

A New Method for Detecting Segmentation Points in Persian Cursive Words

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ABSTRACT

In recent years, online cursive handwriting recognition, has become an interesting field of study as touch screen devices have become more involved in our lives. Due to cursive form of writing and different styles in Arabic-based script, the process of recognizing Persian handwriting is more complicated than many other languages. To reduce the complexity, cursive scripts are divided into smaller parts (containing one letter) in a process called segmentation. Effective identification of segmentation parts has a great impact on the whole recognition process. In this paper, a new method has been proposed for Persian cursive script segmentation based on the language features. Results have shown a 98.9% accuracy in detection of segmentation points.

KEYWORDS: Online Recognition, Persian Handwriting, Segmentation, Words Features

INTRODUCTION

On-line and offline handwriting recognition in different languages have become very popular over recent years. Although, many approaches have been proposed for printed handwriting recognition specially using image processing techniques, there is still so much work that should be done on on-line recognition.

In recent decades, many researches have been carried out handwriting recognition (Plamondon & Srihari, 2000) (Mohamad, Zafar, & Othman, 2006), (Dai, Ruwei, Liu, & Xiao, 2007). While much efforts has been made on Chinese and Latin languages over past two decades, only during last several years, researchers have shown interest in studies of Arabic and Persian languages (Biadisy, Fadi, El-Sana, & NizarHabash, 2006) (Halavati, Jamzad, & Soleymani, 2005) (Pirnia, Khademi, Nikookar, & Bani, 2010) (Daryoush, Khademi, Nikookar, & Farahani, 2012) (Izadi, Haji, & Ching, 2008) (Harouni, Dzulkifl, & Rasouli, 2010) (Daifallah, Zarka, & Jamous, 2009) (Maliki & et al., 2012). Recognizing Persian and Arabic script is complicated due to continuity of writing and features such as different styles of writing and variety of shapes for a letter in different positions.

To reduce the complications in recognition process, words are decomposed into smaller parts, which is called segmentation. Later, by identifying letters within each segment, the whole word will be recognized. Since, correct detection of segmentation points plays an important role for the whole recognition process, many efforts have been made on segmentation points in cursive words over Arabic and Persian languages (Pirnia, Khademi, Nikookar, & Bani, 2010), (Daryoush, Khademi, Nikookar, & Farahani, 2012), (Izadi, Haji, & Ching, 2008), (Harouni, Dzulkifl, & Rasouli, 2010), (Daifallah, Zarka, & Jamous, 2009), (Maliki & et al., 2012).

In this paper, we propose a method for detecting the segmentation points in a cursive word using some unique features of Persian language. The rest of the paper is organized as follows: In next section, we will have a review on researches have been made upon the subject. In Section 3, we introduce our method for detecting segmentation points. Section 4, illustrates the experimental results and finally, the paper will be concluded in section 5.

Literature survey

Due to the importance of segmentation in better recognition of Persian and Arabic cursive words, researchers have presented various methods to identify segmentation points. Among many works, paper (Pirnia, Khademi, Nikookar, & Bani, 2010) has used a list of Persian language features for segmentation phase. One of those features is writing direction; so the points that follow a specific pattern in their direction before and after themselves, will be considered as a segmentation point. Series of directions is another feature that was used, as well. The last repeating points in a series of adjutant points, in addition to the first and the last points of each word is considered as segmentation points. Remaining points will be detected by using first and second derivatives of right and left.

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Samimi et. all (Daryoush, Khademi, Nikookar, & Farahani, 2012) define seven basic shapes and convert input points to them according to some patterns.

Paper (Izadi, Haji, & Ching, 2008) finds curves and features in input points to detect segmentation points. Khaled et. all (Daifallah, Zarka, & Jamous, 2009), consider points in right-to-left direction, and define joint line by angle between points's line and the horizontal axis. Then eliminate some of the joints by checking above and below of the joint and finally, by integrating these joint lines, middle points will be considered as segmentation points.

Proposed Algorithm

In this Section, we present a new method for detection of segmentation points in Persian cursive words using some generic features of Persian Language. Later, these points can be used in recognition process of on-line Persian handwriting. In the following, we first depict the generic features, and then present our algorithm.

The Features

The two main features that we use in our algorithm are as follows:

- In joining of two letters in the general form of Persian handwriting, the last point of the preceding letter will always be placed over the right-to-left writing direction. This point, is the best segmentation point to be detected.
- In the general form of Persian handwriting, there is an obvious difference in gradient of ending points of the preceding and beginning points of the succeeding letter.

Best form of detecting segmentation points happens when the last point of each letter within a word are found. There is a possibility in identifying those points by utilizing the mentioned features. For this purpose, we firstly, find the points that place at the right-to-left writing direction and gradient of a straight line between them are less than a pre-defined threshold. These points are the best candidates for the last points of the previous letter in a joining. If the gradient goes over the threshold for next points, by considering the second feature, the subsequent points are the beginning of the next letter and segmentation point will be detected.

Segmentation Algorithm

of input points, including X and Y coordinates. As we put the pen tip down until picking it up, its movement is a continuous curve, containing series of points, which we define it as a stroke. Persian words could contain one or more stroke. For identifying of segmentation points a specific word, we need to detect In on-line handwriting, when somebody writes a word on the screen, simultaneously, the handwriting is stored as series all the segmentation points for each stroke.

In our new suggested method, according to mentioned features, following steps execute for all strokes in a word:

- 1- Consider the second point of a stroke as current point and set a point variable P to be null.
- 2- If it is the last point of the stroke, go to step 7, otherwise calculate $X_{new} - X_{Previous}$.
- 3- If calculated value is positive, it means movement is from the left-to-right. In this situation, if P is null, set next point as current point and go back to step 2. If P is not a null or calculated value is not positive, it means the movement is from right-to-left and go to step 4.
- 4- Calculate the gradient of a straight line between the current point and the previous point as $\frac{Y_{new} - Y_{Previous}}{X_{new} - X_{Previous}}$.
- 5- If the calculated gradient is less than a threshold, set P as the current point. Then select the next point and go back to step 2. Otherwise, if P is null, just set the next point as the current point and return to step 2. In case that P is not a null, go to step 6.
- 6- Choose the next point and calculate the gradient of a straight line between P and the next point. If the calculated gradient is not less than the threshold, consider P as a segmentation point. Then set P to be null, set the next point of segmentation point as the current point, and go back to step 2. If the calculated gradient is less than the threshold, set the new point as the current point and go back to step 2.
- 7- The End.

In this algorithm, by using the P variable and considering its state, we found points with small gradient and put them in it. Later, by investigating the next points, first points of the subsequent letter that have a higher gradient are found. To avoid input error, in step 6, we check the gradient of a straight line between P and the second point after it. If first high gradient occurs because of an input error, we reject it and investigate the next points.

By executing the above steps for all strokes in a word, last points of all letters will be recognized as segmentation points.

EXPERIMENTAL RESULTS

To assess the efficiency of the proposed method, we developed an application using C# programming language and Microsoft Visual Studio 2010 programming Environment to capture handwritings of different people by a digital pen and detect segmentation points of them. We ask 20 people to write 10 different words by a digital pen. In selection of the words, we try to choose those that capture most structures of the Persian script. Table 1, presents the results of the proposed method.

Table 1. Result of recognized points by proposed approach

Words	Number of expected point	Number of recognized expected point	Number of additional recognized point
باغستان	4	4	3-8
حلاوت	2	2	1-4
تفریط	3	3	0-3
بیننده	4	4	1-4
صریح	2	2	1-4
برلین	3	3	1-3
گلرله	3	3	0-4
فلسطین	5	5	3-7
هرچند	3	3	1-3
تلافی	3	2-3	1-3



Figure 1. Detected points for word “تلافی” a) Segmentation point between “بفی” has been Detected b) Segmentation point between “بفی” has not been Detected

The experimental results showed that all the expected segmentation points, means the last point of each letter in a joining, were founded. However, in some handwritings, the consecutive high gradients in last stroke of “تلافی” results in missing the segmentation point as shown in Figure 1 for two different situations. In addition, according to the experimental results, our proposed algorithm may find some extra points as segmentation points as well. Figure 2 shows detected points for “برلین”. As we can see, the algorithm found an extra point in the last letter “ن”.

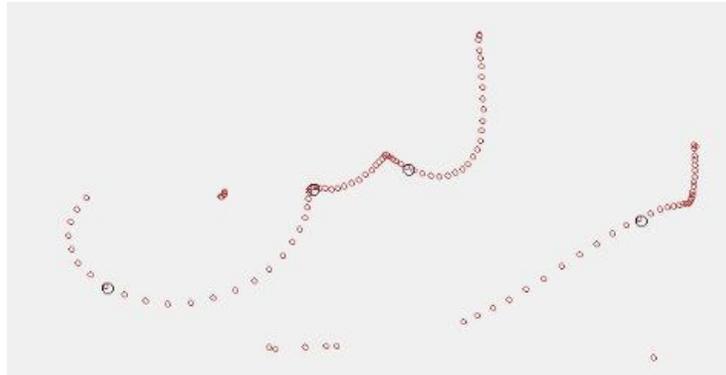


Figure 2. Detected points for word “برلین”

CONCLUSIONS AND FUTURE WORKS

In this paper, we presented a new method for detection of segmentation points in Persian cursive words for On-line handwritings using some specific features of Persian Language. At first, we reviewed related works. Later, two specific features of Persian language are described as well as our proposed algorithm. The experimental results from evaluation of our algorithm have shown that 98.9% of expected segmentation point, means the last point of each letter in a joining, are detected. However, our algorithm identified one or more extra points as segmentation points, too.

For future work and to improve the result of the proposed method, we could define post-process steps to find and remove extra points using Persian letters' diacritic such as dots, slant line, etc. We could also employ the approach introduced in (Pirnia, Khademi, & Nikookar, 2011) to define building blocks for letters and use them with decision tree to identify the body of letters correctly regardless of founded additional segmentation points.

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