliminating the redundant rule, further reduces the time for obtaining the regressive decision rule generation by 15.29% compared to TA-RTED.

## 5.4. Impact of Review detection accuracy of similar pattern

The review detection accuracy of similar pattern is the ratio of number of correct review patterns to the total number of test cases made. The mathematical formulation of review detection accuracy of similar pattern is formulated as given below.

$$A = \left(\frac{No.of\ correct\ review\ patterns}{Total\ no.of\ test\ cases}\right) * 100 \qquad (13)$$

From (13), the detection accuracy '$A$' is measured in a significant manner in terms of percentage (%). Higher the detection accuracy more efficient the method is said to be.

Table 4 Tabulation for review detection accuracy

| **Customer review words** | **Review detection accuracy (%)** | | |
|---|---|---|---|
| | **ARDRM** | **TACI** | **TA-RTED** |
| 50 | 87.53 | 74.11 | 68.21 |
| 100 | 89.31 | 77.27 | 71.25 |
| 150 | 92.14 | 80.10 | 74.08 |
| 200 | 85.14 | 73.10 | 67.07 |
| 250 | 88.21 | 76.17 | 70.15 |
| 300 | 88.15 | 86.11 | 80.11 |
| 350 | 91.35 | 79.31 | 73.21 |

The comparison of customer review detection accuracy is presented in table 4 with respect to different customer review words. Depending on the customer review words, the customer review detection accuracy either increases or decreases but found to be improved using the proposed ARDRM technique.

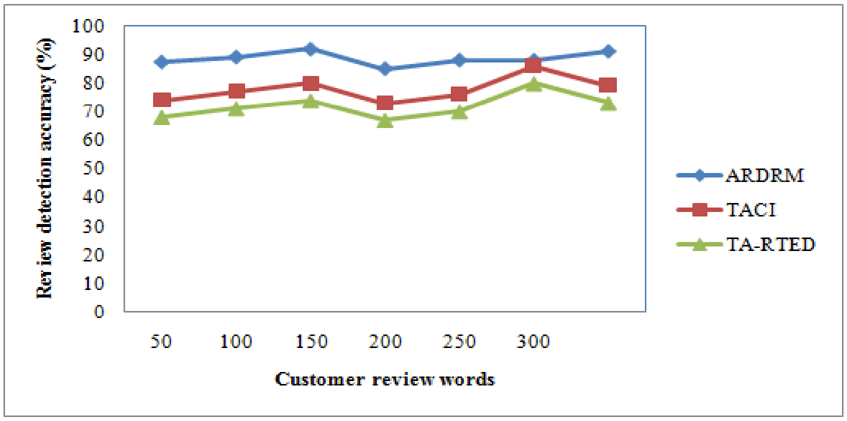

Figure 7. Measure for review detection accuracy

To ascertain the performance of customer review detection accuracy, comparison is made with two other existing works Taxonomy-Aware Catalog Integration (TACI) [1], and Tweet Analysis for Real-Time Event Detection and Earthquake (TA-RTED) [2].

In figure 7, the customer review words varied between 50 and 300. From the figure it is illustrative that the customer review detection accuracy is improved using the proposed ARDRM technique when compared to two other existing works. This is because with the application of

Associative regressive decision-based frequent itemset generation algorithm, the ARDRM technique chooses the rule in a greedy manner by first sorting the rule and detaches the occurrences covered by the rule.

In this way, the customer review detection accuracy is improved using ARDRM by 12.16% when compared to TACI [1]. Furthermore, by applying associative regressive decision model when applied to the generated rules, with higher support value and lower variance improves the customer satisfactory level, therefore improving the review detection accuracy based on their review comments of the customers by 18.93% than when compared to TA-RTED [2].

### 5.5. Performance analysis of customer review classification accuracy using proposed ARDRM and Extreme Learning Machine

The result analysis of the proposed Associative Regression Decision Rule Mining (ARDRM) method is compared with existing Multi-class Sentiment Classification using Extreme Learning Machine (MSC- ELM) [21].

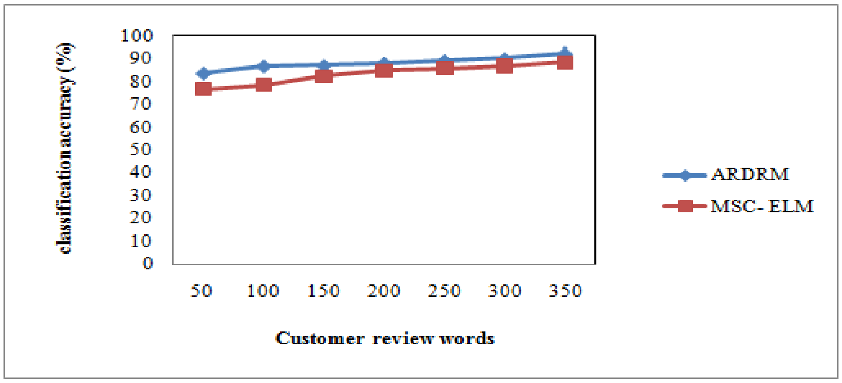

Figure 8. Measure of review classification accuracy

Figure 8 illustrates the customer review classification accuracy of proposed ARDRM and existing Multi-class Sentiment Classification using Extreme Learning Machine (MSC- ELM). From the figure, the customer review classification accuracy is increased in ARDRM. This is because, the Machine Learning Bayes Sentiment Classifier (MLBSC) is applied in ARDRM to classify the class labels for each service reviews. Therefore, the classification accuracy is effectively increased by 6% in ARDRM method compared to existing Multi-class Sentiment Classification using Extreme Learning Machine (MSC- ELM) [21].

## 6. CONCLUSION

In this work, an effective technique called Associative Regression Decision Rule Mining (ARDRM) is presented. The technique improves the review detection accuracy that in turn improves the customer satisfaction based on their review comments and associative regression factor. The goal of Associative Regression Decision Rule Mining is to improve the true positive rate with sentiments correctly identified as belonging to a specific class and therefore to improve the associative regression factor using the customer review words extracted from OpinRank dataset which significantly contribute to the relevance. To do this, we first designed a Machine Learning Bayes Sentiment Classification technique that measures the sentiment class labels based on the Maximum Likelihood estimates for OpinRank dataset this helps to increases the classification accuracy. Then, based on this measure, we proposed a Regressive Sequencing algorithm for improving the association regression factor in an extensive manner. In addition the associative regressive decision rule with frequent itemset generation algorithm eliminates the redundant rule and therefore reduces the time ot extract opinions reviews and therefore true positive rate. Finally, the associative regressive decision model improves the customer review detection accuracy. Extensive experiments were carried out using JAVA and compared with existing methods. The results show that ARDRM technique offers better performance with an improvement of review detection accuracy by 15.55% and reduces the time taken to extract opinions from reviewers by 12.34% compared to TACI and TA-RTED respectively.

## ACKNOWLEDGEMENTS

We thank each one of those who are directly or indirectly helpful in the preparation of this paper. And also we thank our family members for their continuous support and encouragement.

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# A ROUTING PROTOCOL ORPHAN-LEACH TO JOIN ORPHAN NODES IN WIRELESS SENSOR NETWORK

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## *ABSTRACT*

*The hierarchical routing protocol LEACH (Low Energy Adaptive Clustering Hierarchy) is referred to as the basic algorithm of distributed clustering protocols. LEACH allows clusters formation. Each cluster has a leader called Cluster Head (CH). The selection of CHs is made with a probabilistic calculation. It is supposed that each non-CH node join a cluster and becomes a cluster member. Nevertheless, some CHs can be concentrated in a specific part of the network. Thus several sensor nodes cannot reach any CH. As a result, the remaining part of the controlled field will not be covered; some sensor nodes will be outside the network. To solve this problem, we propose O-LEACH (Orphan Low Energy Adaptive Clustering Hierarchy) a routing protocol that takes into account the orphan nodes. Indeed, a cluster member will be able to play the role of a gateway which allows the joining of orphan nodes. If a gateway node has to connect a important number of orphan nodes, thus a sub-cluster is created and the gateway node is considered as a CH' for connected orphans. As a result, orphan nodes become able to send their data messages to the CH which performs in turn data aggregation and send aggregated data message to the CH. The WSN application receives data from the entire network including orphan nodes.*

*The simulation results show that O-LEACH performs better than LEACH in terms of connectivity rate, energy, scalability and coverage.*

## *KEYWORDS*

*WSNs; routing; LEACH; O-LEACH; Orphan nodes; sub-cluster; gateway; CH'*

## 1. INTRODUCTION

LEACH [1] is considered as the basic hierarchical routing protocol (cluster-based approach). It is also one of the most popular cluster based routing algorithms for (Wireless Sensor Networks) WSNs. It combines both the efficiency in energy consumption and the quality of access to the media, and it is based on the division into groups, with a view allowing the use of the concept of data aggregation for a better performance in terms of lifetime.

Cluster Heads (CH) are randomly chosen in a specific election algorithm based on a probability function that takes into account various criteria such as the available energy. The routing

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protocols are actually divided into two families: central data and hierarchical routing protocols. In a hierarchical topology, can be cited references protocols, Younis et al. (2004) have proposed a HEED [2], Lindsey et al. (2002) have proposed a PEGASIS [3], Manjeshwar et al.(2001) proposed a TEEN [4], and A Manjeshwar et al. (2001) proposed a PTEEN [5].

Leach performs the single-hop inter-cluster, directly from CHs to the BS, routing method, which is not applicable to large-region networks Akyildiz et al. (2002) [6]. It is not always a realistic assumption for single-hop inter-cluster routing with long communication range Al-Karaki et al (2004) [7]. Besides, long-range communications directly from CHs to the BS can breed too much energy consumption; despite the fact that CHs rotation is performed at each round to achieve load balancing, LEACH cannot ensure real load balancing in the case of sensor nodes with different amounts of initial energy, because CHs are elected in terms of probabilities without energy considerations Xuxun Liu (2012) [8]. The idea of dynamic clustering brings extra overhead. For instance, CH changes and advertisements may diminish the gain in energy consumption Li, C et al. (2011) [9]. LEACH is very favorable in terms of energy efficiency. however, controlling the number and the location of the clusters head (CHs) and also the size of the clusters about the node number leads to a balance in energy use of the CHs and increasing the lifetime of the network, Asgarali Bouyer et al (2015)[10].

Nevertheless, in a round, the nodes which are not CH may not join a cluster. In such a case, the data which must be collected from the node outside the network (orphan node) could have a great importance in some applications. Hence, these applications will be concrete ones and will satisfy our needs. Obviously, we need to collect data from all distributed nodes inside the network, hence allowing taking the suitable decisions.

The large-scale deployment of controlled high Wireless Sensor Networks (WSNs) necessitates an efficient organization of the networks for high network connectivity and a low orphan node ratio. Where sensor network are randomly deployed, they are not uniformly distributed inside field. As a result, some places in the field don’t benefit from a good connectivity. Hence, the routing protocols conceived for the WSN must have a self organization capacity in order to adapt them to the random distribution of the nodes and the dynamic topology of the network.

An orphan node which does not belong to any CH sends a message towards its nearest neighbors which belong to a cluster (belonging application). A member of the cluster will represent a gateway allowing the link between one or several orphan nodes and the CH.

Among the factors, we must verify that in each round, the number of distributed nodes is approximately equal to the actual number of connected nodes. If the number of connected nodes is less than the required number, the nodes that are not within the reach of CH are called orphan nodes.

In this paper, we propose a protocol called O-LEACH which allows joining the orphan nodes. To solve the problem, one node member of a cluster receives "Orphan notification". The member of the CH will be a gateway. The cluster member receives a request message from a node that belongs to any group and asks for a membership in this group. Different messages are transmitted between the three processes that are: the CH, the member nodes of the cluster (gateway) and the nodes without connectivity orphan nodes (orphan nodes). These transactions generate an adequate link between the orphan nodes and the cluster.

The remainder of this paper is organized as follows: section 2 describes the related work of routing in WSN and emphasizes on existing CH selection method. Section 3 describes O-LEACH protocol. In Section 4, we present the performance evaluation of O-LEACH and its comparison with LEACH. Section 5 concludes the paper.

# 2. RELATED WORK ON ROUTING PROTOCOL

## 2.1. Protocol LEACH

In WSNs, the use of routing protocols designed for the traditional ad hoc networks is inappropriate. This is due to the characteristics allowing distinguishing the two types of networks. Hence, we need to improve or develop new specific routing protocols for WSN. LEACH is considered as the first hierarchical routing protocol. It is also one of the most popular hierarchical routing algorithms for WSN, proposed as part of the project. It combines the efficiency in energy consumption and the quality of access to the media, and it is based on the division into groups, in order to allow the use of the concept of data aggregation for a better performance in terms of lifetime.

Heinzelman proposed that the LEACH cluster formation is made by a centralized algorithm at the base station (BS).

The aim of the LEACH protocol is to form clusters based on the intensity of the received radio signal. Indeed, LEACH uses an algorithm which is distributed where each node decides autonomously whether it will be a Cluster head or not by randomly calculating a probability pu and comparing it to a threshold T(u); Then, it informs its neighborhood about its decision. Each node decides which Cluster head to join by using a minimum transmission of energy (i.e the nearest). The algorithm consists of several rounds and, for each round, a rotation of the role of the Cluster head is initiated according to the probability pu which is chosen and compared to the following formula of the threshold:

$$T(n) = \frac{P}{1 - P * \left(r \bmod \frac{1}{p}\right)} \quad if\ n \in G,$$

$$T(n) = 0 \qquad \text{otherwise}$$

p: the percentage of CHs on the network, r : the current round number and G: the set of nodes that was not CH in the (1/p) preceding rounds.

During a period T, a node n chooses a random number of x whose value is between 0 and 1 (0<x <1). If x is less than a threshold value, then the node n will become a cluster head in the current period. Otherwise, the node n should join the nearest cluster head in its vicinity.

Rounds in LEACH have predetermined duration, and have a set-up phase and a steady-state phase. Through synchronized clocks, the nodes know when each round starts.

## 2.2 Set-up Phase

This phase starts by the announcement of the new round by the sink node, and by taking the decision for a node to become a CH with a probability pi(t) in the beginning of round r+1 which starts at the instant t. once a node is chosen CH, it must inform the other CH nodes about its position in the current round. For this, a warning message ADV containing the identification of the CH is transmitted to all CH nodes by using the protocol MAC CSMA() in order to avoid the collisions between the various CH. Each member informs its CH about its decision.

After the grouping operation, each CH acts as a local control center in order to ensure the coordination between the data transmission inside its group. It creates a schedule TDMA and assigns to each member node a slot for data transmission. The set of slots assigned to the group nodes is called a frame.

Figure 1 shows the formation of clusters in a round. Each cluster includes a CH and some pickup member nodes.

### 2.3 Steady state Phase

This phase is longer than the preceding one, and allows the collection of the received data. By using the TDMA, the members transmit their received data during their slots. This allows them to switch off their communication interfaces outside their slot in order to save energy. Then, these data are aggregated by the various CH which merge and compress then before sending the final result to the sink node.

After a predetermined time, the network will go through a new round. This process is repeated until the moment where all the nodes of the network will be chosen CH, one time, all throughout the preceding rounds. In this case, the round is again initialized to zero.

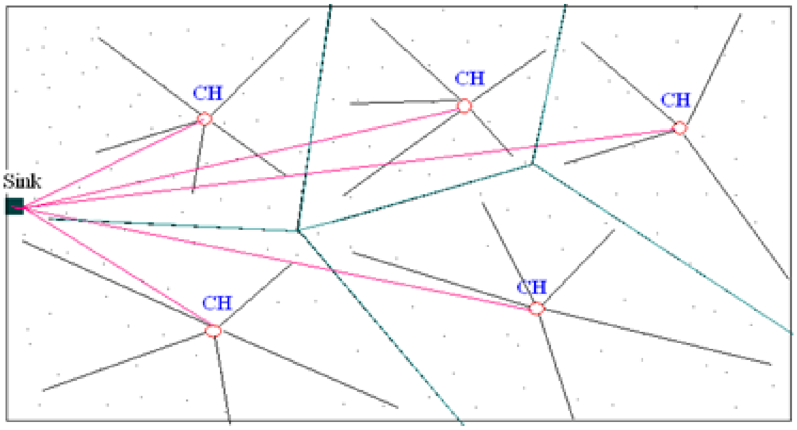

Figure 1. T round in LEACH

### 2.4 Limitation of LEACH

In what follows, we present the advantages as well as disadvantages of the LEACH protocol. During a round, we may not have any CH if the random numbers generated by all the nodes of the network are higher than the probability pi (t).

- ✓ The farthest nodes form the CH die rapidly as compared with the nearest ones.
- ✓ The use of a communication with one jump instead of a communication with several jumps reduces the nodes energy.
- ✓ The LEACH protocol cannot be used in the real time applications since it leads to a long period.
- ✓ The rotation of the CH ensures not to exhaust the batteries. However, this method is not efficient for networks with a big structure because of the overflow of announcements generated by the change of the CH, hence reducing the initial energy gain it's not obvious to have a uniform distribution of the CH.
- ✓ As a result, it is possible to have the CH concentrated in one part of the network. Hence, some nodes won't have any CH in their neighbourhood.

- ✓ LEACH is suitable for small size networks because it assumes that all nodes can communicate with each other and are able to reach sink, which is not always true for large size network.

- ✓ Since CH election is performed in terms of probabilities, it is hard for the predetermined CHs to be uniformly distributed throughout the network. Thereby there exist the elected CHs that are concentrated in one part of the network and some nodes that have not any CHs in their vicinity Seah (2010) [11].

## 3. DESCRIPTION OF O-LEACH PROTOCOL

### 3.1 Orphan Problem and proposed Solution

In Wireless Sensor Networks, low latency, energy efficiency, and coverage problems are considered as three key issues in designing routing protocols Wafa Akkari et al (2015)[12]. The choice of the optimal routes ensures the delivery of information to the base station and reduces the packet delivery delay. Thus, the network must pass across by maximizing the networks life without decreasing its performance. The drawback of the LEACH protocol is the limited use in a wide field since many remote CH nodes die rapidly (as compared to a small field) because the nodes cannot join them.

The optimal percentage of the desired number of CH should be proportional to the total number of nodes. If this percentage is not met, this will lead to greater energy dissipation in the network. Indeed, if the number of CH is very high, there will be a large number of nodes (CH) dedicated to very expensive tasks in energy resources. Hence, there will be considerable energy dissipation in the network. Moreover, if the number of CH is very small, the latter will manage groups of large sizes. Thus, these CH will be consumed rapidly in case an important work is required from them. The routing protocols are actually divided into two families: central data and hierarchical routing protocols.

During the construction of the clusters the pickup nodes choose randomly the CH which can be concentrated in a specific part of the work field. As a result, the remaining part of the field will not be covered (see figure 2) the pickup nodes will be outside the network. The values received by the orphan nodes will not be transmitted to the base station. The problem of the orphan nodes requires finding a solution allowing to join these nodes to the remaining part of the network.

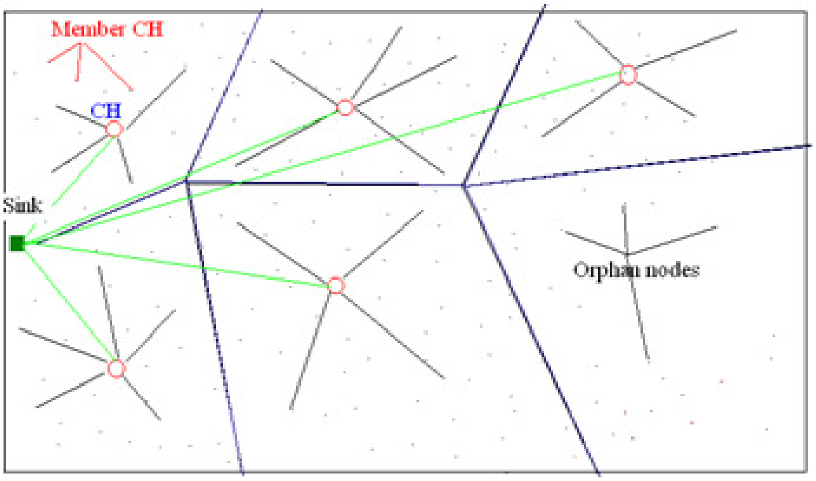

Figure 2. T round in O-LEACH

### 3.2 Set-up Phase extension O-LEACH

The O-LEACH protocol consists of two phases: Set-up phase and steady-state phase as illustrated in figure 3 and figure 4:

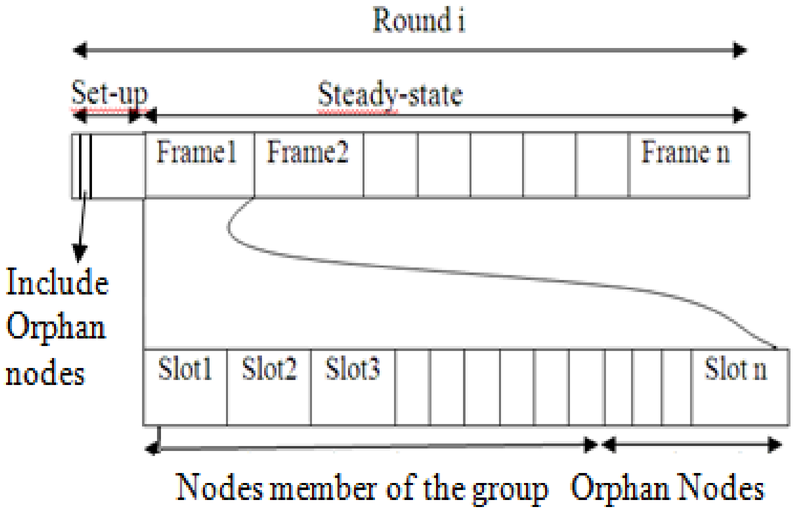

Figure 3. T round in O-LEACH reserved slots

The initialization phase consists in selecting the CH nodes with a certain probability, by the local decision taken by a node to become a CH. After the construction of clusters, a timer is used in order to verify the existence of orphan nodes.

If the answer is positive, CH gateway informs the CH' (the first orphan node having the access to the gateway) about the number of slots to be reserved to the orphan nodes by the CH. The CH' play the same role as the CH.

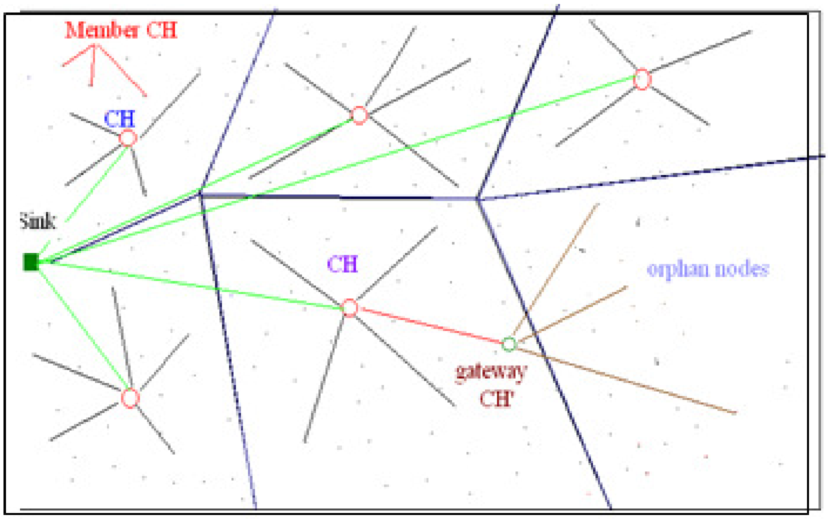

Figure 4. Solution with member gateway CH

### 3.3 Transaction message Proposed Algorithm

Three processes involved in the resolution of orphan nodes, which are orphan nodes, member cluster (Gateway CH') and CH node (figure 5):.

- Orphan nodes send status to member cluster.
- Member cluster says I am a Gateway.
- Orphan nodes join Gateway.
- The Gateway informs the CH node the number of slots.
- CH node reserve number of slots TDMA (Cluster + sub cluster).
- The gateway broadcasts a TDMA slot to each orphan node.

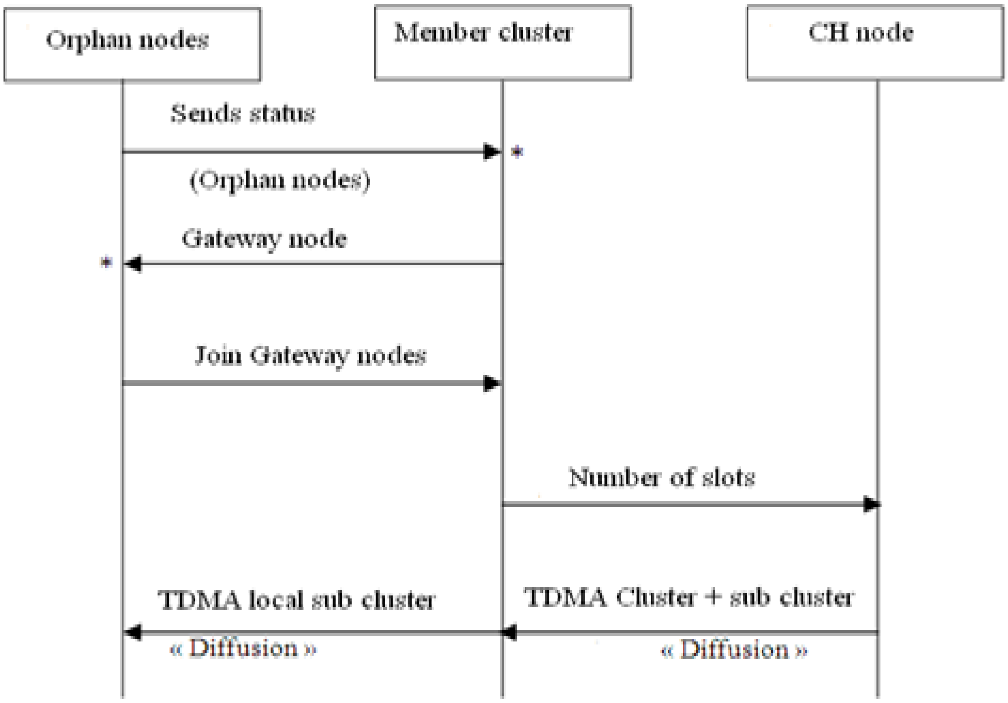

Figure 5. Transaction message

### 3.4 Flowchart of proposed Algorithm

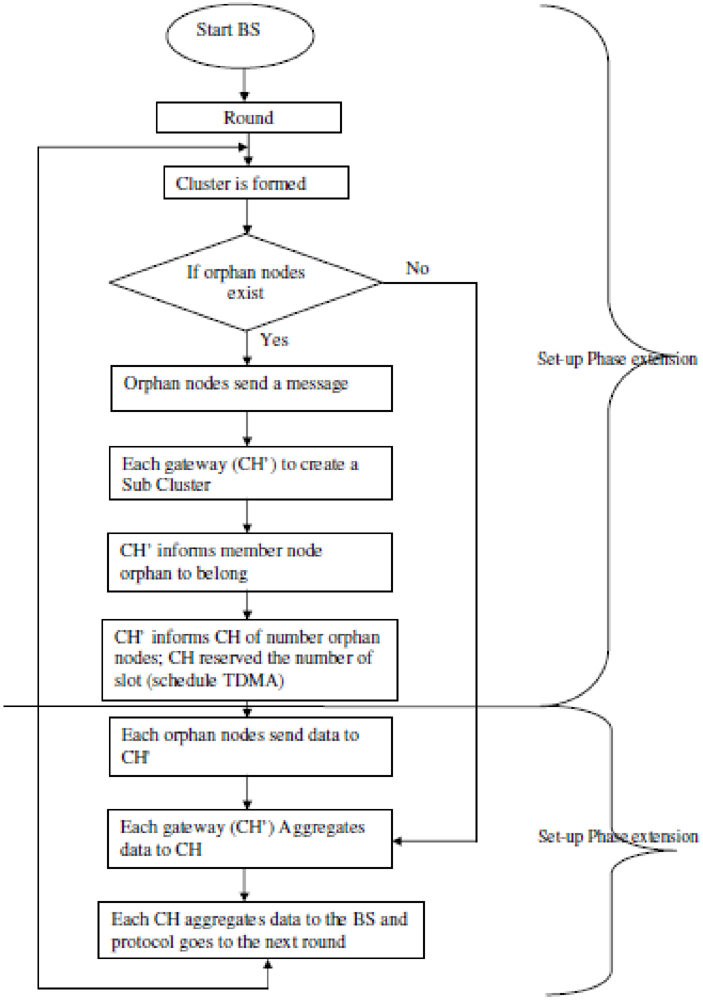
Start BS
Round
Cluster is formed
If orphan nodes exist
No
Yes
Orphan nodes send a message
Each gateway (CH') to create a Sub Cluster
CH' informs member node orphan to belong
CH' informs CH of number orphan nodes; CH reserved the number of slot (schedule TDMA)
Each orphan nodes send data to CH'
Each gateway (CH') Aggregates data to CH
Each CH aggregates data to the BS and protocol goes to the next round
Set-up Phase extension
Set-up Phase extension

Figure 6. Flow chart of proposed algorithm

The proposed algorithm works in rounds. Each round performs these following steps, illustrated in Figure 6:

1) Periodically, the base station starts a new round by incrementing the round number.

2) The selection of the CH in the LEACH protocol according to a probability between 5%and 15%, the number of CH doesn’t exceed the numbers 15 and 5 for each round (as related to the percentage used). For each round, a pickup node chooses a cluster as a head by selecting a random number to be compared to the threshold value. The threshold T(n) is set as: T(n) = {P / 1 – P * (r mod1/P)} if n belongs to G, if not zero. P is the desired percentage of cluster heads, r is the current round, and G is the set nodes that have not been cluster heads in the last (1/P) rounds.

3) As soon as a cluster is formed, the mumber roudes wait for a message from nodes orphan.

4) The node member of a cluster will be a gateway and will inform the orphan node to be a CH'.

5) The construction of sub-clusters with a group leader CH'.

6) The CH' gathers and aggregates the data toward the gateway.

7) The gateway sends two slots to the CH, the first one includes the data of CH' whereas the second one contains the gateway data.

8) The CH gathers the data, makes the necessary treatments and finally transmits them to the BS.

### 3.5 Steady state Phase O-LEACH

This phase allows the collection of the pickup data. By using the TDMA the member nodes of the cluster and the orphan nodes transmit their pickup data during their own slots. The node CH' gathers the pickup data from the neighboring members. Then, these data are aggregated by the CH' which merge and compress them before sending the final result to the CH node through the gateway. The gathers the data of the pickup nodes (members of the cluster and orphan), aggregates and transmit then to the base station.

## 4. O-LEACH PERFORMANCE EVALUATIONS

### 4.1 Simulation set-up

All simulations have been implemented using TinyOS 1.x, simulator TOSSIM and interface TinyViz in order to provide a rich simulation platform. Assuming that 100 nodes are randomly distributed, we used the following metrics to evaluate the proposed protocol O-LEACH compared with LEACH:

- ✓ Orphan Nodes: the number of orphan nodes in each round
- ✓ Network Life time: The number of nodes which are alive at the end of the simulation.
- ✓ Percentage of gateway nodes: the number of gateway nodes in each round.
- ✓ Energy Consumption: the amount of consumed energy by the network in each round.
- ✓ Percentage of CH: percentage of adequate CH in a major distribution nodes sensor.

The base station is located at position (0,0), provided with sufficient energy resources. Each node is equipped with an energy source which is set to 0.5J at the beginning of the simulation. We have set the percentage of CH between 5% and 25%.

### 4.2 Simulation results

In this section, we present and discuss the simulation results of the protocol O-LEACH, to evaluate its performance and the execution of the protocol to show that the number of orphan nodes is almost null. Clustering algorithm distributed as O-LEACH requires that the sensor nodes are synchronized in their implementation. We carried out experiments on the percentage of the desired number of CH between 5% and 20%, the result we shows almost zero values. In the

LEACH protocol, if the number of CH is very high, there will be a large number of nodes (CH) which consume a lot of energy. Thus, there will be considerable energy dissipation in the network. Also, if the number of CH is very small, the latter will manage groups of large sizes. Thus, this CH will be consumed rapidly in case an important work is required and there will be a risk of having a very large number of orphan nodes.

The necessary the timing to search for orphan nodes for a gateway. Each CH receives a message from a gateway and necessitates the timings for search orphan nodes.

The contribution of O-LEACH as compared to LEACH leads to a better network coverage of the whole controlled environment in several applications of WSNs. So, for each network organization (clusters during training set-up phase), we must calculate the total number of orphan nodes and the number of those who could reach a gateway. The ideal is that 100% of orphan nodes could be covered in the network. Moreover calculating the number of packets that arrive to the base station for both algorithms (O-LEACH and LEACH) shows that O-LEACH allows more data availability. O-LEACH is of a major importance, especially if the observed phenomenon occurs at orphan nodes.

The collected values by orphan nodes provide more availability of data at the base station. This enables a better decision in the application and a quick response. The simulation results show that our protocol outperforms the classic approach LEACH in terms of coverage and lifetime.

In fig 7, show the percentage of covered nodes as a function of the numbers of connected nodes to a CH. The number of orphan nodes in O-LEACH is much lower as compared to LEACH which is expected since the major difference comes from the technique used in the gateway.

In fig 8, the number of gateways increases relative to the number of orphan nodes and to the number of distributed nodes. In a uniform distribution, (with 200 nodes) the number of orphan nodes can be more than 15 nodes. The number of gateways will be less or equal to the number of orphans nodes.

In fig. 9, clearly shows the total number of nodes that remain alive over the simulation time. Using LEACH, the first node's death occurs after 950 rounds and near to 1240 rounds, all the nodes are dead. While activating O-LEACH, the first node dies after 1250 rounds and all the nodes' energy expires after 1550 rounds, thanks to the number of gateways that connects the maximum number of nodes to extend the life of the networks.

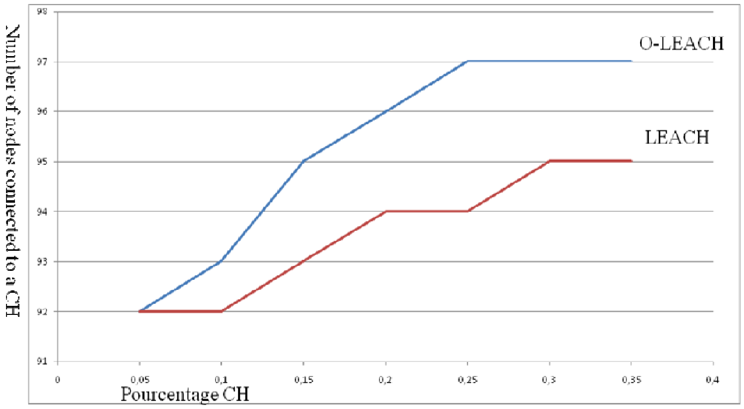

Figure 7. Number of nodes connected to a CH

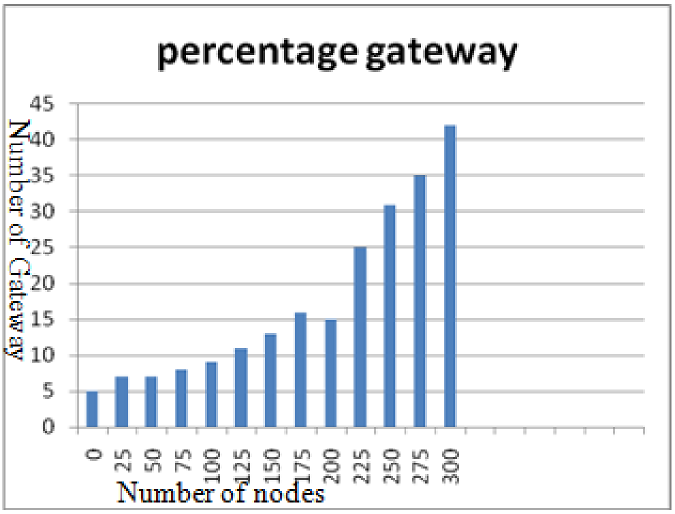

Figure 8. Percentage gateway

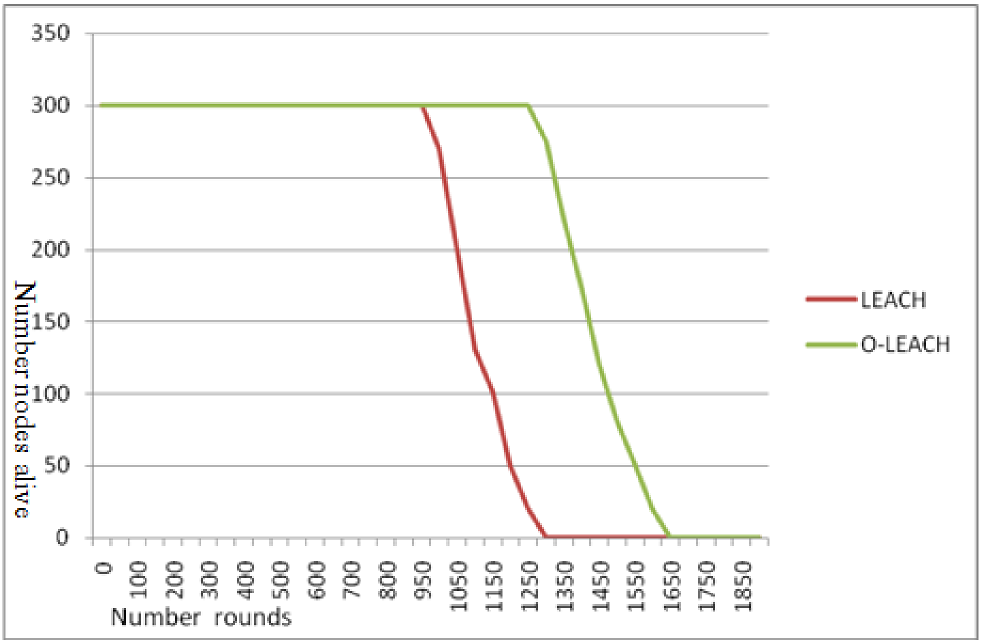

Figure 9. Number of node alive in LEACH and O-LEACH

## 5. CONCLUSIONS

Several kinds of existing clustering protocols have been developed to balance and maximize the lifetime of the sensor nodes in wireless sensor networks. In this paper, we were interested in designing an O_LEACH routing protocol in order to minimize the orphan nodes in a round. It is estimated that the optimal and adequate percentage of the desired CH should be between 8% and 12% of the total number of nodes. Simulation results show that our protocol outperforms the classic approach LEACH in terms coverage and lifetime. Consequently, the cluster will be of a uniform size or each CH has a limited number of members. This involves optimizing the energy and the duration of lifetime of the networks. This protocol can improve the connectivity and of the network reliability with lower orphan nodes. The values collected by orphan nodes provide more availability of data at the base station. This enables a better decision on the application and a quick response.

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