Feature Extraction for Offline Signature Verification System

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Abstract—In this paper, a method is proposed for extraction of features from Offline Signature Verification System. Signature image having in lower right corner of the bank cheque is acquired. Signature image is converted to binary image using Otsu’s method and then bounded in the (rectangle) bounding box. After that, a new feature extraction technique based on signature image splitting is presented. Before finding centre of gravity of the whole signature image, it is initially detected whether it has interesting pixel or not. After finding the centre of gravity, the image is firstly partitioned to achieve four blocks. When partitioning parts of each of four blocks, its block is detected whether it has interesting pixel or not. After detecting pixel, blocks are further partitioned until 64 sub-blocks are achieved. Finally, three robust features are extracted from each sub blocks.

Keyword: Otsu’s, Centre of Gravity, BoundingBox, Splitting Technique, Feature Extraction Technique

I. INTRODUCTION

Feature extraction is a special form of dimensionality reduction in pattern recognition and image processing fields. Offline signature is widely accepted as an authentication in document and personal verification [1].

Signature can be classified into two types which are online signature and offline signature. Offline signature can be captured by digital scanner or camera. Signature image contains unnecessary noise and electronic noise. Therefore, noise elimination is made by spatial and frequency domain techniques. Signature can be assigned as an image. Signature may be written as cursive, graphical marks. Signature cannot be read as character word.

As offline signature is a complex due to the absence of stable dynamic characteristics, it is hard to segment signature strokes due to highly stylish and irregular writing styles. Therefore, offline signature of this paper is split to get small parts of signature image and also achieve the robust features.

This paper is organized as follow: in section 2, some previous works are reviewed. Section 3, is the overall architecture of the proposed system. Section 4 describes the implementation of the proposed system. The last section of this paper is about the conclusion.
The above paper showed global features based on one-dimensional feature. However, horizontal and vertical projections based features are not good in verification stage. Many feature points are good in classification. Therefore, the next paper extracted three robust features based on splitting technique. Black pixel value is only used as feature points. Therefore, the proposed system intended to extract pixel density feature and angle features based on splitting technique.

III. OVERALL ARCHITECTURE OF THE SYSTEM

The overall architecture of the system includes the following: Signature Acquisition, Preprocessing, Feature Extraction and Verification.

IV. IMPLEMENTATION OF THE SYSTEM

The System includes the image acquisition step, preprocessing step, feature extraction step and verification step.

A. Image Acquisition

Offline Signature image containing in lower right corner of bank cheque is cropped out. The acquired signatures are enhanced because signatures contain the unnecessary noises during image scanning.

B. Pre-processing

The offline signatures are preprocessed to prepare the signature for feature extraction process.

1.1. Conversion of Gray image

The acquired signature image is blue color. Therefore, color image is firstly converted to grey scale image using the following equation.

\[
\text{Gray color} = 0.299 \times \text{Red} + 0.5876 \times \text{Green} + 0.114 \times \text{Blue} \quad (1)
\]

1.2. Wiener Filter

Signature image are written on different paper or documents. In order to eliminate the noise, wiener filtering is used.

Wiener filter requires the information about the spectra of the noise and the original signal and it works well only if the underlying signal is smooth. Wiener implements spatial smoothing and its model complexity control correspond to choosing the window size.

Figure 3: Wiener Filter Image.

1.3 Binarization using Otsu’s method

Filter image is converted to binary image using Global threshold (Otsu’s method). Otsu’s method is used to automatically perform histogram shape-based image thresholding or the reduction of a gray level image to a binary image.

The binary image contains background (white) and foreground (black) pixel values. Therefore, background is converted to black (0) pixel value and foreground is converted to white (1) pixel value.

(a) (b)

Figure 4: Binarization (a) Binary Image. (b) Inverted Image.

1.4. Thinning

The goal of thinning is to eliminate the thickness differences of pen by making the image one pixel thick. Reduction of pixel values calculates quickly. For thinning, Morphological operations [7] can be applied.

Figure 5: Thinning Image

1.5. Bounding Box

The required signature image has the unwanted free space area. So, signature image is bounded into the rectangular bounding box.

Therefore, signature image is scanned from top to bottom to obtain the signature image height. Then, Signature image is scanned from left to right to obtain the signature image width.
1.6. Size Normalization

Normalization is required as the size of offline signature varies from person to person and even time to time with the same person.

A method is presented for size normalization. In this method, the length and the width of the signature are computed and then the smaller ones are selected.

1.7. Centre of Gravity

The centre of gravity is firstly found on the whole signature image because signature image is equally split to depend on pixel intensity value.

Therefore, the centre of gravity of the signature image is calculated by using the following equation.

\[
CG_x = \frac{\sum_{i=1}^{N} x(i)}{N}
\]

\[
CG_y = \frac{\sum_{i=1}^{N} y(i)}{N}
\]

(2)

Where \( CG_x \) is the centre of gravity x-coordinate, \( CG_y \) is the centre of gravity y-coordinate and \( N \) is the number of intensity of the signature image \((x, y)\).

1.8. Translation

Then move the signature image centre to coincide with centre of the predefined image space.

C. Feature Extraction

Extracting the feature from signature image is important because feature extraction is necessary in verification step.

In the proposed system, signature image is split to achieve small sub-image parts.

The procedure for extraction feature is shown in Fig 8.

Step 4: Extract Three Features from Step 3.
Pixel Density (F1), Angle Feature (F2), Angle Feature (F3).

Figure 8: Feature Extraction Procedure

Step 1: Partition into four sub-image parts:
If signature image is made to separate parts, several steps will need. Before finding centre of gravity of the signature image, it is firstly detected whether it has interesting pixel or not.

1) To achieve the four parts of image parts, signature image is split with passing through its centre of gravity.

Figure 9: Four parts of Signature Image

Step 2: Partition each of four sub-image part into four rectangular parts:
The proposed system splits the sub-images to obtain a set of 16 sub-image parts in Fig 10.

Figure 10: Sixteen parts of Signature Image

Before finding centre of gravity of the every sub-image, the following three conditions are made for every sub-image.

1) It is detected whether it has interesting pixel or not.
2) If any of white pixel value contains in the sub-image, the next step will be continued.
3) If pixel value does not contain in every sub-image, these image will be assumed as black pixel value.

If these conditions finish, the next step will be continued in Step 1.

Step 3: Partition each of sixteen parts into four sub-image blocks:
The proposed system attempts to achieve the 64 sub-images. The following three conditions are made for every sub-image.

1) It is detected whether it has interesting pixel or not.
(2) If any of white pixel value contains in the sub-image, the next step will be continued.
(3) If pixel value does not contain in every sub-image, these image will be assumed as black pixel value.

If these conditions finish, the next step will be continued in Step2.

Figure 11: Sixty-four parts of Signature Image feature

Step 4: Extraction Three Features:

Without retrieving the whole feature of the signature, signature image is split and then extracted as robust features from all 64 sub-images.

(1) **Pixel Density Feature (F1)**

(1) Find the area of each cell and use this value to obtain the cell size. (Area)
(2) Find the total number of white pixels in each cell.
(3) Divide the area of cell size by the total number of white pixels.

\[
\text{Pixel Density (F1)} = \frac{\text{Area}}{\text{Total number of white pixels}}
\]

(2) **Angle Feature (F2)**

(1) Find the centre of gravity of each cell using equation (4).
(2) Calculate the angle of inclination of each sub-image centre to the lower right corner of the cell.

\[
\text{Angle Feature } = \text{Angle of inclination of centre gravity to the lower right corner (F2)}
\]

(3) **Angle Feature (F3)**

(1) Find the white pixel of each cell.
(2) Find the angle of inclination of each white pixel to the lower right corner of the cell.
(3) Calculate the sum of angle in each cell. (Total Angle)
(4) Find the total number of white pixels.
(5) Divide the sum of angle by the total number of white pixels.

\[
\text{Angle Feature (F3)} = \frac{\text{Total Angle}}{\text{Total number of white pixels}}
\]

The three robust feature sets obtained from this new feature extraction are the feature representation of each user’s signature. Each feature set has 64 vector components (f1, f2,..., f64).

**V. CONCLUSION**

As signature image is bounded in rectangular box, unnecessary areas are removed. As black pixel blocks are not needed to extract features, processing time becomes faster. In partitioning the image, centre of gravity is found instead of using centre of image. By partitioning with centre of gravity, signature pixels of each block are balanced. This paper does not cater for scale and rotation variation. Three features extracted in this research work are very useful for offline signature verification.

**REFERENCES**


