Online Character Recognition of Handwritten Cursive Script

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Abstract

Text recognition is an area of pattern recognition that has been the subject of considerable interest during the last five decades. Handwritten text show wide stylistic variations. In this paper cursive characters have been recognized. Segmentation of words into characters is performed by feature extractor method. The segmented characters are then given as the input to template matching algorithm in which an incoming input is re-sized and each and every character in it is extracted. Then the extracted character is matched against the standard templates. Here pixel by pixel matching takes place for recognition. Recognition of unconstrained handwritten text is very difficult because characters cannot be reliably isolated especially when the text is cursive handwriting. But it is implemented in this project with high accuracy.

Keywords: *pattern recognition, Segmentation, feature extractor, template matching, pixel.*

1. Introduction

In the proposed system, the problem of machine reading handwritten cursive characters is dealt with. The aim is to produce a system that classifies a given input as belonging to a certain class rather than to identify them uniquely, as every input pattern. The system performs character recognition by quantification of the character into a mathematical vector entity using the geometrical properties of the character image.

Ghazali Sulong [1] presents a hybrid strategy for recognition of strings of characters (words or numerals). In a two stage dynamic programming based, lexicon driven approach, first an explicit segmentation is applied to segment either cursive handwritten words. In the second verification stage, statistical features are extracted from each segmented area to recognize characters using a trained neural network. The purpose of character segmentation [2] is to analyze improved performance of segmentation algorithm on IAM benchmark database in comparison to others available in the literature from accuracy and complexity points of view. Segmentation is achieved by analyzing ligatures which are strong points for segmentation of cursive handwritten words. Following preprocessing, a new heuristic technique is employed to over-segment each word at potential segmentation points. Finally, the fine segmentation points are fed to train neural network for validating segment points to enhance accuracy. Hiroto Mitoma [3] proposed a new recognition technique in which category-specific deformations, called eigen-deformations, are utilized to suppress those misrecognitions. Generally, matching results at overfitting are not consistent with the eigen-deformations. Thus, the overfitting can be detected and penalized by a posterior evaluation of this inconsistency. Vassilis Papavassiliou [5] proposed an efficient method based on binary morphology for text-line segmentation in documents. The basic steps of this approach are: a) sub sampling and binary rank order filtering to enhance the text-line structures and b) applying dilations and (p,q)-th generalized foreground rank openings successively to join close and horizontally overlapping regions while preventing a merge in the vertical direction.

2. Online character recognition

In case of online character recognition there is real time recognition of characters. Online systems have better information for doing recognition since they have timing information and since they avoid the initial search step of locating the character as in the case of their offline counterpart. Online systems obtain the position of the pen as a function of time directly from the interface. Offline recognition of characters is known as a challenging problem because of the complex character shapes and great variation of character symbols written in different modes. In the past decades, a great deal of effort has been made towards solving this problem.

3. Context level data flow diagram

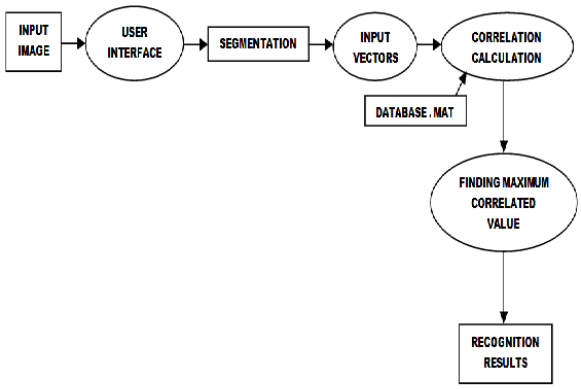

Fig 1: Data Flow Diagram

4. Design specifications

The task itself involves pre-processing, character recognition and optional postprocessing steps. The pre-processing step involves three processes:

Normalisation, feature extraction and segmentation .

Pre-processing is typically carried out in software, but by implementing it in hardware, potential resources on a PDA are released for other applications.

Normalisation aims to correct unwanted variations in the input, with typical processes include: rotation, scaling, shear transform, deskewing, extrema location, centre-of-mass location, zone classification, smoothing, threshold-based anomaly exclusion, resampling in the time and/or spatial domain.

Feature extraction gives the recognizer its expected inputs in such formats as Euclidean distance, velocity or acceleration (requiring differentiation and integration), stroke or interstroke direction expressed either as slope, angle, cosine, sine or curvature, and measure of stroke curviness (stick, arc, curve).

Segmentation is a process of separating characters in a word. It entails classifying a sequence of sample points into strokes and characters, and relating them by order, connectivity and significance. Segmentation is by far the most important aspect of the pre-processing stage. It allows the recognizer to extract features from each individual character. In the more complicated case of handwritten text, the segmentation problem becomes much more difficult as letters tend to be connected to each other.

5. Character recognition

After segmentation process, individual characters are recognized by template matching method. In this method, input character is resized & matched against standard templates in program's database. Here pixel by pixel comparison takes place. Correlation is the best method for comparison, the extracted resized character is correlated with each and every standard templates. Then according to the correlated values, the highest value which is corresponding to all is taken as the identified one. As a whole the input is identified as a text.

6. Correlation coefficient

In probability theory and statistics, correlation (often measured as a correlation coefficient) indicates the strength and direction of a *linear* relationship between two random variables. *Correlation* refers to the departure of two random variables from independence. In this broad sense there are several coefficients, measuring the degree of correlation, adapted to the nature of the data. The correlation coefficient $\rho X, Y$ between two random variables X and Y with expected values μX and μY and standard deviations σX and σY is defined as:

$$\rho_{X,Y} = \frac{E(XY) - E(X)E(Y)}{\sqrt{E(X^2) - E^2(X)}\sqrt{E(Y^2) - E^2(Y)}}. \quad (1)$$

7. Experimental Results

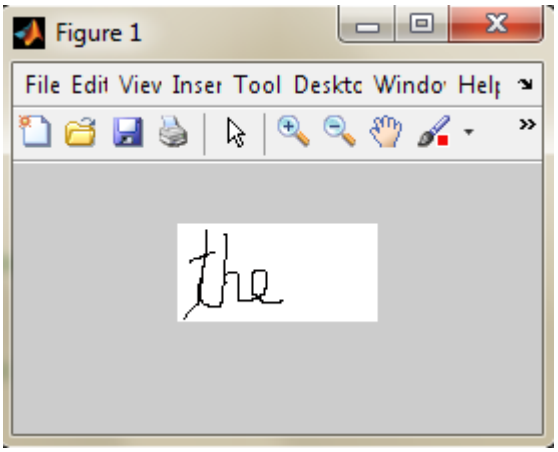

Fig 2: Input character

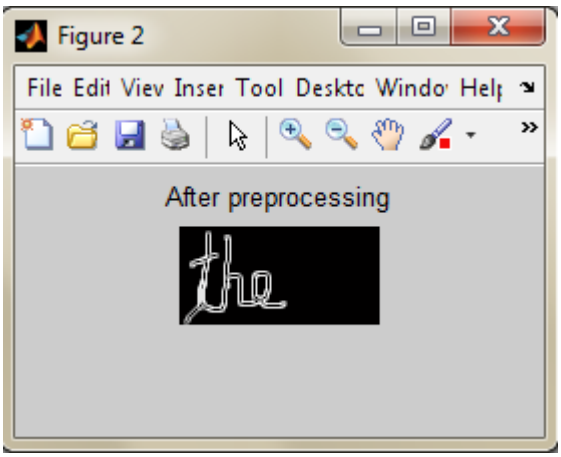

Fig 3: After pre-processing

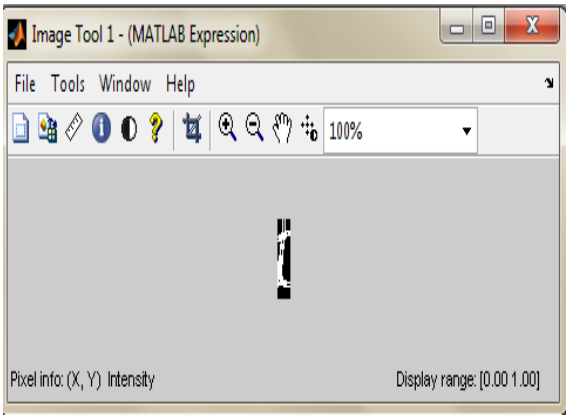

Fig 4: Segmented character (1)

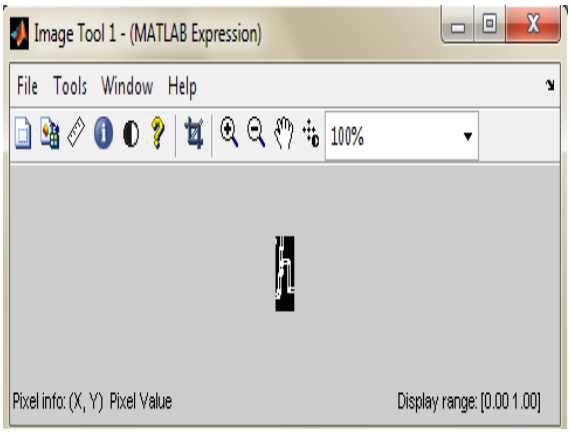

Fig 5: Segmented character (2)

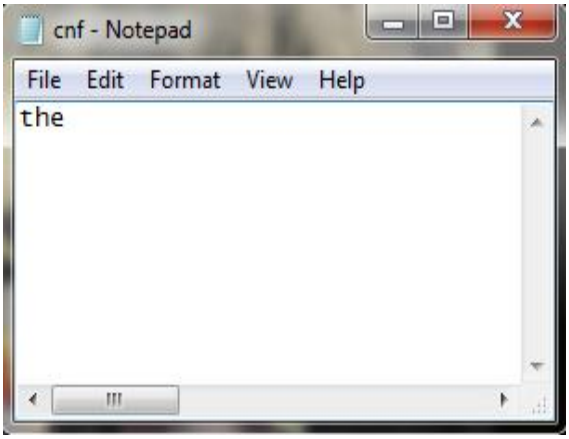

Fig 6: Output recognized character

8. CONCLUSION

In the view of the work carried out following conclusions are drawn: Character segmentation and Character recognition algorithms for online method have been developed. The results are satisfactory and the various inputs and outputs are displayed.

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