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Research Article

BLOCK CONTOUR VECTOR USING GAUSSIAN FILTER IN HOLISTIC HANDWRITTEN WORD RECOGNITION

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ABSTRACT

Holistic handwritten word recognition considers the whole input image as a single word, indivisible unit and recognize the word based on overall shape. In this paper, we present a holistic approach for the off line handwritten word recognition using Gaussian filter with different divergence like horizontal, vertical and 2 diagonal difference to plot the endpoint. The endpoint images are subblocked with different sizes. In each subblock enumerate the number of appearance of dots for feature extraction. The extracted features are fed to SVM classifier to recognize the given holistic word. The proposed system achieves a good recognition accuracy of 3×6 subblock with 24 classes holistic word obtained 90.52%.

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INTRODUCTION

Handwritten word recognition of document images is still an unsolved problem in pattern recognition. During the past decade, incredible development has been achieved in the field of handwritten word recognition. It involves several application areas of handwritten word recognition for automatic reading of postal addresses, bank checks reading and document conversion, etc. Generally holistic or character based methods have been used for handwritten word recognition. In the earlier approach, a whole word is treated and identified as an entity. In the second approach, a word is considered as a sequence of smaller components like characters. In holistic approach is commonly the preferred technique for recognition application. In applications such as recognition of ZIP codes, cheque number, city and street names from the address blocks or street board.

Related Work

Holistic offline word recognition algorithm (Ruiz-Pinales *et al*., 2007) based on perceptual feature extraction. Longest run features in various depths considered vertically along the center of gravity of the word image to extract the features and classified in multi layer perceptron (Acharyya *et al*., 2013). Holistic historical word recognition based on scalar features and profile based features are classified in HMM (Lavrenko *et al*., 2004). Local histogram of the contour chain code is calculated from each zone for feature extraction and classified in HMM (Dehghan *et al*., 2001). New method for extraction and representation of number of dots presented above or below the primary shape and classified in HMM (Mozaffari *et al*., 2007). New method for rotation free online unconstrained handwritten by using gravity center balancing and correction method for feature extraction and fed to LDA classifier (Ding *et al*., 2009). Gabor feature with different orientation of pixel compute corresponding Gabor value, after thinning process on Gabor image these combined line will appear as one single line for extract the features and fed to SVM (Subramaniam *et al*., 2012). Structural, statistical and topological features are extracted from outlining shape of the words and classified in feed forward neural network (Sahlol *et al*., 2014).

Outline of the Work

This paper deals with block contour vector using Gaussian filter divergence in holistic handwritten word recognition.

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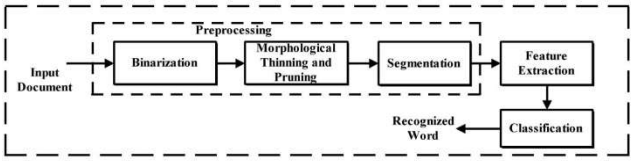

Fig. 1. Holistic handwritten word recognition

The method has been evaluated with handwritten English words collected from different writers with various writing styles. In block contour vector, given holistic word applied for Gaussian filter with four divergence like horizontal, vertical and 2 diagonal difference involved the holistic word and plotted the dots in different manner of each difference and enumerate the number of occurrences of dots in each subblock for feature extraction. The extracted features are fed to SVM for recognition of holistic word. The rest of the paper is organized as follows, Section IV describes proposed holistic handwritten word recognition. Block Contour Vector is described in Section V. Section 4 deals with SVM classification. Section VII shows the experimental results of our approach and Section VIII concluded the work.

Proposed holistic handwritten word recognition

In holistic word recognition, the given input document is preprocessed with binarization, thinning and thicking to eliminate the noise and unwanted effects of the original image. Fig. 1. shows a block diagram of the holistic handwritten word recognition proposed in this paper. This block diagram consists of the following steps:

Input Document

Holistic word recognition uses own handwritten dataset created by different writers, to ensure various writing styles across different age group and different genders. Input document contains 24 general English words collected from 140 different writers with different writing styles and size as shown in TABLEI. The input images are captured using a scanner with 300 dpi resolution and are saved in JPEG/JPG format.

Table 1. Handwritten dataset

S.No	Genders	Age	No.of Samples
1	Male	25-40	60
2	Female	18-26	60
3	Children	8-12	20

Pre-processing

The role of preprocessing is to eliminate the imperfections that are succeeded to handwritten words. The input document may be contained on a deafening, different background and also the quality of the images may be tarnished. It is necessary to improve the input document image quality. There are various tasks involved in the document images are:

Binarization: Input images are initially stored in RGB or gray level format. This means that the intensity of each pixel in the image may vary between a value of 0 and 255. The value of zero indicating a black pixel, whereas a white pixel is represented by the value of 255.

Various shades of gray are represented between these two values are converted into a binary image. For word segmentation, the binary image is inverted as 1 for white (foreground) and 0 for black (background).

Morphological Thinning: The thinning function is similar to shrinking, except that thinning generates a minimally connected line that is equidistant from the boundaries. Some of the structure of the object is maintained. Thinning is also useful when the binary sense of the image is reversed by creating black objects on a white background. If the thinning function is used on this revered image, the results, are minimally connected lines that form equidistant boundaries between the objects.

Morphological Pruning: The pruning algorithm is a technique used in digital image processing based on mathematical morphology. It is used as a complement to the skeleton and thinning algorithms to remove unwanted parasitic components. In this case depedent components refer to branches of a line which are not key to the overall shape of the line and should be removed for accurate segmentation.

Segmentation

Segmentation is the operation of splitting a sentence into multiple words. In this work, segmentation of word is carried out by using horizontal and vertical projection profile (Sulem *et al*., 2006; Mamatha and Srikantamurthy, 2012) are commonly used approach for segmenting the word. Horizontal projection profile is obtained by counting the white pixel values along the horizontal axis for each value of *y* and the white space between the text lines are observed and a line is drawn for text line segmentation is shown in Fig.2. After line segmentation is done, the words are segmented from each line by using vertical projection profiles. For each column, the number of white pixels are counted and the columns with black pixels are used as delimiters for word segmentation as shown in Fig.3. Finally, all the segmented words are uniformly resized to 120×120 width and height respectively.

Fig. 2.Horizontal line segmentation

BCV with Gaussian Filter

The procedure to extract the features is as follows:

- The word image is subblock into N×N over the image.
- Each image applied in Gaussian filter with different variance and Gaussian image is morphological filter to remove pixels on the boundaries of word.

Each subblock enumerates the number of occurrences of white pixels.

Fig. 3.Vertical line segmentation

BCV with Horizontal Variation

Gaussian filter with horizontal variation is applied on 120×120 word image and the Gaussian image is morphological filter to remove pixels on the boundaries of word but does not allow to break apart. The obtained image is divided into six equal parts vertically and three equal parts horizontally (upper, middle and bottom), each subblock enumerates the number of occurrences of white pixels. Thereby 6 dimension features which are extracted from six equal vertical subblock shown in Fig.4 and 3 dimension feature that is extracted from three equal horizontal subblock is shown in Fig.5. Thereby 9 dimension features are extracted from horizontal variation.

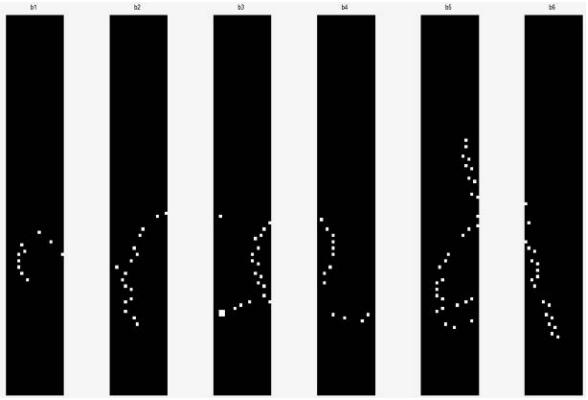

Fig. 4.Six vertical subblock

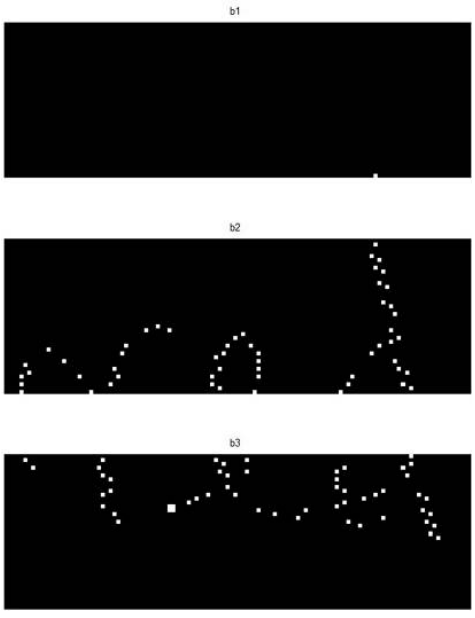

Fig. 5.Three horizontal subblock

Similarly, the word image is divided into four and eight equal parts vertically and three equal parts horizontally and each subblock enumerates the total number of white pixels occurrence. Thereby 7 and 11 dimension features are extracted from different subblocks.

BCV with Vertical Variation

Gaussian filter is applied in vertical variation and the Gaussian image is morphological filter to remove pixels on the boundaries of word but does not allow to break apart.

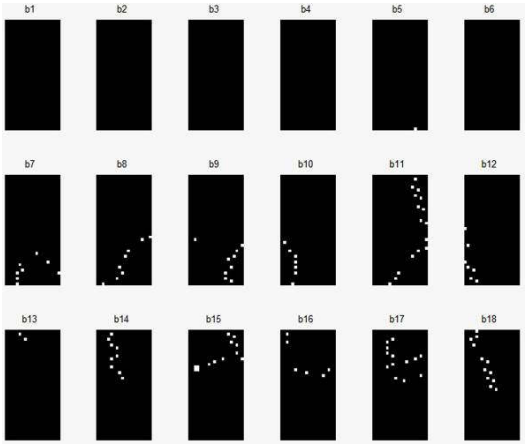

Fig. 6.3×6 Vertical variation subblock

The obtained images are divided into six equal parts vertically and three equal parts horizontally. Each subblock enumerates the total number of white pixels occurrence. Thereby 18 dimension features are extracted from 18 equal vertical variations of 3×6 as shown in Fig.6. Similarly, the word image is divided into 3×4 and 3×8 subblock and the number of occurrences of white pixels in each subblock is counted. As the results 12 and 24 dimension features are extracted from 3×4 and 3×8 subblock.

BCV with 2 Diagonal Variation

Gaussian filter is applied in 2 diagonal variations of left and right direction and the Gaussian image is morphological filter to remove pixels on the boundaries of word but does not allow to break apart.

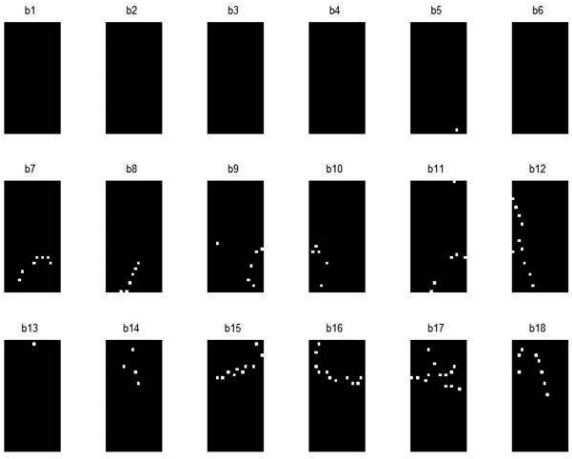

Fig. 7.3×6 Left diagonal variation subblock

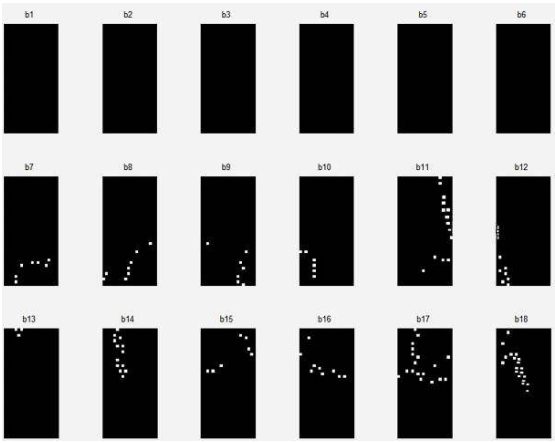

Fig. 8.3×6 Right diagonal variation subblock

Table 2. Different dimension of BCV using Gaussian filter

Subblock	Horizontal	Vertical	Left Diagonal	Right Diagonal	Total
3×4	7	12	12	12	43
3×6	9	18	18	18	63
3×8	11	24	24	24	83

Table 3. Recognition Accuracy of Different dimension of BCV using Gaussian filter

Subblock	Horizontal	Vertical	Left Diagonal	Right Diagonal
3×4	70.83	72.63	69.47	75.78
3×6	71.87	84.37	83.33	82.10
3×8	78.12	81.25	81.05	84.37

The obtained images are divided into six equal parts vertically and three equal parts horizontally. Each subblock enumerates the number of occurrences of white pixels. Thereby 18 dimension features are extracted from 18 equal subblock of 3×6 left diagonal as shown in Fig.7 and another 18 dimension features are extracted from 18 equal subblock of 3×6 right diagonal as shown in Fig.8.

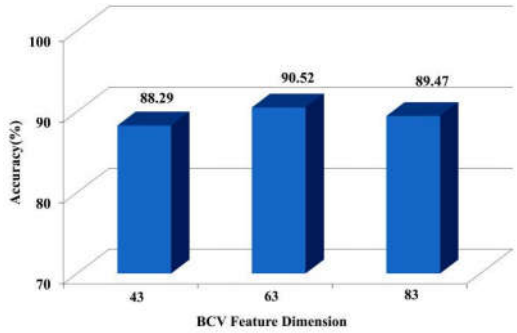

Fig. 9. Different dimension of BCV feature.

Similarly, the word image is divided into 3×4 and 3×8 subblock and the number of occurrences of white pixels in each subblock is counted. As the results 12 and 24 dimension features are extracted from left diagonal and another 12, 24 dimension features are extracted from right diagonal. obtained 43, 63 and 83 dimension features are extracted from (3×4, 3×6, 3×8) subblock as shown in TABLE. II. To combine the feature dimension of horizontal, vertical, left diagonal and right diagonal variations of Gaussian filter

Support Vector Machine

The concept of support vector machine was introduced by Vapnik. The main objective of any system that is capable of learning is to achieve good performance given a sufficient amount of training samples (Cristianini and Shawe-Taylor, 2000; Mitchell, 1997). SVM is one of the most popular techniques for pattern classification and recognition. It is considered to be a tool for linear and nonlinear classification. It belongs to the class of supervised learning method, based on statistical learning theory (Vapnik, 1998; Chang and Lin, 2011). A support vector machine is a maximal margin hyper plane in feature space built by using kernel function. The results in a nonlinear boundary in the input space. The optimal separating hyperplane can be determined without any computations in the high dimensional feature space by using kernel functions.

Experimental Analysis

This section describes the experiments conducted by using BCV with Gaussian filter. The proposed method are applied to extract the features from different subblock sizes and are fed to SVM with RBF kernel for recognizing the handwritten word.

Performance Measure

Recognition accuracy (RA) and error rate (ER) are the commonly used measures and evaluate the performance of the proposed system. These measures are defined as follows:

$$RA = \frac{N_C \times 100}{N_T} \quad (1)$$

$$ER = \frac{N_E \times 100}{N_T} \quad (2)$$

Where N_C is the number of correctly classified samples, N_E is the number of misclassified samples and $N_T = N_E + N_C$.

Performance Measure

The experimental results are carried out in windows 8 operating system with Intel Xeon X3430 processor 2.40 GHz with 4 GB RAM. The efficacy of the proposed features is evaluated with LIBSVM tool \cite{ref14} and a model is developed for each class and these models are used to test the performance with the SVM RBF kernel. In this experimental work, 24 English handwritten words are collected from 140 different writers with different writing styles and size. The handwritten documents were scanned at dimensions of 2528×3507 pixels, 300 dpi images. In this experimental work, 86 writer's sample documents were taken for training and 54 writer's samples were taken for testing, each writer has written 24 English handwritten words. Totally, 2064 (86×24) word samples were taken for training and 1296 (54×24) word samples were taken for testing using SVM. The training and testing samples are used to measure the performance of BCV with Gaussian filter.

BCV with Gaussian Filter using SVM

Features are extracted from different subblock sizes of BCV with Gaussian filter. To evaluate the performance of the proposed approach, various experiments were carried out on different subblock sizes.

In this experiment, the subblock size was empirically fixed for BCV with Gaussian filter for feature extraction. TABLE III shows the recognition accuracy results obtained for different subblock size. To improve the recognition accuracy of the proposed work by combining the feature dimension of four variance, thereby 43, 63 and 83 dimension features are extracted from 3×4, 3×6 and 3×8 subblock and are modelled with the SVM RBF kernel. The proposed system gave higher recognition accuracy of 90.52% using 63 BCV features and lower recognition accuracy of 88.29% using 43 BCV features are shown in Fig. 9.

Conclusion

In this paper, a holistic approach of handwritten word recognition based on Gaussian filter with different orientation are applied to holistic word to plot the endpoint in a different way and the endpoint image are to enumerate the number of dots appeared on the subblock is proposed. There by various sizes of subblock are used in block contour vector, to extract the different feature are fed to SVM with RBF kernel. In this approach 24 classes holistic word and 3×6 subblock of 63 dimension features gives a good recognition accuracy of 90.52%. In future work, intend to enhance a word is considered as a sequence of smaller components like characters and proposed method implemented in each character to extract features and measure the performance in different classifier to enable the robust recognition accuracy.

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