Dhinaharan Nagamalai
Sundarapandian Vaidyanathan (Eds)

Computer Science & Information Technology

International Conference on Computer Science, Information Technology and Applications (CSITA 2015)
Bangalore, India, March 28 ~ 29 - 2015

AIRCC

Volume Editors

Dhinaharan Nagamalai,
Wireilla Net Solutions PTY LTD,
Sydney, Australia
E-mail: dhinthia@yahoo.com

Sundarapandian Vaidyanathan,
R & D Centre,
Vel Tech University, India
E-mail: sundarvtu@gmail.com

ISSN: 2231 - 5403
ISBN: 978-1-921987-36-6
DOI : 10.5121/csit.2015.50801 - 10.5121/csit.2015.50804

Typesetting: Camera-ready by author, data conversion by NnN Net Solutions Private Ltd., Chennai, India

Preface

The International Conference on Computer Science, Information Technology and Applications (CSITA-2015) was held in Bangalore, India, during March 28~29, 2015. The International Conference on Artificial Intelligence (ARIN-2015) and The International Conference on Image and Signal Processing (ISPR-2015) were collocated with the CSITA-2015. 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 CSITA-2015, ARIN-2015, ISPR-2015 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, CSITA-2015, ARIN-2015, ISPR-2015 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 CSITA-2015, ARIN-2015, ISPR-2015

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.

Dhinaharan Nagamalai
Sundarapandian Vaidyanathan

Organization

General Chair

Natarajan Meghanathan	Jackson State University, USA
Dhinaharan Nagamalai	Wireilla Net Solutions PTY LTD, Australia

Program Committee Members

Abdolreza Hatamlou	Islamic Azad University, Iran
Abe Zeid	Northeastern University, USA
Abraham Sanchez Lopez	Autonomous University of Puebla, Mexico
Ahmed Y. Nada Aqu	Al-Quds University, Palestine
Alaa Hussein Al-hamami	Amman Arab University, Jordan
Ali Abid D. Al-Zuky	University of Baghdad, Iraq
Amol D Mali	University of Wisconsin-Milwaukee,USA
Anamika Ahirwar	Rajiv Gandhi Technical University, India
Anil Kumar Dubey	Govt. Engineering College Ajmer
Ankit Chaudhary	Truman State University, USA
Arifa Ferdousi	Varendra University, Bangladesh
Ashraf A. Shahin	Cairo University, Egypt
Ayad Ghany Ismaeel	Erbil Polytechnic University, Iraq
Barbaros Preveze	Cankaya University, Turkey
Basant Kumar Verma	RGM College, India
Bratin Ghosh	Indian Institute of Technology, India
ChanChristine	University of regina, Canada
Chin-Chih Chang	Chung Hua University, Taiwan
Dac-Nhuong Le	Hai Phong University, Vietnam
Derya Birant	Dokuz Eylul University, Turkey
El-Sayed M. EL-Rabaie	Menouf, Egypt
Farshchi	Tehran University, Iran
Fatih Korkmaz	Cankiri karatekin university, Turkey
Grienggrai Rajchakit	Maejo University, Thailand
Hamid Mcheick	Universite du Quebec a Chicoutimi,Canada
Hanan Salam	University of Pierre and Marie Curie, France
Hassini Noureddine	University of Oran , Algeria
Hossein Jadidoleslamy	MUT University, Iran
Isa Maleki	Islamic Azad University, Iran
Islam Atef	Alexandria University, Egypt
Israa SH.Tawfic	Gaziantep University, Turkey
Israa Shaker Tawfic	Ministry If Scienece And Technology, Iraq
Israashaker Alani	Ministry of Science and Technology, Iraq
Kai-Long Hsiao	Taiwan Shoufu University, Taiwan
Kavitha Rajamani	St. Aloysius College, India
Kenneth MAPOKA	Iowa state university, USA
Krishna Prakash K	M.I.T. Manipal, India

Technically Sponsored by

Networks & Communications Community (NCC)

Computer Science & Information Technology Community (CSITC)

Digital Signal & Image Processing Community (DSIPC)

Organized By

Academy & Industry Research Collaboration Center (AIRCC)

TABLE OF CONTENTS

International Conference on Computer Science, Information Technology and Applications (CSITA 2015)

International Conference on Artificial Intelligence (ARIN 2015)

International Conference on Image and Signal Processing (ISPR -2015)

CRITICAL ASSESSMENT OF AUDITING CONTRIBUTIONS TO EFFECTIVE AND EFFICIENT SECURITY IN DATABASE SYSTEMS

Olumuyiwa O. Matthew[1] and Carl Dudley[2]

[1]MSc in Information Technology Management, MCPN, AMBCS,
The University of Wolverhampton, United Kingdom.
o.o.matthew@wlv.ac.uk
[2]Oracle Professor in Database Technology University of Wolverhampton, UK.
UK Oracle User Group Official, oracle ACE Director
carl.dudley@wlv.ac.uk

ABSTRACT

Database auditing has become a very crucial aspect of security as organisations increase their adoption of database management systems (DBMS) as major asset that keeps, maintain and monitor sensitive information. Database auditing is the group of activities involved in observing a set of stored data in order to be aware of the actions of users. The work presented here outlines the main auditing techniques and methods. Some architectural based auditing systems were also considered to assess the contribution of auditing to database security. Here a framework of several stages to be used in the instigation of auditing is proposed. Some issues relating to handling of audit trails are also discussed in this paper. This paper also itemizes some of the key important impacts of the concept to security and how compliance with government policies and regulations is enforced through auditing. Once the framework is adopted, it will provide support to database auditors and DBAs.

KEYWORDS

Auditing, Techniques, Security, Framework, Procedure

1. INTRODUCTION

Database Auditing allows security personnel to ascertain who did what to which data, when and how [1]. It is a mechanism used to monitor the actions of every user in a database [2]. Database auditing helps strengthen the security of the database by keeping logs of the activities performed on a database. It can be used to confirm that data or information is not accessed by those without permission and that they do not go beyond the privileges granted to them by the database administrator.

The security mechanism must not only prevent attacks but also detect potential attacks. After all, the best security policy is still not going to stop every attacker. This is where auditing helps in monitoring the environment and identifying potential attacks [3]. Lu et al [4] describe auditing operations as critical processes for identifying malicious behaviour, maintaining data quality and improving system performance. Mullins [5] said database auditing is the process of monitoring

Dhinaharan Nagamalai et al. (Eds) : CSITA, ARIN, ISPR - 2015
pp. 01–11, 2015. © CS & IT-CSCP 2015 DOI : 10.5121/csit.2015.50801

access to and modification of selected database objects and resources within operational databases and retaining a detailed record of the access where said record can be used to proactively trigger actions and can be retrieved and analysed as needed. This means with auditing records, a database administrator can carry out analysis on the trend of events in a database system.

Database auditing is an increasingly important aspect of database security. The implementation of user identification, authentication and access control are part of the security measures, but with all of these in place, database is still not fully secured. None of these measures are capable of monitoring and logging database activities, to allow subsequent detection of security breaches [2]. To manage access to sensitive data, a user can be subjected to a variety of authentication and access control mechanisms which implement rules and controls for known and acceptable data access behaviours. But to protect against and discover unknown or unacceptable behaviours always requires a need to monitor data access. To assist in this task, a database system that provides an audit facility must be used.

The level of security that a database system offers is, at least in part measured by the level of auditing that can be implemented with the system. Yang [6] explains that there is no security without auditing; therefore security and auditing should be implemented in an integrated fashion. Auditing database activity and access can help identify security issues and resolve them quickly. Auditing as a function needs to play a central role in ensuring compliance with regulations because an audit produces documentation of actions, practices and conduct of a business or individual. It can be used to measure compliance to policies, procedure, process and law. So, it helps measure the compliance of both the developers and users to the business ethics.

This paper has been divided into different sections. Section 1 is a brief introduction to the subject of database auditing. Section 2 gives an overview of existing techniques, models and architectures. Section 3 has the finding from the research and proposed algorithm for the auditing procedure. Section 4 is about the risk assessment. Section 5 concludes the paper focusing on recommendation.

2. RELATED WORKS

Database auditing is now seen as a major factor in determining the security level of a database system. It is proven that no system or database can be one hundred per cent secured but the ability of it to recover from attack as quickly as possible with the help of auditing facilities provided by the DBMS is of paramount importance. Liu and Huang [7] said that all architects must bolster policies by using database auditing in addition to other security features built into all major database platforms. This is an indication that security measures alone cannot ensure security without auditing. Different actions are performed on a database ranging from logging, deletion, update, and privilege control. All these actions contributes to the security of a database depending on the basis to which they are carried out.so auditing is used to check for the genuineness of every actions performed on a database. Huang and Liu [7] put it that database auditing involves observing a database so as to be aware of the actions of the database users, to help ensure that information is not accessed by those without the correct permissions.

Looking at the concept from the field of telecommunications industry, the term data audit was explained by Bagchi et al [9] as a broad range of custom and ad hoc, application- level techniques for detecting and recovering from errors in a switching environment. Elshiekh and Dominic [10] looked at auditing in terms of a statistical database used as a mechanism for keeping up-to-date logs of all queries made by each user and constantly checking for possible compromise whenever a new query is issued. Kogan and Jajodia [11] put it that auditing capability is one of the

requirements for secure databases and that a secure database management system, among other things, has to provide not only facilities for recording the history of all updates but high-level support for querying this history as well. This is an indication that this concept at any time can query i.e. audit any update done to the system to ascertain the quality of information in the database.

2.1 Database efficiency improvement

Wentian and Miklaus [12] point out that auditing the changes to a database is critical for the identification of malicious behaviour, maintenance of data quality and improving system performance. Waraporn [13] gives two major reasons for database auditing which are to have data log files which helps in the recovery of transactions and also in the investigation of transactions. This is true because information security in term of authentication and authorisation can help protect information but does not provide help in investigating transaction activity. Therefore, the efficiency of the system can also be improved with the use of auditing techniques. Every system should have self-check facilities to improve its quality and efficiency.

2.2 Database auditing for compliance

Database auditing has also helped to improve the compliance of organisations to the different acts and regulations concerning data privacy from both the customer's and the organisation's points of view. When databases are audited, data integrity is maintained. Due to the high rate of information and financial fraud, several laws and regulations were propounded by different governments to militate against this trend. Hasan and Winslett [14] historically informed that the drumbeat of financial accounting scandals, from ENRON in 2000 to Satyam InfoTech in 2008, has prompted the introduction of regulations intended to guarantee the integrity of business records. This gives room for companies to have control over their sensitive data. Organisations that handle sensitive data are now held to a much higher standard of data access accountability [15]. This arises from the different regulatory compliance laws enforced by different countries and regions. Yang [6] explain that auditing as a function needs to a play a central role in ensuring compliance because an audit documents actions, practices and conduct of a business or individual. It then measures their compliance to policies, procedure, process and law. Regulations such as the following have common auditing-related requirements: Sarbanes-Oxley Act, Health Insurance Portability and Accountability Act (HIPAA), International Convergence of Capital Measurement and Capital Standards- a Revised Framework (Basel II), Japan Privacy Law and European Union Directive on Privacy and Electronic Communications.

2.3 Database auditing methods

There are different auditing techniques and methods depending on what type of auditing to be carried out or what data is to be audited. According to Mullins [5] database auditing can be categorized into three major types. Namely:

- Authorization Auditing - Who can do what?
- Access Auditing - Who did what, Modifications?
- Replication Auditing - Who copied which data where.

While Noreen et al [8] itemized the following as different methods

- **Triggers** - Set of procedures that automatically executes in response to a certain event.
- **Transactional Log** - A log maintained by SQL Server to store information of almost any activity taking place on the database Server.

- **C2 Auditing** - It records the database information that goes beyond server level events.
- **Default Trace** - It runs as a background service of MS SQL Server 2005 and assists the database administrator (DBA) to check the database users' activities.

While according to Srivastava [16] said auditing techniques are divided into the following types:

- **Statement Auditing-** The auditing of selective SQL statements irrespective of the schema object on which they are fired is Statement auditing. For example, auditing on the DDL statement fired by a user.
- **Privilege Auditing-** Privilege auditing is nothing but the audit of the usage of selective privileges like the Create Table privilege by a user. Privilege auditing can be done on any user or on all users.
- **Schema Object Auditing -** Auditing on specific schema objects is met by schema object auditing. All DML activities, Grant and Revoke performed on a specific table or all tables within a schema can be captured.
- **Fine Grained Auditing-**Fine grained auditing provides auditing on data access based on the data content.

Dudley [17] itemized the different types of auditing techniques that can be used on the Oracle database including the default System-based auditing, fine-grained auditing, trigger-based auditing, flashback techniques and flashback data archive.

Each of the authors prove and explain all the techniques with examples to show the impact on security.

2.4 Database auditing models, framework etc

There are few open source projects or publication in this area. However, the following related publications in database auditing derive frameworks, algorithms, architectures, techniques, or models for carrying out database auditing.

Bagchi et al [9] came up with an audit subsystem architecture that shows the design of the database audit process and its interaction with other system components. The proposed audit framework provides audit functionality and consists of the top-layer shell (the ***audit interface)*** and the individual elements that implement specific audit triggering, error detection and recovery techniques.

Bottcher and Steinmetz [18] proposed another system architecture for a privacy audit system of any XML database, extended by a middleware that consists of a query log and a backlog. These two above architecture were proposed as a solution to carry out basic audit in a system.

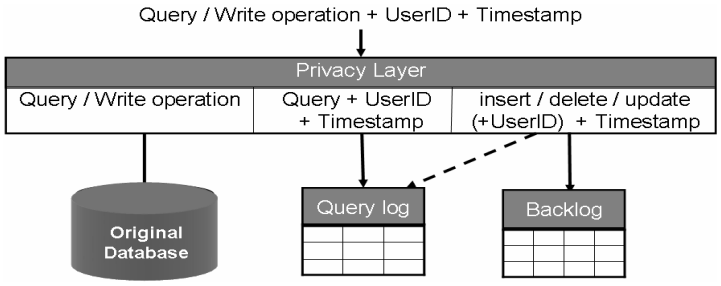

Figure 1- system architecture [18]

Another architecture was shown in Woo et al [19] which has three main components for auditing a database system. The logger, analyzer and notifier.

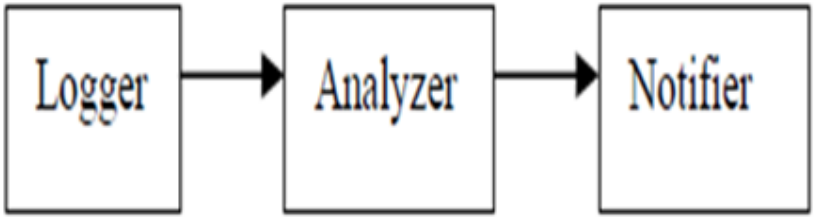

Figure 2-Anatomy of Auditing System (Bishop 2003) in Woo et al [19]

Woo et al produce this architecture in order to verify every access made into the system. The analyser does this by analysing every query and update activity on the system and comes up with authorizations which the notifier will further send to the appropriate session as the case may be.

Agrawal et al [20] have developed an architecture for their Sarbanes-Oxley solution which consists of four main components: (i) workflow modelling, (ii) active enforcement, (iii) workflow auditing, and (iv) anomaly detection. Agrawal solution was designed for compliance purposes and incorporates the work process into the system.

Johnson and Grandison [21] also proposed an architecture based system called Hippocratic Database(HDB) which enables compliance with security and privacy regulations without impeding the legitimate flow of information.

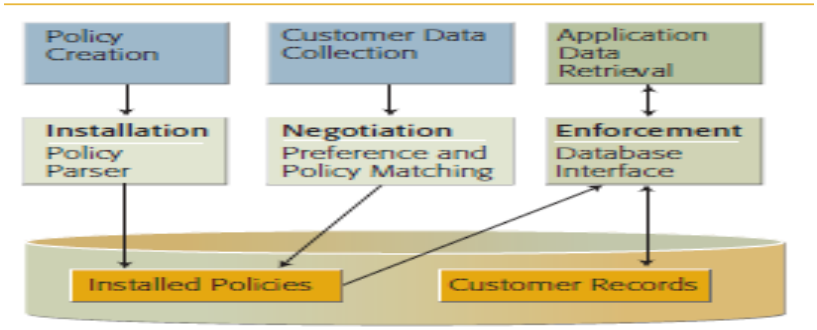

Figure 3- HDB active enforcement architecture [21]

Yangquig et al [22] produced an audit model that set up traces through database stored procedures to collect audit data The audit module stored and transported audit data in standard XML format to the audit server.

Noreen et al [8] proposed a system architecture for a target database on which auditing is to be performed. It is mounted on an instance of Microsoft SQL Server (MS SQL 2005).

Zonnone et al [23] also proposed an approach that will verify the compliance of user behaviour with data protection policies. The introduction of all these architectures only serves to emphasise the importance of auditing to any database environment. Security is not complete until there is an effective and efficient auditing system in place.

2.5 Database Audit and Protection (DAP) versus Database Activity Monitoring (DAM)

DAP — a term Gartner has developed to replace the earlier DAM concept — refers to suites of tools that are used to support the identification of and reporting on inappropriate, illegal or otherwise undesirable behaviour in RDBMSs, with minimal impact on user operations and productivity. These suites have evolved from DAM tools (which offered analysis of user activity in and around RDBMSs) to encompass a more comprehensive set of capabilities, including:

- Discovery and classification
- Vulnerability management
- Application-level analysis
- Intrusion prevention
- Support for unstructured data security
- Identity and access management integration

DAP provides better auditing and monitoring support than native logging, which can add significant overhead and does not provide the same level of granularity as DAP tools. DAP, moreover, provides comprehensive cross-platform support in heterogeneous database environments, and can serve as an effective addition to identity and access analytics [24].

3. DISCUSSION OF FINDINGS

Database auditing is a recognised technology used to determine if security and other policies are being violated. It is used in obtaining details about system usage, data modification and to help in the detection and recovery of database systems from system failure or human errors. Therefore the implementation and management of this technology is critical to the efficiency and performance of the system.

3.1 Auditing procedures and techniques

The auditing procedures in most environments start with logging activities (i.e when and how logging was done). This includes the logon and logoff records with failed and successful ones. Every environment provides this. The second stage is to check for privileges, user's definitions and other security attributes like role definition, password changes, deletion and addition of users. The third stage is to check for changes made to the database schema such as data being copied from one table to an additional table thereby changing the schema. The fourth stage is the auditing of the use of sensitive data. The fifth stage is concerned with auditing the changes made to stored procedures or codes. Other auditing stages that can be carried out involve the audit of database errors because attackers tend to make several erroneous attempts before making head way. Also, auditing any changes made to the definition of what is to be audited. These identified procedures were proposed in the framework for auditing shown below.

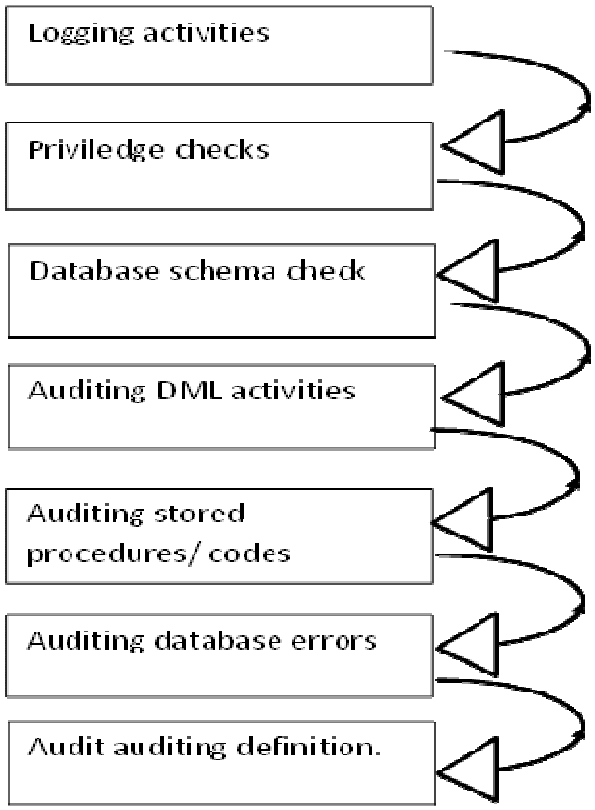

Figure 4 -A framework for auditing procedure

3.2 Impact of auditing on security

Auditing activities within a database can help identify security issues and also resolve those issues. In fact it can be said that there is no security without auditing. The following are areas identified in which auditing impacts greatly on the security of a database.

- Auditing activities enable future accountability for current actions.
- Auditing activities can help deter users and even intruders from inappropriate actions based on that accountability.
- These activities also help in investigating suspicious activity.
- It helps Notify an auditor of actions by an unauthorized user.
- Also helps detect problems with an authorization or access control implementation.
- Auditing activities also address auditing requirements for compliance.

3.3 Impact of government policies and regulations on auditing

There exist today numerous policies and regulations which have been put in place because increasing numbers of organisations are faced with sensitive information protection difficulties. These policies have stringent requirements on the collection, processing and disclosure of personal data. Now because of the difficulties associated with companies coping and enforcing these laws, there is a new trend to adopt a database compliance auditing system. It is obvious that without a compliance auditing system in place it is very difficult for organisations to monitor and enforce compliance with the policies and regulations.

Johnson and Grandison [21] give an example of a company called BankCo which uses HDB active enforcement to operate as a middleware layer above the database enforcing fine-grained policies. These policies are advised to be built into the database which gives the organisation a control measure over who has access, when the access occurs and where the access took place.

3.4 How to handle audit trail size

The database auditors are responsible for monitoring access to the database and tracking malicious actions after they have occurred [4]. When auditing is enabled in any DBMS, the audit output is recorded in an audit trail. The size of this trail can grow out of control when database activity increases. This will lead to issues such as how to keep it to a manageable size. Nando [25] explains the solution could be to relocate the audit trail to a different tablespace (Oracle) and set up an automatic purge process to keep its size under control. Nando [25] pointed out that this is one of the new features in Oracle Database 11g release2. This enables the database administrator to move audit trails from the SYSTEM tablespace to a different area of choice, allowing better management of the audit trail and to minimise the performance impact and disk space management.

Well-kept audit trail involving sensitive data should be part of any database deployment [26]. This helps in keeping track of malicious activity on the database. The failure to get this detailed audit records of database activity represents a serious organizational risk on many level. Many enterprises will turn to native audit tools provided by their database vendors or rely on ad-hoc and manual solutions. These approaches do not record details necessary to support auditing, attack detection, and forensics. Furthermore, native database audit mechanisms are notorious for consuming CPU and disk resources forcing many organizations to scale back or eliminate auditing altogether. Finally, most native audit mechanisms are unique to a database server platform. For example, Oracle logs are different from MS-SQL, and MS-SQL logs are different form DB2.

4. RISK ASSESSMENT

Based on nCircle [27] survey data breaches increased by 95% in 2010. The survey also shows that audit cost in 2008 to 2009 increased by 45%, while from 2009 to 2010 it increased to 47% (nCircle 2010 p4). Also from the nCircle [27] survey, meeting security compliance requirements was the biggest security concern in 2010 with 30% among other areas of concern. The PWC [28] survey, shows that there are two major factors acting as the driver for information security expenditure which are protecting customer information (34%) and complying with laws/regulations (17%).

Therefore, organisations should have a database compliance auditing system which has in place all the policies and laws applicable to their operations. This incorporates enforcement compliance with internal security policies and the ability to demonstrate continuous compliance.

5. CONCLUSION

In this paper, a critical assessment of auditing has been performed and an auditing procedural framework was developed. The rationale of the work presented here is to review some existing auditing techniques and architectures to bring out major benefits, in order to produce a framework which will effectively facilitate the database auditor to perform the intricate task of auditing. This procedure must be customized to the processes and operations already in place, and the relevant policies and regulations. This will allow organisations to enforce automated security and privacy controls that will align with existing laws and regulations to facilitate cross-border information

transfers. The adoption of a particular architecture or model for auditing activities has strategically placed organisations in a high level of effective security.

The work done on the auditing procedural framework can be enhanced in future by the inclusion of other stages of auditing not identified here and other functionalities. Firstly, each stage can be expanded by splitting it into sub-stages which will make it a more comprehensive system. Secondly, the entire proposed framework could be incorporated into a DBMS for adoption by organisations as part of their process.

Recommendation is also made to organisations to adopt a compliance auditing system which has policies and regulations inbuilt. This provides a control measure over those that have access, when and where access is made and also allows the demonstration of continuous compliance.

REFERENCES

[1] Dudley, C. (2012) Database Auditing. Lecture 14: 7C1006L14 [online]. [Accessed 17 May 2012]. Available at http://wolf.wlv.ac.uk/stech/68343/Slides/7CI006.

[2] Qiang, H. and Lianzhong, L. (2009) A Logging Scheme for Database Audit, Computer Science and Engineering, 2009. WCSE '09. Second International Workshop on 2009, pp. 390-393.

[3] Baccam, T (2010) Oracle database security: what to look for and where to secure. SANS analyst Program, April 2010. [Online]. London. [Accessed 23 may, 2012]. Available at: http://download.oracle.com/doc

[4] Lu, W., Miklau, G. and Immerman, N. (2013) Auditing a database under retention policies. The VLDB Journal—The International Journal on Very Large Data Bases [online], 22(2), pp. 203-228 .

[5] Mullins, C. (2008) Database Auditing. NEON enterprise software. Texas. [Accessed 24 July, 2012]. Available at:<http://www.neonsoft.com.

[6] Yang, L. (2009) Teaching database security and auditing. In Proceedings of the 40th ACM technical symposium on Computer science education (SIGCSE '09). ACM, New York, NY, USA,241-245.DOI=10.1145/1508865.1508954 http://doi.acm.org/10.1145/1508865.1508954

[7] Liu, L. and Huang, Q. (2009) A Framework for Database Auditing, Computer Sciences and Convergence Information Technology, 2009. ICCIT '09. Fourth International Conference on 2009, pp. 982-986.

[8] Noreen, Z. Hameed, I. and Usman, A. (2009) Development of database auditing infrastructure. In Proceedings of the 7th International Conference on Frontiers of Information Technology (FIT '09). ACM, New York, NY, USA, Article 78, 6 pages

[9] Bagchi, S., Liu, Y., Whisnant, K., Kalbarczyk, Z., Iyer, R., Levendel, Y. and Votta, L.(2001) A framework for database audit and control flow checking for a wireless telephone network controller, Dependable Systems and Networks, 2001. DSN 2001. International Conference on 2001, pp. 225-234.

[10] Elshiekh, A. and Dominic, P. (2008) A new auditing scheme for securing statistical databases Information Technology, 2008. ITSim 2008. International Symposium on. [Online]. pp.1-5.

[11] Kogan, B. and Jajodia, S. (1991) An audit model for object-oriented databases Computer Security Applications Conference, 1991. Proceedings., Seventh Annual. [Online]. pp.90-99.

[12] Wentian, L. and Miklau, G. (2009) Auditing a Database under Retention Restrictions, Data Engineering, 2009. ICDE '09. IEEE 25th International Conference on 2009, pp. 42-53.

[13] Waraporn, N. (2010) Database Auditing Design on Historical Data. In Proceedings of the Second International Symposium on Networking and Network Security (ISNNS '10). Jinggangshan, China, April. 2010, pp. 275-281

[14] Hasan, R and Winslett, M. (2011) Efficient audit-based compliance for relational data retention. In Proceedings of the 6th ACM Symposium on Information, Computer and Communications Security (ASIACCS '11). ACM, New York, NY, USA, 238-248.

[15] Mazer, M. (2006) Auditing Databases for Compliance and Risk Management, DM Review, vol. 16(3), pp. 18-19

[16] Srivastava, M. (2009) Fine Grained Auditing in Oracle 10g [online]. [Accessed 28th July, 2012]. Available at: < http://hosteddocs.ittoolbox.com/ms080609.pdf>

[17] Dudley, C. (2012) Auditing techniques for oracle database 11g. Lecture delivered during oracle conference 2012, Texas, USA.

[18] Bottcher, S. and Steinmetz, R. (2006) Finding the Leak: A Privacy Audit System for Sensitive XML Databases, Data Engineering Workshops, 2006. Proceedings. 22nd International Conference on 2006, pp. 100-100.

[19] Woo, J., Lee, Sael. And Zoltowski, C (2007) Database Auditing [online]. [Accessed 24th July, 2012]. Available at :http://www.citeseerx,ist,psu.ed

[20] Agrawal, R., Johnson, C., Kiernan, J. and Leymann, F. (2006) Taming Compliance with Sarbanes-Oxley Internal Controls Using Database Technology Data Engineering, 2006. ICDE '06. Proceedings of the 22nd International Conference on. [Online]. pp.92-92.

[21] Johnson, C. and Grandison, T. (2007) Compliance with data protection laws using Hippocratic Database active enforcement and auditing [online].

[22] Yangqing, Z., Hui, Y., Hua, L. and Lianming, Z. (2009) Design of a New Web Database Security Model, Electronic Commerce and Security, 2009. ISECS '09. Second International Symposium on 2009, pp. 292-295.

[23] Zannone, N., Petkovic, M. and Etalle, S. (2010) Towards data protection compliance [online]. IEEE, pp.1-4Available at: http://wlv.summon.serialssolutions.com/

[24] Wheatman, J. (2012) Database Auditing Monitoring is evolving into Database Audit and protection. Gartner Incorporation [online] February, 2012, [Accessed 22 September,2012]. Availableat:http://www.gartner.com/technology/

[25] Nando, A. (2010) managing Audit trails. Oracle Magazine [online] November 2010, [Accessed 19 September 2012].Available at:http://www.oracle.com/technetwork....

[26] Akanji, A. and Elusoji, A. (2014) A Comparative Study of Attacks on Databases and Database Security Techniques. [online].

[27] Ncircle (2010) information security and compliance trend study: Technical report [online]. California. [Accessed 03 August 2012]. Available at <:http://www.inteco.es/file/us>

[28] PWC (2012) Information security breaches survey: Technical report [online]. London. [Accessed 03 August 2012]. Available at :< http://www.pwc.co.uk/.../uk-information-security-breaches-survey-technica>

AUTHORS

Olumuyiwa Matthew received B.Tech and MSc degrees in Computer Science and Information Technology Management respectively. He is currently working towards the PhD degree with the department of Mathematic & Computer Science University of Wolverhampton, Uk. His current research interest is issues relating to the adoption of Multi-tenant database.

Carl Dudley holds the post of Emeritus Professor in Database Technology at the University of Wolverhampton, UK. He has been active within the Oracle database environment for the last 27 years, being a director of the UK Oracle User Group and speaking regularly at international conferences since 1991. He has also participated in the SQL Standards ISO group. In November 2002, Carl was selected as 'DBA of the Year' by Oracle Corporation. This worldwide award was given to him in recognition of his contribution to the Oracle user community and his work on innovative Oracle Server projects. Carl achieved Oracle ACE Director status in 2009 and is now a Fellow of the British Computer Society. His research interests lie in database performance tuning and database security.

INTENTIONAL BLANK

HIDDEN MARKOV MODEL APPROACH TOWARDS EMOTION DETECTION FROM SPEECH SIGNAL

K.Sathiyamurthy[1], T.Pavidhra[2], B.Monisha[3] and K.VishnuPriya[4]

Computer science and engineering, Pondicherry Engineering college, Puducherry, India
[1]sathiyamurthyk@pec.edu
[2]pavidhra0030@pec.edu
[3]monisha0026@pec.edu
[4]vishnupriya.pk94@gmail.com

ABSTRACT

Emotions carry the token indicating a human's mental state. Understanding the emotion exhibited becomes difficult for people suffering from autism and alexithymia. Assessment of emotions can also be beneficial in interactions involving a human and a machine. A system is developed to recognize the universally accepted emotions such as happy, anger, sad, disgust, fear and surprise. The gender of the speaker helps to obtain better clarity for identifying the emotion. Hidden Markov Model serves the purpose of gender identification.

KEYWORDS

HMM, Emotion recognition, Forward-Backward algorithm

1. INTRODUCTION

Need for natural way of communication between humans and machines arises as the computer plays a vital part in present world. This demands the computer to recognize its present situation and react differently which involves understanding a user's emotional state. Speech is the key input to an emotion recognition system. It is a potential way to communicate intentions and emotions. Speech features are extracted and classified using HMM and neural networks. Emotions help us to make decisions. The way men and women process their emotional memories also seem to differ. Women have better memories of their emotion than men. So they forget memories of the incidents happened before receiving emotionally charged information. This indicates that women are more pretentious to emotional content which means women and men process emotions in different parts of their brain. Evaluation of emotions and encoding of the memory is much more tightly integrated in women than in men. Hence gender plays a vital role in identifying the emotion. Hidden Markov Model is used for classifying the gender of the speaker. Markov model is a stochastic model for designing frequently changing systems in which the future states depend only on the present state and not on the sequence of events prior to the occurrence of the current state. A statistical Markov model with hidden states called hidden Markov model (HMM) is used in this paper. Next this paper illustrates the relationship related works.

Dhinaharan Nagamalai et al. (Eds) : CSITA, ARIN, ISPR - 2015
pp. 13–19, 2015. © CS & IT-CSCP 2015 DOI : 10.5121/csit.2015.50802

2. RELATED WORKS

A work on A new architecture of intelligent audio emotion recognition done by Chien Shing Ooi, Kah Phooi Seng , Li-Minn Ang , Li Wern Chew [1]. It uses prosodic and spectral features. It has two main paths. Path 1 is for processing the prosodic features and path 2 for the spectral features. Bi-directional Principle Component Analysis (BDPCA) and Linear Discriminant Analysis (LDA) are done. The performance of the system is evaluated on eNTERFACE'05 and RML databases. Using audio emotion recognition the gender is not considered for detecting the emotion. Next work deals with gender recognition using Naive-bayes method.

A work on Gender Specific Emotion Recognition through Speech Signals [2] done by Vinay, Shilpi Gupta, Anu Mehra. The system has two modules one for Gender Recognition (GR) and the other for Emotion Recognition (ER). Features like pitch, energy and MFCC are extracted and then emotion recognition strategy is adapted. The result shows that a prior idea about the gender of speaker helps in increasing the performance of system. This approach has been implemented by using Naive Bayes method. But this system does not consider age which is also an important phenomenon for detecting the emotion. Next work deals with age and gender recognition.

A work on Automatic speaker age and gender recognition using acoustic and prosodic level information fusion [3] done by Ming Li ∗, Kyu J. Han, Shrikanth Narayanan. It has three sub systems. Gaussian mixture model using MFCC features, Support vector machine based on GMM mean super vectors and another SVM utilizing 450-dimensional utterance level features. Pitch, time domain energy, frequency domain harmonic structure energy and formant for each syllable are considered for analysis in subsystem. The subsystems have been used to achieve competitive results in classifying different age and gender groups. The database used to evaluate this approach is the aGender database. But this system does not use large database.

A work on **S**peaker state recognition using an HMM-based feature extraction method [4] done by R. Gajˇsek ∗, F. Miheliˇc, S. Dobriˇsek. This system uses acoustic features for recognizing various paralinguistic phenomena. The acoustic features are modeled with UBM by building a monophone-based Hidden Markov Model instead of representing UBM in the Gaussian Mixture Model (GMM). It is done by a two step process involving the transformation of the monophone-based segmented HMM–UBM to a GMM–UBM and then adapting the HMM–UBM directly. Both approaches supervise the emotion recognition task and the alcohol detection task. Here they used two corpuses, FAU-Aibo containing emotionally distinguished speech of children, and VINDAT for adult speech after alcohol consumption.

3. SYSTEM DESIGN

Fig 1 depicts the architecture of the proposed system. The proposed system consists of 4 stages. In the first stage random speech samples were collected from different speakers. This input is given to the signal processing stage where jAudio tool process the given input is processed to extract the required speech features. The features used are spectral centroid, spectral roll-off, spectral flux, spectral variability, root mean square, fraction of low energy window and zero crossing. Values for the above features are saved in an XML file. The values are classified into two ranges namely high and low based on all the values in the dataset as in table 1.

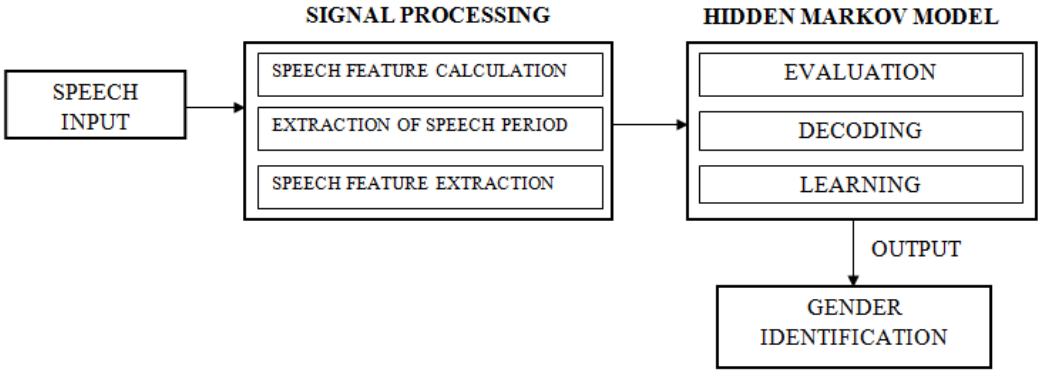

Figure 1. Architecture

Table 1. Data set

S. N	SPECTRAL CENTROID	ROLLOFF	FLUX	VARIABILITY	ROOT MEAN SQUARE	FRACTION FLOW ENERGY WINDOW	ZERO CROSSING	GENDER
1	HIGH	HIGH	HIGH	HIGH	LOW	HIGH	HIGH	MALE
2	HIGH	HIGH	LOW	HIGH	LOW	LOW	HIGH	MALE
3	HIGH	LOW	HIGH	LOW	HIGH	HIGH	LOW	MALE
4	LOW	HIGH	HIGH	HIGH	HIGH	LOW	HIGH	MALE
5	LOW	LOW	LOW	LOW	LOW	HIGH	LOW	FEMALE
6	LOW	HIGH	HIGH	HIGH	HIGH	HIGH	HIGH	FEMALE
7	HIGH	HIGH	HIGH	HIGH	HIGH	LOW	HIGH	FEMALE
8	HIGH	HIGH	LOW	HIGH	LOW	LOW	HIGH	FEMALE

4. IMPLEMENTATION OF PROPOSED WORK

HMM is used to recognize the gender of the speaker from the features in the XML file. HMM is modeled as in fig 2 with the gender {male, female} as the hidden states and the features {spectral centroid, roll-off, flux, variability, root mean square, fraction of low energy window, zero crossing} as the visible states.

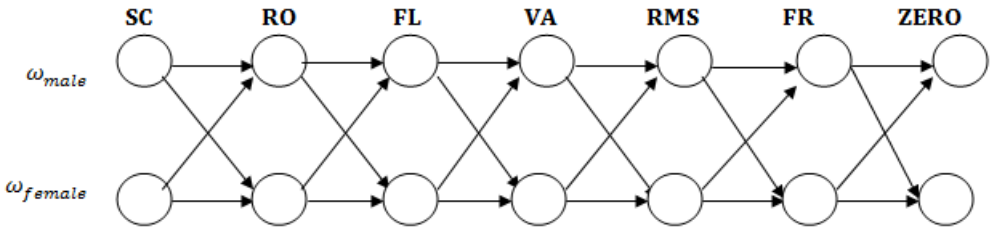

Figure 2. HMM MODEL

4.1. METHODOLOGY

We may have states at time t that are influenced directly by state at t -1.There are transition from one state to another (with certain probability) — Markov ModelThe states have a certain probability of generating various output symbols — the observations.Human can only see the

obervation, but not the underlying Markov Model. (Hence Hidden).The state at any time t is denoted $\omega(t)$. A sequence of states of length T is denoted by

$$\omega^T=\{\omega(1)\ ,\omega(2),\omega(3),\ldots,\omega(T)\}$$

Production of any sequence is described by the transition probability:

$$P\ (\ \omega_j(t+1)|\omega_i(t)) = a_{ij}$$

Transition prob. need not be symmetric, i.e.$a_{ij}\ \neq a_{ji}$ in general.We can observe some visible symbols v(t) at time t. However, the underlying state is unknown, i.e. hidden. In any state, we have a probability of emitting a particular visible state v_k(t), i.e. the same state may emit different symbols, and the same symbol may be emitted by different states.We denote this prob:

$$P\ (v_k(t)|\omega_j(t)) = b_{jk}$$

Because we can only observe the visible states, while the ω_i are unobservable, it is called Hidden Markov Model.

4.2. COMPUTATION

The underlying network is a finite state machine, and when associated with transition probabilities, they are called Markov networks. A final or absorbing state ω_0 is one which if entered, is never left. We require some transition must occur at each step (may be to the same state), and some symbol must be emitted. Thus, we have the normalized conditions.

$$\sum_j a_{ij}=1\ \forall_i$$
$$\sum_k b_{jk}=1\ \forall_j$$

There are 3 central issues: (a). Evaluation process- Given a_{ij} and b_{jk}, Determine the prob. that a particular sequence of visible states V^T was generated by that model. Problem of the model produces a sequence V^T of visible state is which is mentioned in the equation below:

$$P\ (V^T) = \sum_{r=1}^{r_{max}} P\ (\ V^T|\omega_r^T)\ P\ (\omega_r^T)$$

where each r indexes a particular sequence $\omega_t\ = \{\omega(1),\omega(2),\ldots..\omega(T)\}$ of T hidden states. In the general case of c hidden states, there will be rmax = cT possible terms. As we are working with a 1st order Markov process,

$$P\ (\omega_r^T) = \prod_{t=1}^{T} P\big(\omega(t)\big)|\omega(t-1)$$

i.e. a products of a_{ij}'s.The output symbol only depends on the hidden states, we can write

$$P(V^T|\omega_r^T) = \prod_{t=1}^{T} P(v(t)|\omega(t))$$

i.e. a product of b_{jk}'s. Hence,

$$P\ (V^T) = \sum_{r=1}^{r_{max}} \prod_{t=1}^{T} P(v(t)|\omega(t))|P(\omega(t)|\omega(t-1))$$

4.3. INTERPRETATION

Visible states v(t) is equal to the sum over all rmax possible sequence of hidden states of the conditional prob. that the system has made a particular transition, multiplied by the prob. that it then emitted the visible symbol in the target sequence.We can compute recursively define

$$a_j\ (t)=\begin{cases}0 & t=0 \text{ and } i \neq \text{initial state}\\ 1 & t=0 \text{ and } i=\text{initial state}\\ \left[\sum_i a_{i(t-1)a_{ij}}\right] b_{j(v(t))} & \text{otherwise}\end{cases}$$

α_j (t) denotes the probability of observing the sequence up to time t, and ending in state j.

$$\alpha_j\ (t) = P\ (v\ (1)\ v\ (2)\ldots\ldots\ v\ (t);\ I_t = i)$$

For the final state ω_0, we return α_0(T) for the final state. Computation Complexity O(c^2T). (b).decoding problem - Given the model and a set of observations V^T, determine the most likely sequence of hidden state $\omega_T$that led to those observation.We define backward variable:

$$\beta_j(t) = P(v(t+1);\ v(t+2);\ \ldots\ldots;\ v(T)\ |\ I_t = j)$$

$$\beta_i(t) = \begin{cases}0 & \omega_i(t) \neq sequence's final\ state\\ 1 & \omega_i(t) = sequence's final\ state\\ \sum_j \beta_j(t+1)a_{ij}b_j\big(v(t+1)\big) & otherwise\end{cases}$$

β_j(t) is the probability of starting from state j at time t, going through the observations and reach the final state.Time complexity: O(c2T). (c). learning problem - Given the coarse structure of the model (i.e. number of states, number of visible symbols), and a set of training observation of visible symbols, determine the parameters a_{ij} and b_{jk}.

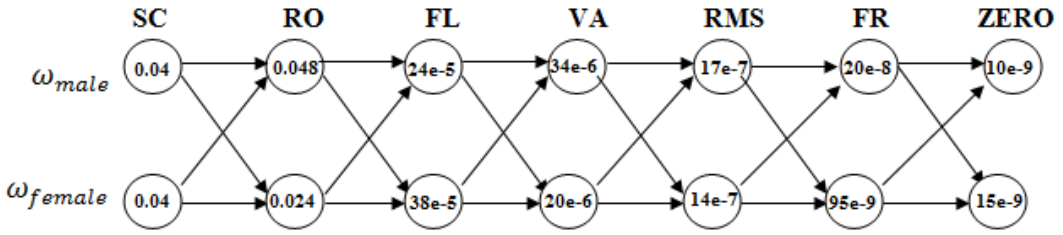

Figure 3. Forward Evaluation

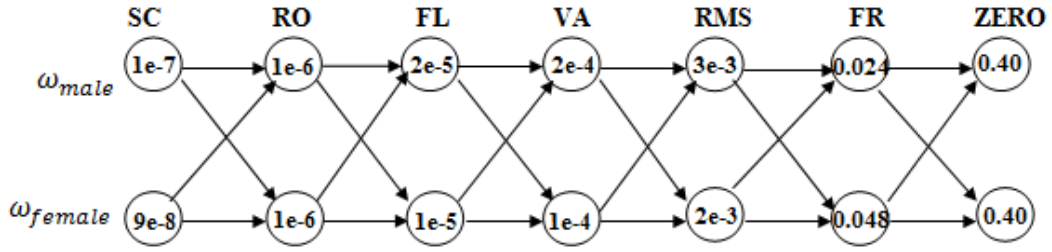

Figure 4. Backward Evaluation

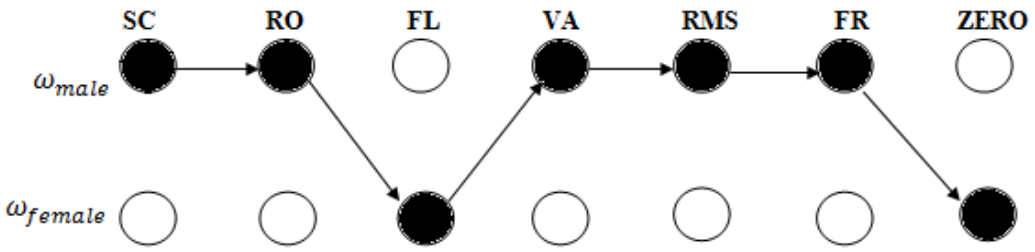

Figure 5. Pattern

5. CONCLUSION AND FUTURE WORKS

In this paper, the adoption of jahmm library for implementing HMM which has gender as the hidden state and speech features as the visible state. Speech features are extracted using jAudio tool. The future works include implementation of neural network for detecting the emotion with the help of speech features and the additional HMM output (Gender).

REFERENCES

[1] Chien Shing Ooi, Kah Phooi Seng, Li-Minn Ang & Li Wern Chew, (2014) " A new approach of audio emotion recognition", Expert System with Applications, Vol. 41, pp 5858–5869 .

[2] Vinay, Shilpi Gupta & Anu Mehra, (2014) "Gender Specific Emotion Recognition Through Speech Signals", International Conference on Signal Processing and Integrated Networks (SPIN), pp 727-733.

[3] Ming Li, Kyu J. Han, Shrikanth Narayanan, (2013) "Automatic speaker age and gender recognition using acoustic and prosodic level information fusion", Computer Speech and Language, Vol. 27, pp 151–167.

[4] R. Gaj sek, F. Miheli c, S. Dobri sek, (2013) "Speaker state recognition using an HMM-based feature extraction Method", Computer Speech and Language, Vol. 27, pp 135–150.

[5] Ajmera, J., Burkhardt, F., (2008) "Age and gender classification using modulation cepstrum", In: Proc. Odyssey, p. 025.

[6] Campbell, W., Sturim, D., Reynolds, D., Solomonoff, A. (2006b.) "SVM based speaker verification using a GMM supervector kernel and NAP variability compensation", In: Proc. ICASSP, pp. 97–100.

[7] Ayadi, M. E., Kamel, M. S., & Karray, F. (2011) "Survey on speech emotion recognition: Features, classification schemes, and databases", Pattern Recognition, 44(3), 572–587.

[8] Bhaykar, M., Yadav, J., & Rao, K. S. (2013) "Speaker dependent, speaker independent and cross language emotion recognition from speech using GMM and HMM", Paper presented at the Communications (NCC), 2013 National Conference on (15–17 Feb).

AUTHORS

Dr. K. Sathiyamurthy is working as an Assistant Professor at Pondicherry Engineering College in the department of Computer Science And Engineering

T. Pavidhra is a student at Pondicherry Engineering College in the Department of Computer Science and Engineering

B. Monisha is a student at Pondicherry Engineering College in the Department of Computer Science and Engineering

K. Vishnu Priya is a student at Pondicherry Engineering College in the Department of Computer Science and Engineering

INTENTIONAL BLANK

TEXT MINING AND CLASSIFICATION OF PRODUCT REVIEWS USING STRUCTURED SUPPORT VECTOR MACHINE

Jincy B. Chrystal[1] and Stephy Joseph[2]

[1]M.Phil. Computer Science, IIITM-K, Trivandrum, Kerala
jincyb.mphilcs2@iiitmk.ac.in
[2]M.Phil. Computer Science, IIITM-K, Trivandrum, Kerala
stephyjoseph.mphilcs2@iiitmk.ac.in

ABSTRACT

Text mining and Text classification are the two prominent and challenging tasks in the field of Machine learning. Text mining refers to the process of deriving high quality and relevant information from text, while Text classification deals with the categorization of text documents into different classes. The real challenge in these areas is to address the problems like handling large text corpora, similarity of words in text documents, and association of text documents with a subset of class categories. The feature extraction and classification of such text documents require an efficient machine learning algorithm which performs automatic text classification. This paper describes the classification of product review documents as a multi-label classification scenario and addresses the problem using Structured Support Vector Machine. The work also explains the flexibility and performance of the proposed approach for efficient text classification.

KEYWORDS

Text classification, Multi-label classification, Structured Support Vector Machine

1. INTRODUCTION

With the rapid growth of technology and its applications, text data has become one of the important information sources in real world scenarios. In such a scenario, text classification plays an important role in organizing the text documents into different categories. Considering the convenience and relevance of text classification, the dataset used in this work encompasses a large collection of product reviews of electronic gadgets. This paper presents the construction of a classification model in multi-label domain for the classification of product review documents. As the first phase of this work, text mining is carried out inorder to model and structure the information content of textual sources. The result of text mining process generates text documents with relevant and high quality information which indeed contributes to efficient text classification. The work deals with the general problem of text classification, but using a new approach of Multiclass-Multilabel classification using Structured Support Vector Machine.

The Structured SVM is a supervised learning algorithm designed for complex outputs and structured output spaces and it performs the learning by using discriminant function over input-

Dhinaharan Nagamalai et al. (Eds) : CSITA, ARIN, ISPR - 2015
pp. 21–31, 2015. © CS & IT-CSCP 2015 DOI : 10.5121/csit.2015.50803

output pairs. The learning phase of the specified method involves the feature extraction and grouping of features into multiple classes and hence multiple labels. Here the text classification is a multi-labeled problem, where each document can belong to more than one class. We propose a multi-label text classification model that maps a set of categories to each input document and so the output of the classifier will be a vector rather than a single class label. The resultant model thus performs multi-label text classification of product review documents and it also focuses on the precision, accuracy and performance of the system by the creation of a confusion matrix which measures the degree of prediction and classification of text documents.

2. METHODOLOGY

The proposed work describes Structured Support Vector Machine as a Multi-label text classifier for the classification of product review documents. The entire system is organized into four major modules namely, Preprocessing, Learning, Classification and Evaluation. The preprocessing stage involves the techniques and processes which completes task of text mining. The structured SVM is formulated by the training and testing modules which indeed represents the learning and classification tasks. Finally the evaluation phase measures the efficiency and performance of the system. The workflow of the proposed system is represented as follows.

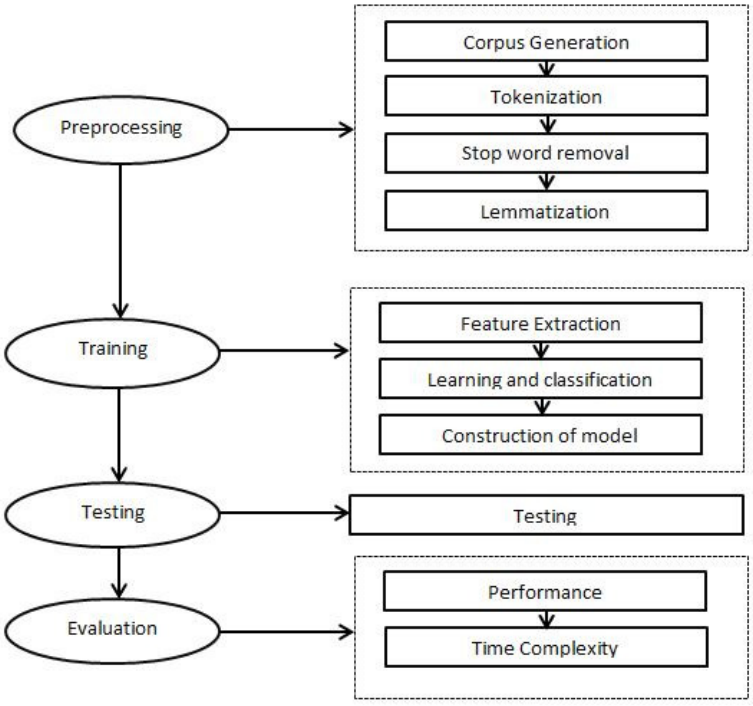

Figure 1. Proposed System

2.1. Corpus

The experiment of this work is carried out on a text corpus which is a collection of product reviews of various electronic gadgets. The electronic gadgets include Mobile Phones, Tablets, Laptops, Pendrives, Televisions, Datacards, Memory cards, Printers, Speakers, Washing Machines, Air conditioners, Vacuum Cleaners, Fans, Microwave Ovens etc. The corpus is

organized as a multi-label dataset with 105 features, 25 classes, 1500 review documents for training, and 500 review documents for testing.

2.2. Pre-processing

2.2.1. Tokenization

Tokenization is the first pre-processing stride of any natural language processing and corpus generation. It is the process of replacing the meaningful sentence in to individual words with space as the delimiter and it retain all the valuable information's. Each individual words are known as tokens. These tokens are the key elements of the NLP.

In our experiment, tokenization is one of the pre-processing steps of our corpus generation. One lakhs corpus was considered in our work. The tokenization methodology is used to split the corpus sentence into words. The python script are using for corpus tokenization. In our corpus, the tokenization help us to knowing the total frequency of words in corpus.

2.2.2. Stop word removing

Stop word removing is one of the pre-processing stage of natural language processing. It is the method of removing the common stop words in English like 'is', 'was', 'where', 'the', 'a', 'for', 'of', 'in' exe. The stop words in corpus make little difficult for coups processing and feature extraction. To avoid this issues we are choose stop word remover.

In our experiment, the python stop word scrip and NLTK toolkit are used for stop word removing processing. The stop word remover help to remove the extra common words from the corpus and help to reduce the size of the corpus and it will help us easy to identify the key words in the corpus and frequency distribution of concept words in overall concepts.

2.2.3. Lemmatization

Lemmatization is the process of obtaining the "lemma" of a root word with involves reducing the word forms to its root form after understanding the parts of speech and the context of the word in the sentence [1]. In our methodology the lemmatization is one of the NLP procedure for getting the root words from the huge corpus. It will help us to label the most frequent word in that corpus.

Here the lemmatization works the following way. First to establish a link between the corpuses an English dictionary. The English dictionary contains all form of words and also had the all inflected form of verbs. Based on the dictionary the lemmatization process are takes place. This process is to replace inflected and past form of the word with corresponding bass or root words. After the lemmatization process we got the root words and these root words are used to processing the labelling process in the support vector machine algorithm.

2.3. Training

2.3.1. Feature Extraction

The text feature extraction of this work is performed by using Term Frequency – Inverse Document Frequency approach and similarity matching of words. The general problem of text feature extraction can be done by tf-idf method, but there are situations in which the term frequency criteria fail to do so. For example, we may have a review document which doesn't find the frequency of a particular term and thus couldn't map to a feature explicitly. In such cases, the

similarity of words and their synonyms are to be considered and grouping of such words is done to extract the features. The following section describes these methods in detail.

Term Frequency – Inverse Document Frequency (tf-idf) is a popular feature extraction method which reflects the relevance of a word in a particular document among the corpus. It is a numeric statistical approach which is often considered as a weighing factor in Information Retrieval and Text Mining and its value is directly proportional to the number of times a word appears in a particular document. Denote a term by 't', a document by 'd' and a corpus by 'D', the Term Frequency TF (t, d) is defined as the number of times the term 't' appears in document 'd' while Document Frequency DF(t, D) is defined as the number of documents that contains the term 't'. However, some frequent terms may not provide any relevance for the task of feature extraction and the weight of such terms should be diminished. For this, the 'Inverse Document Frequency' approach is used to distinguish relevant and non-relevant keywords which results in minimization of weight of frequently occurring non-relevant terms and maximisation of weight for terms that occur rarely. The idf gives the measure of specificity of a term which can be expressed as the inverse function of the number of documents in which the term occurs.

The tf-idf based feature extraction is performed by modelling the documents in vector space. The first step in modelling is the creation of an index vocabulary (dictionary) of terms present in the training documents. Now the term frequency gives the measure of how many times the words in the dictionary are present in the testing documents. Mathematically, tf and idf are calculated as follows:

$$tf(t,d) = 0.5 + \frac{0.5 \times f(t,d)}{\max\{f(w,d) : w \in d\}}$$

Where f(t, d) denotes the raw frequency of the term, 't' and f(w, d) represents the raw frequency of any term in the document.

$$idf(t,D) = log\frac{N}{|\{d \in D : t \in d\}|}$$

where N denotes the total number of documents in the corpus and the denominator denotes the occurrence of term t in document d.

Similarity matching and grouping of words is performed inorder to extract features from review documents which does not explicitly specify the features. For this, we formulate a perceptual grouping of similar words that falls under a single class. Inorder to map a group of such words to a particular feature, it is essential to find out the hyponyms and hypernyms for each relevant word in the document. This work uses the WordNet Interface of NLTK Python for generating the hyponyms and hypernyms of words in each document. An illustration of the grouping of features is given below:

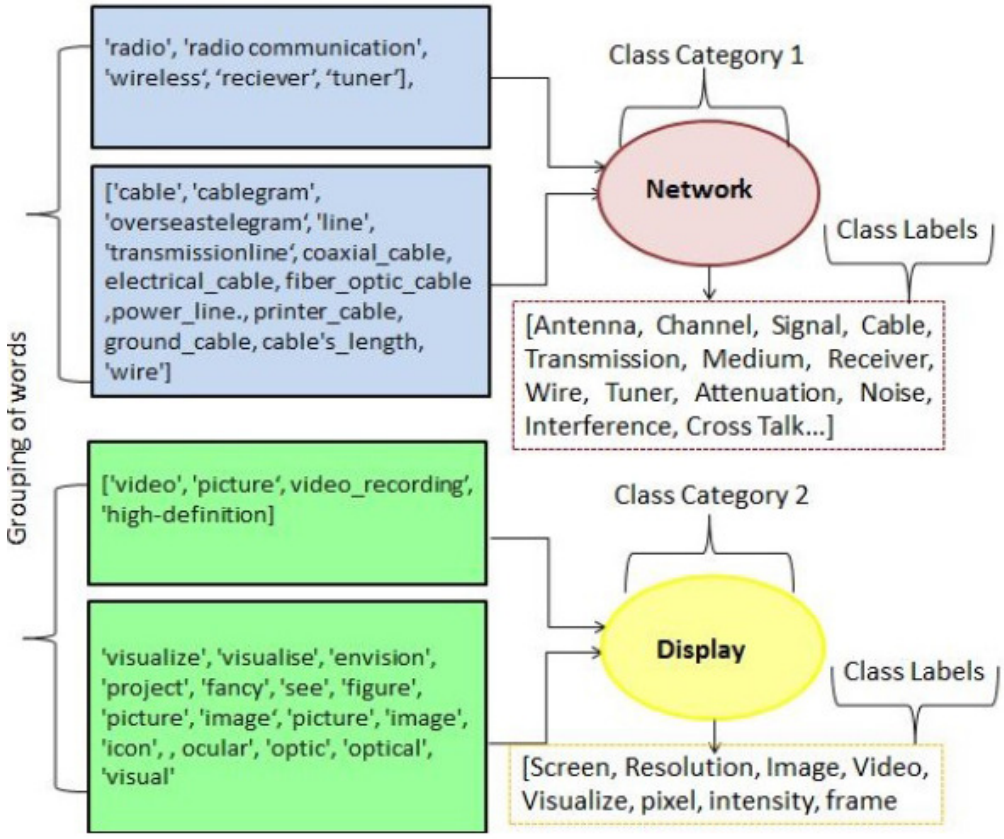

Figure 2. Grouping of Features

2.3.2. Learning and Classification

The paper presents the classification of words in product reviews to different class labels based on the various features of the product. Since the corpus is associated with text reviews, a grouping approach of feature extraction is done in this work, which results in the formulation of multiple classes and multiple class labels. Hence the classification problem is represented as a multi-class multi-label problem and this work proposes a new approach called 'Structured Support Vector Machines' for learning and classification. The problem addresses the issues of complex outputs including multiple dependent output variables and structured output spaces. The proposed method is to perform Multi label classification using Structured SVM. The method approaches the problem by generalizing large margin methods to the broader problem of learning structured responses. This approach specifies discriminant functions that exploit the structure and dependencies within structured output spaces. The maximum margin algorithm proposed in Structured SVM has the advantages in terms of accuracy and tenability to specific loss functions.

2.3.3. Structured Support Vector Machines

Structured SVM is a Support Vector Machine (SVM) learning algorithm for predicting multivariate or structured outputs. It performs supervised learning by approximating a mapping h: X→Y using labelled training samples (x1,y1),….(xn,yn). Unlike the regular SVMs which consider only univariate predictions like in classification and regression, SSVM can predict complex objects like trees, sequences or sets. Examples of problems with complex outputs are

natural language parsing, sequence alignment in protein homology detection and Markov models for Parts Of Speech (POS) tagging. The algorithm can also be used for linear-time training of binary and multi-class SVMs under linear kernel. The algorithm uses quadratic programming and is several orders of magnitude faster than prior methods. SVM^{struct} is an instantiation of the Structured Support Vector Machine algorithm and it can be thought as an API for implementing different kinds of complex prediction algorithms. In this work, Python interface to SVM^{struct} is used for implementing the multi-label classification.

In the SSVM model, the initial learning model parameters are set and the pattern-label pairs are read with specific functions. The user defined special constraints are then initialised and then the learning model is initialised. After that, a cache of combined feature vectors is created and then the learning process begins. The learning process repeatedly iterates over all the examples. For each example, the label associated with most violated constraint for the pattern is found. Then, the feature vector describing the relationship between the pattern and the label is computed and the loss is also computed with loss function. The program determines from feature vector and loss whether the constraint is violated enough to add it to the model. The program moves on to the next example. At various times (which depend on options set) the program retrains whereupon the iteration results are displayed. In the event that no constraints were added in iteration, the algorithm either lowers its tolerance or, if minimum tolerance has been reached, ends the learning process. Once learning has finished, statistics related to learning may be printed out and the model is written to a file and the program exits.

After the learning process, a model is created and written to a file for classification. For the testing phase, the learned model is read with and the testing pattern-label example pairs are loaded with. Then, it iterates over all the testing examples, classifies each example, writes the label to a file, finding the loss of this example, and then may evaluate the prediction and accumulate statistics. Once each example is processed, the classification summary statistics are printed out with and the program exits. The learning and classification module of struct SVM model is represented as follows:

Structured output SVMs extends SVMs to handle arbitrary output spaces, particularly o**nes with non-trivial structure** (E.g. textual translations, sentences in a grammar, etc.). Learning a structured SVM requires solving an optimisation problem by choosing the highest scoring output for each input

$$\hat{\mathbf{y}}(\mathbf{x};\mathbf{w}) = \operatorname*{argmax}_{\mathbf{y}\in\mathcal{Y}} \langle \mathbf{w}, \Psi(\mathbf{x},\mathbf{y}) \rangle$$

The evaluation of a structured SVM requires solving the following problem and the efficiency of using structured SVM (after learning) depends on how quickly the inference problem is solved.

$$\operatorname*{argmax}_{\mathbf{y}\in\mathcal{Y}} \langle \mathbf{w}, \Psi(\mathbf{x},\mathbf{y}) \rangle$$

Then we define a loss function Δ(y, y^) measuring how well the prediction y^ matches the truth label y. Finally we define a constraint generation function which captures the structure of the problem. Generating a constraint for an input-output pair (X, y) means identifying what is the most incorrect output that the current model still deems to be compatible with the input. The margin rescaling formulation and slack rescaling formulation are represented as follows:

$$\max_{\hat{y}\in\{-1,+1\}} \Delta(y,\hat{y}) + \langle \Psi(\mathbf{x},\hat{y}),\mathbf{w}\rangle - \langle \Psi(\mathbf{x},y),\mathbf{w}\rangle$$

And

$$\max_{\hat{y}\in\{-1,+1\}} \Delta(y,\hat{y})[1 + \langle \Psi(\mathbf{x},\hat{y}),\mathbf{w}\rangle - \langle \Psi(\mathbf{x},y),\mathbf{w}\rangle].$$

Where w is the parameter vector to be learned, $\Psi(x, y) \in R^2$ is the joint feature map and F(x,y; w) is an auxiliary function.

The SVM^{struct} implements the 1-slack cutting plane algorithm which is an equivalent formulation of the Structural SVM quadratic program and is several orders of magnitude faster than prior methods.

2.3.4. Pseudo code

2.3.4.1. SVM_Python_Learn ()

1. Check out all the command line arguments.
2. Load the Python Module
3. Parse_Parameters
   Sets the attributes of sparm based on command line arguments.
4. Read_Examples
   Reads and returns x, y example pairs from a file.
5. Initialize_model
   Initializes the learning model
6. Construct cache of Ψ(x, y) vectors used in training.
7. Train model and iterate over all training examples until no constraints are added.
8. Return a feature vector describing the input pattern x and correct label y.
   - If Margin scaling, find the most violated constraint and then classify example. Return y' associated with x's most violated constraint.
   - If Slack scaling, find the most violated constraint slack and then classify example. Return y' associated with x's most violated constraint.
   - Return a feature vector describing pattern x and most violated label y'.
   - Return the loss of y' relative to the true labelling y.
   - If the new constraint significantly violates the existing Quadratic Programming, add it to the SVM QP.
   - Print_Iteration_Stats
   - Print the statistics once learning has finished.
9. Train model, and iterate over all training samples until no constraints are added.
10. Print_Learning_Stats
    Print statistics once learning has finished.
11. Write_Model
    Dump the struct model to a file.
12. Exit

2.3.4.2. SVM_Python_Classify ()

1. Check out all the command line arguments.
2. Load the Python Module

3. Parse_Parameters_Classify
   Process the custom command line arguments
4. Read_Model
   Load the struct model from a file
5. Read_Examples
   Reads and returns x, y example pairs from a file.
   - Classify_example
     - Given a pattern x, return the predicted label
   - Write_label
     - Write a predicted label to an open file.
     - Return the loss of y' relative to the true labelling y
   - Eval_Prediction
     - Accumulate statistics about a single training example.
6. Iterate over all examples
7. Print_testing Stats
8. Print statistics once classification has finished.
9. Exit

3. CONCLUSION AND PERFORMANCE EVALUATION

In the experiment phase of this work, 500 testing samples are selected for testing and performance evaluation. The confusion matrix provides an idea about the actual and predicted classifications done by the classification system. It is also created for identifying the miss classifications and missed classifications. The confusion matrix generated after the testing process is as follows:

n=500	**Learn NO**	**Learn YES**	
Actual NO	TN = 27	FP = 50	77
Actual YES	FN = 48	TP = 375	423
	75	425	

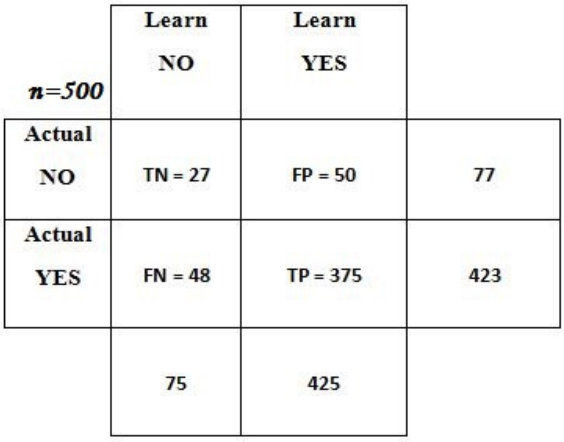

Figure 3. Confusion Matrix

The following is the list of measures that are often computed from the above confusion matrix:

Table 1. Confusion Matrix measurements

Measures	**Values**
Accuracy	80.4 %
Misclassification Rate (Error Rate)	19.6 %
True Positive Rate (Recall)	88 %
False Positive Rate	64 %
Specificity	35 %
Precision	88 %
Prevalence	84 %

n= number of population
True positive (TP)
True negative (TN)
False positive (FP)
False negative (FN)

The below table values are representing the accuracy of the proposed structured supporting vector machine learning algorithm for text mining and classification of the product reviews.

Table 2. Accuracy table

Accuracy = (TP+TN)/total	**False Positive Rate**: FP/actual no
Misclassification Rate= (FP+FN)/total [Also known as "Error Rate"]	**Specificity**: TN/actual no
True Positive Rate: TP/actual yes [Also known as **"Recall"**]	**Precision**: TP/predicted yes **Prevalence**: actual yes/total

4. CONCLUSION

We formulated a Structured Support Vector Machine learning paradigm for the classification of texts from various product reviews. The problem is represented as a multi-class multi-label problem and addressed by Struct SVM Python Implementation. The system results in an overall accuracy of 80.4% with enough flexibility and ability to handle specific loss functions. The remarkable characteristic feature of this algorithm is its capability for training complex models. The final outcome of this work is the classified words in the review text into multiple class labels according to the extracted features. The accuracy and performance of the system is measured and found to be an optimized method in the case of a Multi-label text classification scenario.

REFERENCE

[1] Bullinaria, John A., and Joseph P. Levy. (2012) "Extracting semantic representations from word co-occurrence statistics: stop-lists, stemming, and SVD." Behavior research methods 44.3: 890-907.

[2] Chrupała, Grzegorz. (2006) "Simple data-driven contextsensitive lemmatization."Procesamiento del Lenguaje Natural 37 :121-127.

[3] Fagan, Joel L., et al.(1991) "Method for language-independent text tokenization using a character categorization." U.S. Patent No. 4,991,094. 5 Feb. 1991.

[4] Joachims, Thorsten. "Transductive inference for text classification using support vector machines." ICML. Vol. 99. 1999.

[5] Korenius, Tuomo, et al.(2004) "Stemming and lemmatization in the clustering of finnish text documents." Proceedings of the thirteenth ACM international conference on Information and knowledge management. ACM.

[6] Plisson, Joël, Nada Lavrac, and Dr Mladenić. (2004) "A rule based approach to word lemmatization.".

[7] Torres-Carrasquillo, Pedro A., Douglas A. Reynolds, and J. R. Deller Jr(2002). "Language identification using Gaussian mixture model tokenization."Acoustics, Speech, and Signal Processing (ICASSP), 2002 IEEE International Conference on. Vol. 1. IEEE, 2002.

[8] De Heer T (1982) “The application of the concept of homeosemy to natural language information retrieval. Information Processing & Management,” 18:229–236.

[9] Harman D (1992)” Relevance feedback revisited.” In: Proceedings of the 15th International ACMSIGIR Conference on Research and Development in Information Retrieval (SIGIR-92), pp. 1–10.

[10] Harman D et al. (1995) Performance of text retrieval systems. Science, 268:1417–1418.

AUTHORS

1. Jincy B. Chrystal

Jincy B. Chrystal
Student, MPhil-Computer Science
Indian Institute of Information Technology and Management- Kerala (IIITM-K),
Trivandrum, Kerala,
jincyb.mphilcs2@iiitmk.ac.in

Short Biography

My interests lie with Machine learning. Throughout my professional career I've worked on technologies how to train and learn the machines. Now I'm focusing on the supervised machine learning algorithms. And doing the research on how these algorithms are used to train the machine perfectly.

2. Stephy Joseph

Student, MPhil-Computer Science
Indian Institute of Information Technology and Management- Kerala (IIITM-K),
Trivandrum, Kerala,
stephyjoseph.mphilcs2@iiitmk.ac.in

Short Biography

My interests lie with multimedia technologies. Throughout my professional career I've worked on technologies that identify, extract features from multimedia resources. Now I've focused on the voice features extracted from video files.

INTENTIONAL BLANK

WCTFR : WRAPPING CURVELET TRANSFORM BASED FACE RECOGNITION

Arunalatha J S[1], Ramachandra A C[2], Tejaswi V[3], Shaila K[1] , Raja K B[1], Dinesh Anvekar[4], Venugopal K R[1], S S Iyengar[5], L M Patnaik[6]

[1]Department of Computer Science and Engineering University Visvesvaraya College of Engineering, Bangalore University, Bangalore-560001
[2]Alpha College of Engineering, Bangalore
[3]National Institute of Technology, Surathkal, Karnataka
[4]Nitte Meenakshi Institute of Technology, Bangalore.
[5]Florida International University, USA
[6]Indian Institute of Science, Bangalore, India

ABSTRACT

The recognition of a person based on biological features are efficient compared with traditional knowledge based recognition system. In this paper we propose Wrapping Curvelet Transform based Face Recognition (WCTFR). The Wrapping Curvelet Transform (WCT) is applied on face images of database and test images to derive coefficients. The obtained coefficient matrix is rearranged to form WCT features of each image. The test image WCT features are compared with database images using Euclidean Distance (ED) to compute Equal Error Rate (EER) and True Success Rate (TSR). The proposed algorithm with WCT performs better than Curvelet Transform algorithms used in [1], [10] and [11].

KEYWORDS

Biometrics, Curvelet, Total Success Rate, Euclidean Distance.

1. INTRODUCTION

The biological features are inherent to physiological and behavioral features of the person. Features such as Fingerprint, Iris, and Face are physiological in nature and remain constant throughout. The Keystroke and Signature are behavioral in nature which may not remain constant. Compared to all biological features, Face recognition technology has been considered as one of the solutions for high security systems and has a great deal of interest both in academics and industry. Though face recognition is physiological in nature the feature extracted may not be constant and challenged by variations in illumination, pose, and occlusion. The facial expressions are also used for communicating emotions, disagreement and intensions.

There are various challenges in designing an algorithm for face recognition, some of the common ones are aging problem, small interclass differences, changes in expressions, changes in positions, illumination etc.. Feature extraction is one of the techniques which can be used to solve these

Dhinaharan Nagamalai et al. (Eds) : CSITA, ARIN, ISPR - 2015
pp. 33–39, 2015. © CS & IT-CSCP 2015 DOI : 10.5121/csit.2015.50804

problems. There are two ways to extract the features of the face, they are complete subspace analysis and local feature description.

Better features can be extracted using Curvelet theory than by Wavelet mechanism. Curvelet theory has powerful frame work to extract key local facial features which includes multi scale and multi direction. The features of test biometric are compared with features of each biometric samples of an enrolment module using either distance formulae or classifiers to authenticate validity of a person.

Motivation: Face recognition does not require cooperation of a person and can be captured at reasonable distance. Face recognition is a challenging task to recognize due various parameters such as illumination, pose, expression, background, eyeglasses, makeup etc.., and hence robust algorithm is necessary to recognize the face under the variation of these parameters to make the biometric technology card-less, paperless and cashless.

Contribution: In this paper, WCTFR algorithm is proposed to recognize a person. The features of test set and database are obtained using wrapping curvelet transform. The obtained coefficients are rearranged to get feature set of database and test set. The obtained features are compared using Euclidean Distance to compute EER and TSR.

Organization: This paper is organized into following sections. Section 2 is an overview of related work. Algorithm for proposed system is given in section 3. Performance Analysis of the system is presented in Section 4 and Conclusions are contained in Section 5.

2. RELATED WORK

Elaiwat et al., [1] present a Curvelet-based feature extraction algorithm for 3-D face recognition. This identifies important key-points such as scale, orientation, curvelet position, spatial position and magnitude on the face by examining curvelet coefficients in each subband. Rotation-invariant multi-scale local surface descriptors are built around the identified key points to extract distinctive facial features for robust feature matching. The proposed algorithm is robust and accurate for varying illumination and facial expressions with a better verification rate than [2], [3], [4] and [5].

Hui and Hu [6] proposed an algorithm for face recognition. Compared to wavelet transforms, the curvelet transform has better directional and edge representation abilities; hence the face image is decomposed to get low frequency coefficients by curvelet transform. $(2D)^2$ PCA with an exponential decay factor is applied on these selected coefficients to extract feature vectors and thus achieves reduction in dimension. The nearest neighbor classifier is adopted for classification. Experiment is carried out on ORL and Yale face database.

Muzhir and Sulaiman [7] presented a feature extraction approach using wavelet-curvelet technique in order to extract facial features. This approach is based on the similarities preserved by wavelet and curvelet transform. This technique aims to reduce the dimensionality to reduce the computational power and memory consumption, the nearest mean classifier is adopted to recognize different faces.

Radha and Nallammal [8] presented a comparative analysis of face recognition methods using PCA, Linear discriminant analysis and Independent Component analysis based on curvelet

transform. Curvelet transform is multi-resolution analysis method to improve directional elements with an isotropy and better ability to represent sparse edges and other singularities along curves. These approaches are used for dimensionality reduction. The LDA based curvelet transform gives a better recognition rate and efficient dimensionality reduction technique compared to other two methods.

Shafin et al., [9] proposed a face recognition method that uses curvelet texture features for face representation. Features are computed by taking mean and standard deviation of transformed face images and captures more accurate edge information which improves performance and reduces complexity of computation. The system is evaluated with Yale, ORL and Face94 databases. Ashirbani and Jonathm [10], describes the recognition of facial expression from still images using combination of digital curvelet transform and local binary patterns. The curvelet transform is applied to face at specific scale and orientation then from selected curvelet sub-bands local binary patterns are extracted to form the descriptive feature set of expressions. The expression recognition is performed using a nearest neighbor classifier with chi-square as dissimilarity metric.

3. ALGORITHM

Problem definition: The Wrapping Curvelet Transform Technique is applied on a set of face test image and a set of training images of a face database.

The objectives are to:

(i) Increase the Total Success Rate (TSR) and
(ii) Reduce the Equal Error Rate (EER).

Algorithm of proposed face recognition system is as given in Table 1.

The face images are first read from the ORL database. Preprocessing is performed to resize the image into 256x256 pixels. The color images are then converted to gray scale image. The Wrapping Curvelet Transform is applied on to the process test model at scale 5 and angle 16. The above procedure is applied for each test image features. The Euclidean distance parameter are considered with the test image and compared with the database image features. The Euclidean distance is less than the threshold value between the test image and the database image, then the image is considered to have match with the database image.

Table 1: WCTFR: Wrapping Curvelet Transform based Face Recognition.

Input: - Face database, Test face image
Output: - Recognition of a person

1. Face images is read from the ORL database
2. Resize the face images to [256 * 256] pixels.
3. Convert the color images to gray scale image.
4. Apply Wrapping Curvelet Transform on the resized image at scale five and angle sixteen (WC 5, 16).

$$C(j,l,k) = \int \hat{f}(\omega)\,\tilde{U}(S_{\theta_l}^{-1}\omega)e^{i\langle b,\omega\rangle}\,d\omega$$

5. Repeat steps 1 to step 4 for the test image
6. Test image features are compared with the database features using Euclidean distance.
7. Image with Euclidean distance less than the threshold value, then, the image is considered as *matched* image, otherwise the image is *not matched.*

4. PERFORMANCE ANALYSIS

Table 2: FAR, FRR and TSR for different PIDB and PODB

Threshold	PIDB:PODB														
	5:10			5:15			5:5			10:5			15:5		
	FRR	FAR	TSR	FRR	FAR	TSR	FRR	FAR	TSR	FRR	FAR	TSR	FRR	FAR	TSR
3.0	1.00	0.00	0.00	1.00	0.00	0.00	1.00	0.00	0.00	0.100	0.00	0.00	0.93	0.00	00
4.4	0.80	0.00	0.20	0.80	0.00	0.20	0.80	0.00	0.20	0.90	0.00	0.10	0.86	0.00	0.6
5.6	0.60	0.00	0.40	0.60	0.00	0.40	0.60	0.00	0.40	0.80	0.00	0.20	0.80	0.00	0.13
6.2	0.60	0.00	0.40	0.60	0.00	0.40	0.60	0.00	0.40	0.70	0.00	0.30	0.73	0.00	0.20
6.3	0.40	0.00	0.60	0.40	0.00	0.60	0.40	0.00	0.60	0.60	0.00	0.40	0.66	0.00	0.26
6.6	0.40	0.00	0.60	0.40	0.00	0.60	0.40	0.00	0.60	0.50	0.00	050	0.60	0.00	0.33
6.8	0.40	0.00	0.60	0.40	0.00	0.60	0.40	0.00	0.60	0.50	0.00	0.50	0.53	0.00	0.40
7.3	0.40	0.00	0.60	0.40	0.00	0.60	0.40	0.00	0.60	0.50	0.00	0.50	0.40	0.00	0.46
7.7	0.20	0.00	0.80	0.20	0.00	0.80	0.20	0.00	0.80	0.40	0.00	0.60	0.33	0.00	0.53
7.9	0.20	0.00	0.80	0.20	0.00	0.80	0.20	0.00	0.80	0.20	0.00	0.80	0.20	0.00	0.66
8.9	0.20	0.00	0.80	0.20	0.06	0.80	0.20	0.00	0.80	0.20	0.00	0.80	0.13	0.13	0.73
9.5	0.20	0.00	0.80	0.20	0.06	0.80	0.20	0.00	0.80	0.10	0.10	0.90	0.13	0.20	0.73
9.6	0.00	0.00	0.99	0.00	0.06	0.99	0.00	0.00	0.99	0.10	0.20	0.90	0.06	0.20	0.80
10.1	0.00	0.10	0.99	0.00	0.13	0.99	0.00	0.00	0.99	0.10	0.40	0.90	0.06	0.40	0.80
10.3	0.00	0.40	0.99	0.00	0.40	0.99	0.00	0.20	0.99	0.10	0.80	0.90	0.06	0.60	0.80
11.2	0.00	0.50	0.99	0.00	0.60	0.99	0.00	0.40	0.99	0.10	0.80	0.99	0.00	1.00	0.86
12.0	0.00	0.60	0.99	0.00	0.73	0.99	0.00	0.40	0.99	0.00	0.80	0.99	0.00	1.00	0.86

The Performance Parameters such as FRR, FAR, EER and TSR for the ORL face database is discussed in detail for the proposed model. The recognition rate for different number of features per image is calculated using Euclidean distance. The performance parameters are computed for different number of Persons in Database (PID) and Persons out of Database (POD). We have considered PID: POD as 5:10, 5:15, 5:5, 10:5 and 15:5. The variations of FRR, FAR and TSR with the threshold for ORL database is given in Table 2. The values of FAR and TSR increases from 0 to maximum value as threshold value increases. The values of percentage FRR decreases from 100 to 0 as threshold value increases. The maximum success rate of the proposed algorithm for ORL database is 99.7%. The values of FRR and FAR decreases and increases respectively as threshold value increases. It is observed that the value of EER is zero for the threshold value of 10 with the Percentage of TSR is 99.7.

Table 3 shows the percentage variation of TSR and EER of the proposed model for different number of Persons Inside Database (PID) and Persons Outside Database (POD). It is observed from the table, when number of PID is low TSR is high and EER is low. When number of PID is high, TSR is low and EER is high. It is also observed that EER is low, at lower threshold values as we increase the number of persons inside database. When PID is almost equal to POD, the probability of genuine samples being accepted and invalid samples being rejected is high, hence TSR is 0.997.

Table 3: The variation of TSR and EER for different PID:POD ratios

PID:POD	TSR	EER
5:10	1.00	0.00
5:15	0.95	0.50
5:5	1.00	0.00
10:5	0.90	0.10
15:5	0.86	0.13

Table 4: Comparison of TSR(%) of proposed WCTFR with [1], [10] and [11].

Sl No	Authors	Techniques	TSR(%)
1	Huo and Song [11]	Curvelet (3,8) +SPCA	93.70
2	Saha and Jonathan [10]	Curvelet (3,8) +LBP	93.69
3	Elaiwat et al.,[1]	Curvelet (2,3) +3D Images	98.20
4	**Proposed algorithm (WCTFR)**	**Wrapping Curvelet (5, 16)**	99.70

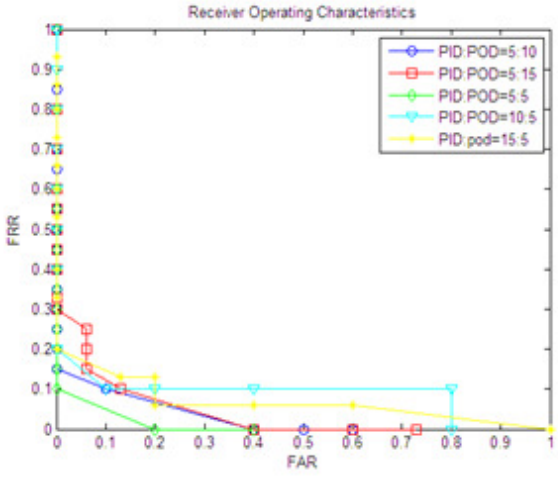

Fig. 1: ROC characteristics of WCTFR.

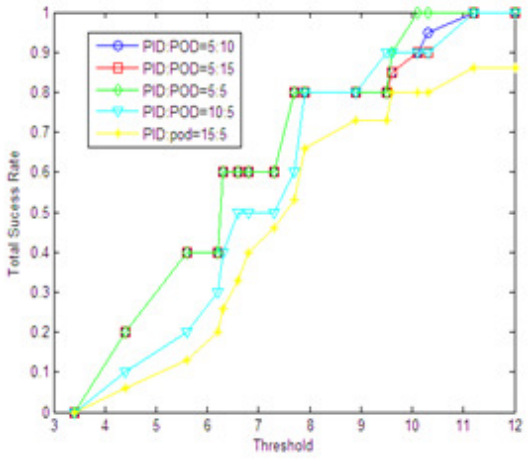

Fig. 2: Total Success Rate *versus* Threshold for different PID:POD ratios for WCTFR.

The Receiver Operating Characteristics (ROC) for different PID: POD ratios are as shown in Fig.1, it is a plot of FRR versus FAR for different PID: POD ratios. The plot of TSR versus Threshold for different PID: POD ratios are as shown in Fig. 2. It is observed that TSR is high for lower threshold values as number of persons outside database increases and TSR is low for higher threshold values as number of persons inside database increases. The proposed algorithm gives maximum TSR of 0.997 when it is operated between thresholds of 10.5 to 12.0 of feature set. The Performance of Proposed method is compared with the existing algorithms which are given in Table 4. In the existing algorithms, they have used Curvelet with level three and orientation eight and also they have used additional techniques like SPCA and LBP. In the proposed WCTFR algorithm we have considered level five and orientation sixteen which increases the directional features and hence the algorithm has better performance than [1], [10] and [11] by 1.5%.

5. CONCLUSIONS

The face recognition is a Physiological biometric trait to identify a person efficiently. In this paper Wrapping Curvelet Transform based Face Recognition algorithm is proposed. The curvelet Coefficients are generated from face images and resized to Coefficient Matrix to form features. The EER and TSR are computed by comparing a feature of test image with database image features using Euclidean Distance. It is observed that performance parameter values of EER and TSR are better in the case of proposed algorithm compared with the existing algorithms.

REFERENCES

[1] S. Elaiwat, M. Bennanoun, F. Boussaid and A. El-sallam, "3-D Face Recognition using Curvelet Local Features," *IEEE Signal Processing Letters,* vol. 21, no. 2,pp. 172-175, February 2014.

[2] P. Liu, Y. Wang, D. Huang, Z. Zhang, and L. Chen, "Learning the Spherical Harmonic Features for 3-D Face Recognition," *IEEE Transactions on Image Processing,* vol. 22, no. 3, 2013.

[3] D Smeets, J Keustermans, D Vandermeulen, and P Suetens, "Meshsift: Local Surface Features for 3-D Face Recognition under Expression Variations and Partial Data," *Computer Vision and Image Understanding,* vol. 117, no. 2, 2013.

[4] Y. Ming and Q. Ruan, "Robust Sparse Bounding Sphere for 3-D Face Recognition," *Image Vision and Computation,* vol. 30, no. 8, 2012.

[5] Y. Lei, M. Bennamoun, M. Hayat, and Y. Guo, "An Efficient 3-D Face Recognition Approach using Local Geometrical Signatures," *Pattern Recognition,* 2013.

[6] Ma Hui and Hu Fengsong, "Face Recognition using Curvelet Transform and $(2D)^2$PCA," *International Journal on Education and Management Engineering,* pp. 23-28, 2012.

[7] Muzhir Shaban Al-Ani1 and Alaa Sulaiman Al-waisy, "Face Recognition Approach based on Wavelet - Curvelet Technique," *International Journal on Signal and Image Processing*, vol. 3, no. 2, pp. 21-31, 2012.

[8] V Radha and N Nallammal, "Comparative Analysis of Curvelets Based Face Recognition Methods," *Proceedings of the World Congress on Engineering and Computer Science,* vol. 1, 2011.

[9] Shafin Rahman, Sheikh Motahar Naim, Abdullah Al Farooq and Md Monirul Islam, "Curvelet Texture based Face Recognition using Principal Component Analysis," *International Conference on Computer and Information Technology*, pp. 45-50, 2010.

[10] Ashirbani Saha and Q. M. Jonathan Wu, "Facial Expression Recognition using Curvelet based Local Binary Patterns," *IEEE International Conference on Acoustics Speech and Signal Processing*, pp. 2470-2473, 2010.

[11] Hanjun Huo and Enuo Song, "Face Recognition using Curvelet and Selective PCA,"*International Conference on Intelligent Control and Information Processing*, Dalian, China, pp. 348-351, 2010.

AUTHOR INDEX