MOMENT INVARIANTS BASED FEATURES EXTRACTION FOR CLASSIFICATION OF SYRIAC ALPHABET LANGUAGE

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ABSTRACT

The aim of this research is to convert the image of Syriac letter to an electronic reading letter in the computer. The proposed recognition process begins by segmenting the image of Syriac alphabet into Sub-images of characters and computing seven or six or five or four or three or two or one invariant moment for each sub-image of character as features then building a database which depends on these features for recognition task. The character was inserted to the Recognition System with different rotation angles between 0º and 360º and the results of recognition were excellent and were also completely equal when using 7or 6 or 5 or 4 or 3 moments, and when the first two moments were used there was a little difference in the rate of recognition at the angle 25º, but the recognition ratio differed when using the first one only.

KEYWORDS: *OCR, Invariant Moments, pattern recognition, and Syriac character recognition.*

I. INTRODUCTION

Optical Character Recognition (OCR) is the most important areas seeking researchers to make progress to provide easy transfer of handwritten documents or printed documents by computer, which have only a paper document about it and work to save it in digital form to use it in the transmissions of different text script [1].Object recognition is a task performed daily by living beings and is inherent to their ability and necessity to deal with the environment. It is performed in the most varied circumstances - navigation towards food sources, migration, identification of predators, identification of mates, etc. with remarkable efficiency [2].

The development of methods capable of emulating the most varied forms of object recognition has evolved along with the need for building "intelligent" automated systems, the main trend of today's technology in industry and in other fields of activity as well in these systems objects are represented in a suitable way for the type of processing they are subject to such representations are called patterns [3]. Character recognition systems can contribute tremendously to advancement of automation process and can improve the interaction between man and machine in many applications [4].

Optical Character Recognition (OCR) of Syriac language is a research field that is socially very relevant and challenging. The social relevance lies in fact that the OCR can help preserve documents of the past for posterity. Many ancient manuscripts can be digitized and stored away for future editing and utilization using OCR. Transformation to electronic records is one of the most important objectives of the recent civilization, and the cultural interaction between the thought of the present generation and the previous ones is very important for the developed life and settled societies.

Syriac is an ancient Iraqi language, and it is culturally used by human beings in Iraq. It has many religious scripts as well as scientific and literary books which have been completed and achieved throughout the long history and efficient civilization for this language, and conveying this important thought for communication between the present and past generations.

Over the past decades, many different researches and papers have been concerned with the recognition of Latin, Arabic, Russian, Chinese, and Japanese characters, but no research has been achieved towards the automatic recognition of Syriac characters.

Discriminating Syriac language alphabet by means of computer is regarded as the basic foundation for the integrated work for the mental record from paper to electronic record in order to convert Syriac scripts and books to electronically printed texts, preserving the ancient Iraqi legacy and to publish it through internet and to be available.

This paper is concerned with East Syriac alphabet, which are the features of each character being extracted by using moments to build the database that are used for classification .

The paper is organized as follows. Section 2 presents related work, Section 3 shows Syriac language overview; Section 4 presents Optical Character Recognition System. Section 5 introduces Moment invariants. In Section 6 the proposed technique for Syriac characters recognition is presented. Section 7 shows experimental and results for Optical Character Recognition system technique of Syriac alphabet. Finally, conclusions and future work are provided in Section 8 and 9 respectively.

II. RELATED WORK

The features extraction stage, playing the main role in the (OCR) recognition process, controls the accuracy of recognition by the information passed from this stage to the classifier (recognizer). In [5] G. Abandah and N. Anssari proposed a novel feature extraction approach of handwritten Arabic letters. Zahedi and Eslami [6] deployed a scale invariant feature transform method to extract a set of features in Farsi and Arabic language OCR systems. Moussa et al [7] used texture analysis to extract global features to reduce the processing difficulties in a recognition system and to make the Arabic printed multi-font recognition successful. N.Sridevi and P.Subashini[8] have proposed offline approach for handwritten Ancient Tamil scripts using different feature extraction methods. I.K.Pathan et al have proposed offline approach for handwritten isolated Urdu characters in their wok mentioned in [9], Authors have used moment invariants (MI) feature to recognize the characters. A.S. Rahma and I. F.Nassir [10] are computed the seven moments for each English character as features for recognition task.

III. A SYRIAC LANGUAGE OVERVIEW

The Syriac language is one of the Semitic languages that is being spoken in Iraq, Syria, Turkey and Iran by Assyrians. It's an ancient language, one of the rarest and oldest in the world.

The Syriac alphabet consists of 22 characters as shown in Figure 1, which is written from right to left. The structure of most Syriac characters consists of small loops combined with curves; most of Syraic characters have strokes [11].

Figure 1. Syriac Alphabet [13]

Figure 2. Letters "kap" and "Noon" have two different end versions

Most of the characters are universal, i.e, can be used at the beginning of the word, in the middle and at the end. Some, however, will change shapes depending on their position in the word. For

instance, letter "meem" looks different when it is at the beginning or in the middle from when it is written at the end. Also, the letters "kap", and "Noon" have two different end versions as shown in Figure 2, one that will join the letter before it, and another that will not [12].

IV. OPTICAL CHARACTER RECOGNITION (OCR) SYSTEM

Optical Character Recognition (OCR) is one of the oldest sub fields of pattern recognition with a rich contribution for the recognition of printed documents. OCR systems scan the documents printed on a paper as an image and recognize the characters present in the document image to form a separate digital text document, which can be edited or processed.

The general character recognition system often consist of 4 stages viz. preprocessing, normalization, feature extraction and classification. The Figure 3 shows flow of the steps involved in a general recognition system.

After acquiring the images from the scanners the first stage will be a preprocessing step in which the noise removal, skew/slant correction is often performed as the images captured from the scanners often have noise and or skewed. The second step is the normalization as the input character images are often in different font sizes. Normalization to a particular size makes it easy for the feature extractor. After normalization these character images are subjected to thinning or skeletonising. Selection of features extraction method is probably the single most important factor in achieving high recognition performance. Feature extraction plays a very vital role [14].

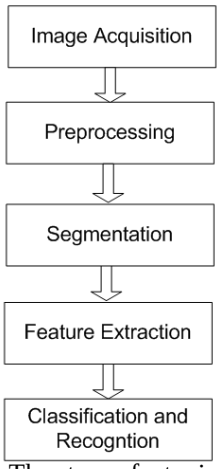

Figure 3: The steps of a typical OCR system.

Currently there are many OCR systems available for handling printed English documents with reasonable levels of accuracy. Such systems are also available for many European languages as well as some of the Asian languages such as Japanese, Chinese, etc. [15]. However, there are no reported efforts at developing OCR systems for Syriac languages.

V. MOMENT INVARIANTS

Hu[16] first introduced seven moment invariants based on normalized geometrical central moments up to the third order moment invariant is to use region-based geometric moments that are invariant to translation and rotation. It identified seven normalized central moments as shape features, which are also scale invariant. Let F (x, y) denote an image in the two-dimensional spatial domain.

Geometric moment of order p + q is denoted as:

$$m_{p,q} = \sum_{x} \sum_{y} x^{p} \; y^{q} \; F(x,y) \qquad (1)$$

For p,q=0,1,2,…… N , the central moments are expressed as :

$$x_{c=} \; m_{1.0} \; / \; m_{0,0}$$

$$y_{c=} \; m_{0,1} \; / \; m_{0,0}$$

Where $m_{1.0}$ mentioned in equation 3 and (x_c , y_c) is called the center of the region of object [17]. Hence the central moments of order up to 3 can be computed as:

$$\left.\begin{aligned}
\mu_{0,0} &= m_{0,0} \\
\mu_{1,0} &= 0 \\
\mu_{0,1} &= 0 \\
\mu_{2,0} &= m_{2,0} - x_c\, m_{1,0} \\
\mu_{0,2} &= m_{2,0} - y_c\, m_{0,1} \\
\mu_{1,1} &= m_{1,1} - y_c\, m_{1,0} \\
\mu_{3,0} &= m_{3,0} - 3x_c\, m_{2,0} + 2m_{1,0}\, {x_c}^2 \\
\mu_{1,2} &= m_{1,2} - y_c\, m_{1,1} - x_c m_{0,2} + 2{y_c}^2\, m_{1,0} \\
\mu_{2,1} &= m_{2,1} - 2x_c\, m_{1,1} - y_c m_{2,0} + 2{x_c}^2\, m_{0,1} \\
\mu_{0,3} &= m_{0,3} - 3y_c\, m_{0,2} + 2{y_c}^2\, m_{0,1}
\end{aligned}\right\} \quad (2)$$

The normalized central moment denoted $\eta_{p,q}$, are defined as:

$$\eta_{p,q} = \mu_{p,q} / {\mu^y}_{0,0} \quad (3)$$

Where

$$\gamma = p + q / 2 \quad (4)$$

For $p + q = 2,3$,
a set of seven transformation invariant moments can be derived from the second- and third-order moments as follows [17] [18].

$$\left.\begin{aligned}
\phi_1 &= \eta_{2,0} + \eta_{0,2} \\
\phi_2 &= (\eta_{2,0} - \eta_{0,2})^2 + 4{\eta_{1,1}}^2 \\
\phi_3 &= (\eta_{3,0} - 3\eta_{1,2})^2 + (3\eta_{2,1} - \eta_{0,3})^2 \\
\phi_4 &= (\eta_{3,0} + \eta_{1,2})^2 + (\eta_{2,1} + \eta_{0,3})^2 \\
\phi_5 &= (\eta_{3,0} - 3\eta_{2,1})(\eta_{3,0} + \eta_{1,2})[(\eta_{3,0} + \eta_{1,2})^2 - 3(\eta_{2,1} + \eta_{0,3})^2] \\
&\quad + (3\eta_{2,1} - \eta_{0,3})(\eta_{2,1} + \eta_{0,3})[3(\eta_{3,0} + \eta_{1,2})^2 - (\eta_{2,1} + \eta_{0,3})^2] \\
\phi_5 &= (\eta_{3,0} - 3\eta_{1,2})(\eta_{3,0} + \eta_{1,2})[(\eta_{3,0} + \eta_{1,2})^2 - 3(\eta_{2,1} - \eta_{0,3})^2] \\
&\quad + (3\eta_{2,1} - \eta_{0,3})(\eta_{2,1} + \eta_{0,3})[3(\eta_{3,0} + \eta_{1,2})^2 - (\eta_{2,1} + \eta_{0,3})^2] \\
\phi_6 &= (\eta_{2,0} - \eta_{0,2})[(\eta_{3,0} + \eta_{1,2})^2 - (\eta_{2,1} + \eta_{0,3})^2] + 4\eta_{1,1}(\eta_{3,0} + \eta_{1,2})(\eta_{2,1} + \eta_{0,3}) \\
\phi_7 &= (3\eta_{2,1} - \eta_{0,3})(\eta_{3,0} + \eta_{1,2})[(\eta_{3,0} + \eta_{1,2})^2 - 3(\eta_{2,1} + \eta_{0,3})^2] - (\eta_{30} + 3\eta_{1,2})(\eta_{2,1} + \\
&\eta_{0,3})[3(\eta_{3,0} + \eta_{1,2})^2 - (\eta_{2,1} + \eta_{0,3})^2]
\end{aligned}\right\} \quad (5)$$

This set of normalized central moments is invariant to translation, rotation, and scale changes in an image.

VI. THE PROPOSED TECHNIQUE FOR SYRIAC CHARACTERS RECOGNITION

In this section, the proposed recognition system is described. A typical character recognition system consists of pre-processing, segmentation, feature extraction, classification and recognition.

6.1. Image Acquisition

In Image acquisition, the recognition system acquires a scanned image as an input image. The image should have a specific format such as JPEG, BMT etc. This image is acquired through a scanner, digital camera or any other suitable digital input device.

6.2. Pre-processing

The pre-processing is a series of operations performed on the scanned input image. It essentially enhances the image rendering it suitable for segmentation. The various tasks performed on the image in pre-processing stage for example, Binarization process that converts a gray scale image into a binary image using global thresholding technique.

6.3. Segmentation

In the segmentation stage, A Syriac image of characters is decomposed into sub-images of individual characters. First, the image is divide into lines, then each line is segmented into isolated character. Whitespace division is the simplest method used for segmentation. In case of dividing the image into lines, the segmenter simply searches for horizontal line of only background pixels and divides between segments at that juncture, but in case of segmenting line the segmenter searches for vertical line of only background pixels and divides between characters.

6.4 Proposed Feature extraction Method

This stage extracts the moments for each Syriac letter as attributes to build a database for each letter by using Equation 5. Algorithm 1 performs the segmentation and extraction features .Table 1 shows the seven invariant moments for Syriac alphabet.

Algorithm (1): Segmentation and extraction algorithm
Input : Image contains Syriac characters **Output** : **Char(27,7)** array of the seven invariant moments of Syriac characters
Step1: segmentation the image of Syriac characters into sub-images of individual Syriac characters Step2: **c=1** // *counter of the Syriac characters* While c < =27 do : **m**=1 // *counter of the seven moments of each character* While **m** <=7 do: Compute the moment m of the Character by using Eq. 5 and store the result in **Char (c,m).** **m = m +1** End While **c=c+1** End while.

6.5. Classification and Recognition Stage:

The classifier is used to make a final decision according to extract feature and acquired knowledge. The classification stage of this technique depends on the moment invariants database to classify the input character; algorithm 2 performs the classification task. The entered character will be recognized by selecting the shortest distance between the invariant moments of entered character and each Syriac character by using the following equation:

$$D_A = (A_1 - \&_1)^2 + (A_2 - \&_2)^2 + (A_3 - \&_3)^2 + \cdots + (A_7 - \&_7)^2 \quad \ldots \quad (7)$$

D_A: the distance between the invariant moments of entered character and each Syriac character A_n : the nth invariant moments of each Syriac character , where n=1…7.
$\&_n$: n^{th} invariant moments of entered Syriac character , where n=1…7.
The moments that are used to find the distance are 7 or 6 or 5 or 4 or 3 or 2 or 1.

Algorithm (2) classification algorithm
Input : Image contains Syriac character with rotation between 0º and 360º **Output** : The recognized character
Step1: enter a Syriac character with rotation between 0º and 360 ºangles Step2: compute the three moments for the entered character by applying equation 5 and do the following : 1-Find the distance between the invariant moments of entered character and Syriac characters database ,using the following equation : $D_A = (A_1 - \&_1)^2 + (A_2 - \&_2)^2 + (A_3 - \&_3)^2$ Step3: select the shortest distance that represents the recognized character End

Table 1: Moment Invariants for East Syriac letters

	Φ1	Φ2	Φ3	Φ4	Φ5	Φ6	Φ7
ܐ	0.181383887	0.000632738	4.61E-05	2.23E-05	8.59E-11	-5.54E-07	-1.32E-10
ܒ	0.220626847	5.81E-05	4.07E-06	0.000291752	3.82E-08	-5.09E-07	-7.29E-08
ܓ	0.239399887	0.000455268	0.000248784	2.56E-05	-2.01E-09	1.04E-08	1.10E-09
ܕ	0.192233809	0.001389065	0.000266424	6.27E-05	-1.13E-09	-2.32E-06	2.16E-09
ܗ	0.199314527	0.000797993	0.000133141	0.000140512	-1.17E-08	-2.48E-06	-1.84E-08
ܘ	0.194300426	0.001086723	0.000237957	8.44E-05	-1.03E-08	-2.28E-06	9.61E-10
ܙ	0.178956899	0.001107986	0.000288251	1.41E-05	-5.39E-10	-4.62E-07	4.49E-10
ܚ	0.193553989	0.000209437	3.95E-05	0.000128662	1.35E-08	-5.04E-07	-1.67E-08
ܛ	0.267302093	0.001360808	0.000168265	3.50E-05	-2.93E-10	-1.06E-06	-1.39E-09
ܝ	0.182152983	0.000311977	4.99E-05	3.78E-05	-6.46E-10	-2.22E-07	-1.73E-09
ܟ	0.219982534	0.000147567	3.08E-07	0.000243334	2.30E-08	5.10E-07	-5.99E-08
ܠ	0.226911717	0.000978743	0.000181595	0.000177831	-1.80E-08	-5.08E-06	4.51E-09
ܡ	0.212970115	0.000916108	0.000122092	0.000118635	-1.23E-09	-3.58E-06	4.60E-09
ܢ	0.238186761	0.00010544	8.90E-05	4.39E-05	2.00E-09	3.96E-07	3.66E-10
ܣ	0.249597769	0.000298211	2.03E-05	0.000386794	9.15E-08	6.50E-06	-5.09E-08
ܥ	0.213007673	0.000799736	0.000313507	0.00021483	5.93E-08	-2.52E-06	-6.96E-08
ܦ	0.206189487	0.000182018	6.30E-07	0.000154116	2.67E-09	-3.69E-07	-3.04E-08
ܨ	0.177857543	0.000914259	0.000233418	1.25E-05	-5.07E-10	-2.73E-07	2.40E-10
ܩ	0.174229803	0.000278489	6.48E-05	2.57E-06	2.92E-11	2.52E-08	-2.55E-11
ܪ	0.223071337	0.000202739	1.54E-05	0.000352286	5.37E-08	-8.49E-07	-1.29E-07
ܫ	0.235799084	0.000524198	2.74E-07	6.29E-05	1.93E-10	-3.17E-07	-3.28E-09
ܬ	0.235394496	0.000237806	8.63E-06	0.000148685	4.24E-09	-8.52E-07	-1.74E-08
ܐ	0.181221353	0.000835444	0.000193531	1.98E-05	-1.07E-09	-5.35E-07	6.90E-10
ܒ	0.216285354	0.00015121	5.88E-06	0.00031815	3.90E-08	-2.08E-06	-1.09E-07
ܓ	0.191216861	0.001322448	0.000223111	5.73E-05	-4.26E-10	-2.06E-06	1.18E-09
ܕ	0.221562295	3.02E-05	9.32E-06	0.000267071	3.66E-08	8.72E-07	-3.50E-08
ܗ	0.197171027	0.000706651	7.80E-05	8.34E-05	-3.64E-09	-1.52E-06	-2.01E-09

VII. EXPERIMENTAL AND RESULTS

The first step in this work is to build a database of the Syriac alphabet by calculating the moments of each character after the segmentation of the Syriac alphabet image into equal sizes of sub- image characters, next step is to find the distance between the invariant moments of entered character and each Syriac character to be used later in classification, Recognition step doing by selecting the shortest distance between the invariant moments of entered character and Syriac characters database

by using equation (7). The character is entered with different rotations between 0° and 360° , by using 7 or 6 or 5 or 4 or 3 moments as extracted features for classification, the results of the recognition rate are completely equal, algorithm 3 computes the recognition rate. Table 2 shows the results of recognition rate.

***Algorithm*(3) Recognition rate algorithm**
Input : Image contains Syriac alphabet with rotation between 0º and 360º **Output** : recognition rate for Syriac alphabet using 1 , 2 ,3,4,5,6 or 7 moments with rotation between 0º and 360º
Step1: do the following for each Syriac alphabet(27 sub-images of Syriac characters) with rotation between 0º and 360 ºangles: **m**=7 // *the number of moments that is used for recognition* While **m** > 0 do: 1: compute the recognition rate when using m moments 2-**m**=**m**-1 End While

Using seven or six or five or four or three moments to extract the features, the same results of recognition rate are achieved. So the proposed classification algorithm (algorithm 2) used three moments instead of 7 moments, this reduce the time needed to recognize the character. Table 5 shows the recognition time in millisecond for one character by using moments between 1 to 7. For example if a word consists of eight characters, the recognition time by using 7 moments to recognize characters of this word is approximately 77.4*8 =619.2 millisecond, but while using three moments the recognition time is approximately 75.3*8 =602.4 millisecond.

When the first two moments were used to extract the features, there was a little difference in the rate of recognition at the angle 25º as shown in Table 3, but the discrimination ratio differed when only the first one moment was used, the result is shown in Table 4.

Table 2: Recognition rate of Syriac letters with rotation in different angles based on 7 or 6 or 5 or 4 or 3 moment invariants

Angle	Recognition Rate
0°	100%
25°	81.48%
45°	59%
75°	088.88%
90°	100%
120°	70%
160°	70%
180°	100%
200°	85.18%
250°	70%
270°	100%
300°	74%
330°	85.18%

Table 3: Recognition rate of Syriac letters rotation in several different angle based on 2 moment Invariants

Angle	Recognition Rate
0°	100%
25°	77.77%
45°	59%
75°	88.88%
90°	100%
120°	70%
160°	70%

180°	100%
200°	85.18%
250°	70%
270°	100%
300°	74%
330°	85.18%

Table 4: Recognition rate of Syriac letters rotation in several different angle based on first one Moment Invariants

Angle	Recognition Rate
0°	100%
25°	74%
45°	48.14%
75°	81.48%
90°	100%
120°	70.37%
160°	70.37%
180°	100%
200°	81.48%
250°	70.37%
270°	100%
300°	74%
330°	81.48%

Table 5: The recognition time (MS) of using moments between 7 to 1

Number of Moment	The recognition time(MS)for one character
7	77.4
6	76.4
5	75.9
4	75.4
3	75.3
2	75.1
1	74.5

VIII. CONCLUSIONS

From the results that we obtained in section 7 (Experimental and Results), we have come to see that using seven, six, five, four or three moments to extract the features, the same results of recognition rate are achieved, Due to these results it can be used three moments instead of four or five or six or seven moments to recognize the character, this leads to reduce the time of the Syriac character recognition system.

IX. FUTURE WORK

We intend to develop a method to recognize Syriac words and text; this will be followed by developing a system for the integrated work for the mental record from paper to electronic record.

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