# MODIFIED APPROACH TO TRANSFORM ARC-FORM-TEXT TO LINEAR-FORM-TEXT: A PREPROCESSING STAGE FOR OCR

Vijayashree C S [1], Shruthi C V [2] and Vasudev T [2]

[1] P.E.T Research Foundation, P.E.S College of Engineering, Mandya-571401, India.
[2] Maharaja Research Foundation, Maharaja Institution of Technology, Mysore-571 438, India.

***ABSTRACT***

*Arc-form-text is an artistic-text which is quite common in several documents such as certificates, advertisements and history documents. OCRs fail to read such arc-form-text and it is necessary to transform the same to linear-form-text at preprocessing stage. In this paper, we present a modification to an existing transformation model for better readability by OCRs. The method takes the segmented arc-form-text as input. Initially two concentric ellipses are approximated to enclose the arc-form-text and later the modified transformation model transforms the text in arc-form to linear-form. The proposed method is implemented on several upper semi-circular arc-form-text inputs and the readability of the transformed text is analyzed with an OCR.*

***KEYWORDS***

*Artistic-text, Arc-form-text, Linear-form-text, OCR.*

## 1. INTRODUCTION

Document image analysis (DIA) is an important research discipline in the area of Image Processing. Many researchers are working on different problems of document images starting from image acquisition to image understanding [1,2]. The research in this field is focusing to come out with generic approaches to accomplish automation in document reading, extracting contents from documents and these have lead into many vibrating research problems [2]. The results of the research on the above problems are converging towards the generic solutions to major issues in DIA.

In spite of considerable research work in the area of DIA, a major issue which is not sufficiently addressed is, reading or extracting the contents of the text which appear in artistic-form in a document. Many documents, especially certificates, marks cards, sign boards, logos, etc., have artistic text. In addition, many official seals on the documents for authentication are also artistic in nature. The contents of such artistic-text definitely have some valuable information that has to be processed. Most of the graduation certificates issued by the Universities contain the name of the university in artistic form. If such document has to be processed by an Optical Character Reader (OCR), the OCR should be able to read such artistic-text or proper pre-processing is required to make that text readable by OCR. Few such artistic-texts in documents are, text appearing in triangular-form, arc-form, circular-form, wave form. Samples of such artistic-texts are shown in Figure 1. The contents of such text normally convey the identity information like company's name, type of document, etc., which is the main source for classification of the document.

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Figure 1. Samples of artistic-form text in document

Documents containing artistic-text, when subjected to reading by OCRs, fail to be read, as the OCRs are developed to read linear texts. Hence, it is necessary to transform artistic-text to linear text such that OCRs are able to read the contents efficiently. Approaches developed for general skew detection and correction are not suitable to transform such artistic-text documents into linear form. Hence, it is required to come out with different approaches that can transform artistic-form text into linear form text and make the same suitable for reading by an OCR.

## 2. RELATED WORK

One of the major problems encountered in DIA is implicit/inherent skew noticed in document images [3,4]. Inherent skew, is due to the natural inclinations of text lines in the document. Considerable amount of work is reported in literature on explicit skew detection [5-16]. Each of the approaches reported in literature on explicit skew detection has its own advantages and limitations, and these approaches are not extendable for detecting inherent skew. Since artistic texts also have inherent orientation in the document, artistic-texts are said to have implicit skew. To the best of our efforts while surveying for literature in the direction of implicit skew detection and correction, we could find the work of Pal et al in detecting multiple implicit skewed lines within a document[3], i.e., detecting lines within the document having different orientations and the work carried out by Vasudev et al to transform arc-form-text to linear-form[17]. Vishwanath et al[18] have proposed connected component Technique for character extraction from document image having artistic-form-text. The implicit skew in extracted characters is detected using Hough Transform and corrected. Further Vishwanath et al[19] have proposed Radon transform for the detection of implicit skew in the extracted characters and their correction. The work proposed by Vasudev et al[17] performs transformation to considerable extent but suffers from tilt deformation and an additional stage is required for tilt corrections in the model. Further, the readability efficiency after transformation is claimed as 84% in this method. This drawback of the approach proposed by Vasudev et al[17] has motivated us to continue the work to design an efficient transformation model that transforms the arc-form-text to linear-form-text without tilt deformation to produce the output suitable to OCR for better readability.

The proposed work assumes that the arc-form-text has been segmented out from the document and is free from noise. Further, it is assumed that the arc-form-text in the document is either circular or elliptical in shape and is limited to only in the upper half circle or ellipse. The proposed model has two stages. The initial stage is to estimate two concentric imaginary ellipses to enclose the arc-form-text. This stage is performed as proposed in [17] and the same is briefed in section 3. In the second stage transformation takes place and section 4 describes the modified transformation model. Experimental results are discussed in section 5. The conclusion of the work is given in section 6.

## 3. ENCLOSURE OF TEXT WITHIN SUITABLE ARCS

The transformation model to transform arc-form-text to linear-form requires two imaginary elliptical arcs [20] to be searched which encloses the arc-form-text. The procedure developed in [17] is made use in this work. Figure 2 shows sample of arc-form-text and Figure 3 illustrates the

estimation of two imaginary elliptical arcs enclosing the arc-form-text under consideration using the algorithm given in [17].


Figure 2. Arc-form input text

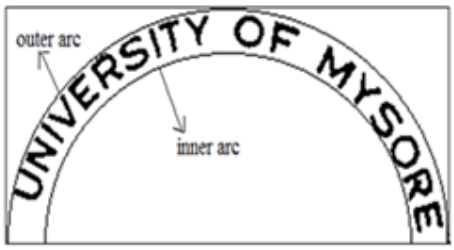



Figure 3. Two imaginary arcs drawn to enclose Arc-form-text

Though the inner arc does not contribute much during the process of transformation, it is useful in detecting the height of the text and to restrict transformation process to be within the arc-form region. After enclosing the arc- text between two imaginary suitable arcs, it is required to transform all the points on this elliptical band into a linear band of points and the same is explained in the subsequent section.

## 4. MODIFIED TRANSFORMATION MODEL

The principle adopted to perform transformation is a point processing technique [4]. In this transformation model, a set of points representing line in one orientation is transformed to represent a line of points in another orientation. Extending this concept, an arc-form text can be considered as a set of n consecutive lines in different orientations, where n being the distinct points on surface of the outer arc. These n lines with different orientations are transformed to n vertical lines, which results in the text appearing horizontally linear. For comprehension, Figure 4 shows how lines within two arcs having different orientation are represented as n vertical line.

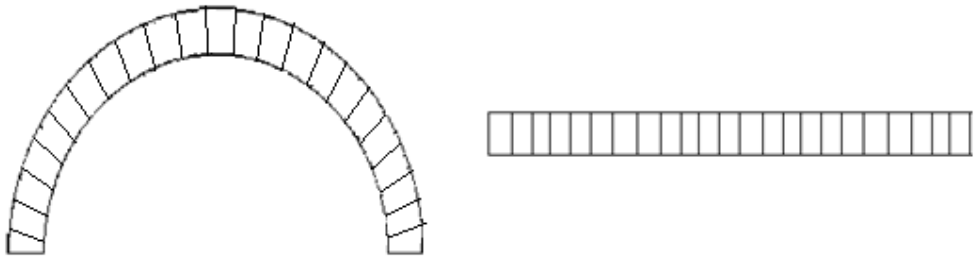


Figure. 4 Representation of n lines in different orientation within two arcs as n vertical lines

A transformation function T can be expressed as,

$S = T [F]$ (1)

where

$F = \{l1,l2,\ldots,ln\}$ , li $\forall$ i = 1,…,n is the $i^{th}$ line within arcs having m points

$S = \{lt1,lt2,\ldots ltn\}$ , lti $\forall$ i = 1,…,n is the $i^{th}$ transformed line having m points

T is the transformation function that simply puts the points of $l_i$ on $l_{ti}$ and

$l_i = \{p_1,p_2,\ldots,p_m\}$ , $p_j$ $\forall$ j = 1,…,m is the $j^{th}$ point on the $i^{th}$ line within the arc

$lt_i = \{q1,q2,..,qm\}$ , qj $\forall$ j = 1,…,m is the $j^{th}$ point on the $i^{th}$ transformed line

$\exists$ qk = T[pk] $\forall$ k = 1,… m, m is the number of points in the $k^{th}$ line l and transformed line lt

To transform arc-form text to linear, as shown in Figure 5 a series of lines from the centre of the arc are drawn to each point on the surface of outer arc.

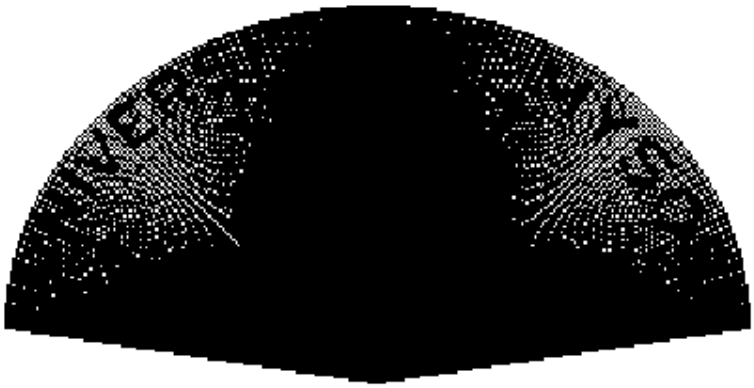


Figure 5. Lines drawn from centre of the ellipse

Algorithm for the transformation is given below:

Input: Text image enclosed with outer and inner arcs.

Output: Linear-form text

1. L is the blank document
2. For each point on the outer arc $(x_j, y_j)$
   a. Draw the line from the centre of arc to outer arc $(x_j,y_j)$
   b. Determine point of intersection on inner arc $(x_{j`},y_j`)$
   c. Consider the line *l* from $(x_j,y_j)$ to $(x_j`,y_j`)$
   d. For each $l_i$

      Transform m points of $l_i$ to $l_{ti}$

   e. append $l_{ti}$ into L.


Figure 6. Transformed text to linear-form

Result of the implemented algorithm for the sample input Figure 2 is shown in Figure 6. It is evident from Figure 6 that arc-form-text gets transformed to linear form, without tilt deformations. However variations in height in few characters and distortions are noticed due to the contributions of aspect ratio and stair case effect in lines.

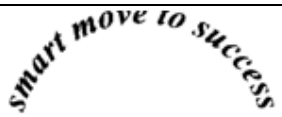
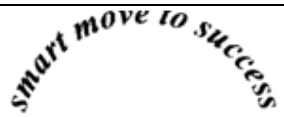
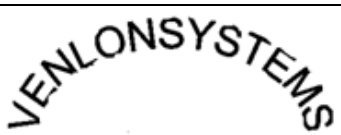
## 5. EXPERIMENTAL RESULTS

Experiments are conducted on arc-form-text with different sizes and different arc shapes for English texts. The results of experiments establish an overall readability between 73% - 100% in transformed and tilt corrected text which is quite promising and encouraging. The result provides a better input for OCRs. Experimental results before usage of the proposed approach is shown in

Table 1. Experimental results illustrated in Table 2 indicate that the proposed approach efficiently transforms arc-form-texts to linear-form-texts which are suitable for OCRs.

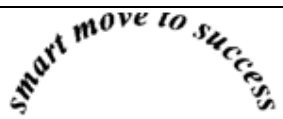
Analysis of readability by an OCR of the text before transformation and after transformation is performed with respect to English text using the OCR " Readiris Pro 9 ". In this process, first, the samples of arc-form-text are taken as input to OCR and subjected to be read by the OCR and the result is tabulated in Table 1. The transformed text of proposed method is subjected to be read by OCR and the result is tabulated in Table 2.

Table 1. OCR's readability of arc-form-text

| Input arc-form-text | OCR Recognition | Readability |
|---|---|---|
|   |   | 0% |
|   |   | 0% |
|   |   | 0% |
|   |  | 0% |
|   |   | 0% |
|   |   | 0% |
|   |   | 0% |

| | | |
|---|---|---|
|  |  | 0% |
|  |  | 0% |
|  |  | 0% |

Table 2. OCR's readability before and after correction

| Input arc-form-text | Transformed text and OCR Recognition of text | Readability |
|---|---|---|
|  |  | 10/10 -> 100% |
|  |  | 18/18 -> 100% |
|  |  | 18/18 -> 100% |
|  |  | 11/13 -> 84.61% |
|  |  | 20/21 -> 95% |
|  |  | 14/14 -> 100% |

| | | |
|---|---|---|
|  | UNIVERSITY OF BELGAUM<br>UNIVERSITY OF BELGAUM | 19/19 -> 100% |
|  | HANDLE WITH CARE<br>*HANDLE* W1TH CARE | 14/14->100% |
|  | SOURCE OF RICHNESS<br>SOURce OF RICHNESS | 11/15-> 73.33% |
|  | ADVENTURE SPORTS<br>ADVENTURE SPORTS | 15/15->100% |

Table 1 indicates that an arc-form-text is given as input to OCR, it recognizes the text as picture rather than text and retains it in the picture form and the readability of text by OCR is obviously 0%. This demands that most of the OCRs do require linear text for reading. The Table 2 shows that the transformation of arc-form-text to linear-form-text. Numerator indicates the number of characters recognized and denominator signifies the total number of characters in the text. The method has been tested with over 300 plus samples and it shows average readability of 95%. Table 2 also illustrates the reading efficiency of OCR and shows considerably better results than the method proposed [17], which was claimed as 84%. Analysis of readability by OCR is done at only two stages – (i) arc-form-text and (ii) transformed text. Further, the method has been experimented on the arc-form-text of other languages. The output is promising and few sample outputs are given in Figures 7 and 8.

Figure 7.a Kannada arc-form input text

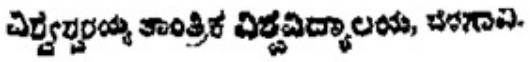


Figure 7.b Transformed text to linear-form

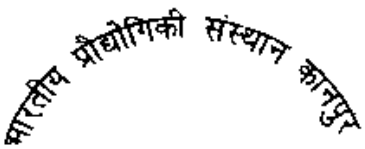


Figure 8.a Hindi arc-form input text

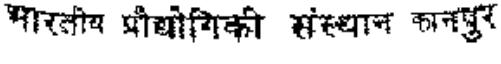


Figure 8.b Transformed text to linear-form

## 6. CONCLUSIONS

The proposed approach efficiently transforms an arc-form-text without tilt deformations and thereby makes better readability by an OCR with a readability of 95%. This approach employs the principle of ellipse drawing algorithm for transformation. Any image processing application with the computational complexity $O(n^2)$ is considered to be less expensive. Because of considerable time complexity and simple point processing technique in spatial domain, the proposed method is claimed as a simple and less complex approach to transform arc-form text to linear-form. The readability by OCR increases as compared to the earlier approach proposed by Vasudev et al[17] with slight variation in height of characters and distortions. The method can be extended comfortably to transform text from other languages. A method to restrict variations in the heights of the characters due to aspect ratio and eliminate distortions due to stair case effect in final output is under investigation which can enhance the output more effectively and efficiently.

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## AUTHORS

Vasudev T is currently Professor in the Department of Computer Applications, at Maharaja Institute of Technology, Mysore. He obtained his Bachelor of Science and Post-Graduate Diploma in Computer Programming with two Masters Degrees, one in Computer Applications and the other one in Computer Science and Technology. He was awarded Ph. D. Degree in Computer Science from University of Mysore. He has 30 years of experience in academics. He has published over 30 articles in reputed journals in his area of research Digital Image Processing, specifically Document Image Processing.

Vijayashree C. S, obtained her B.E. Degree in Computer Science from B.I.T, Bangalore and M.E. Degree in Computer Science from U.V.C.E, Bangalore. She is pursuing research towards her Ph. D. Degree in Computer Science of University of Mysore, Mysore, at P.E.S. College of Engineering, Mandya

Shruthi C. V, obtained her B.E. Degree from VTU, Belgaum. Currently she is a student in the Department of Computer Science and Engineering, Maharaja Institute of Technology, Mysore. She is pursuing her PG Degree in Computer Science and Technology of VTU, Belgaum.