# Applications of Image Preprocessing Techinques in Handwritten Signatures

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***Abstract :*** In any decision software system, a data set is split into two sets: training and testing. The set of samples that help to build up a classifier of the specified system are termed as training set. On the other hand, testing sets are applied to verify the performance of the classifier. Usually, once a training set is developed, the test to verify a sample begins, i.e. selection of training set is the initial stage preceding the development of testing set. The samples included in a training set are known and authentic. But in a test set the samples present are a mixture of authenticated and questionable ones. In proposed system, offline handwritten signature samples are taken as desired samples of training and testing sets. Here, we have discussed preprocessing steps in handwritten signatures which are vital to improve the accuracy of a system.

***IndexTerms* - Resizing, Contrast stretching, Removal of redundant bordering components, Removal of involuntary scratches, Adjustment of signature's spaces, Adjustment of signature's baseline.**

## I. INTRODUCTION

In any pattern recognition system, the main aim is to increase its accuracy. This accuracy depends on each of the steps (from data acquistion to classification stage) involved in that particular system. Among them, image preprocessing is one the crucial steps that is reponsible for enhanceing the system's efficiency. In the present study we take the aplication area of handwritten signatures, which are to pe procesed for classification of forgery, to analyse the impact of preprocessing techniques. In case of signatures, sometimes, the collected samples (both training and testing sets) are found to be noisy with redundant and involuntary scratches which may degrade the system's performance. To reduce such uneven elements, a signature is preprocessed such that an improved image can be obtained. We have illustrated (as in **Fig. 1**) applications of preprocessing techniques in handwritten signatures which gives a clear indication about the imporatnce of such techniques [Gonzalez, Woods and Eddins (2010)] [www.mathworks.in] [Ahmed, H. and Shukla, S. (2012)] [Rathi, A., Rathi, D. and Astya, P. (2012)] [Azzopardi, G. (2006)] [Biswas, S., Kim, T. H. and Bhattacharyya, D. (2010)] [Kaur, J. and Sharma, R. (2017)] [Jain, C., Singh, P. and Rana, A.(2018)] .

## II. ELABORATION OF PREPROCESSING TECHNIQUES IN OFFLINE HANDWRITTEN SIGNATURES

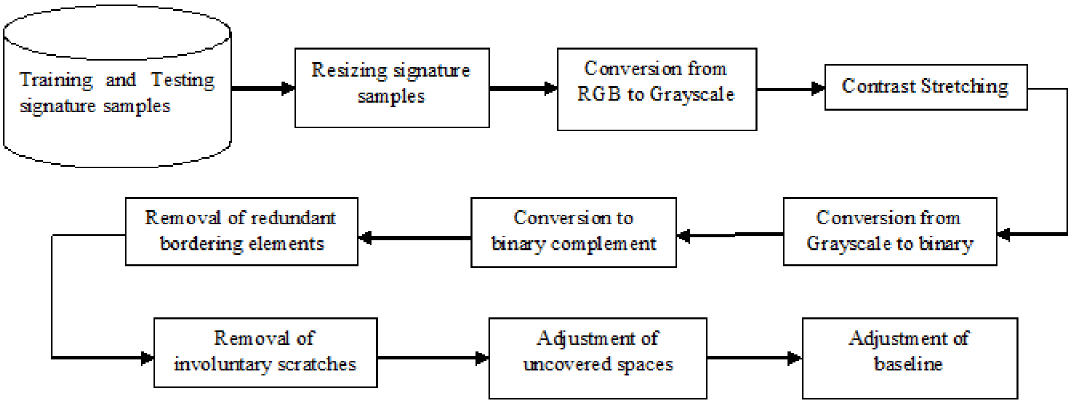
Training and Testing signature samples
Resizing signature samples
Conversion from RGB to Grayscale
Contrast Stretching
Conversion from Grayscale to binary
Conversion to binary complement
Removal of redundant bordering elements
Removal of involuntary scratches
Adjustment of uncovered spaces
Adjustment of baseline

Fig. 1: Applied preprocessing techniques in the proposed signature samples

### 2.1 Resizing signature sample

Conventionally, handwritten signature samples are first processed with scanner and then edited with Photoshop software. Usually, the resultant samples that are captured in digitized form are found to be greater in size. Therefore, to operate smoothly, we have resized the signatures into smaller sizes (100×300 pixels) without affecting original signature.

### 2.2 Conversion from RGB to Gray scale

A grayscale signature is a simplified version of RGB sample which is obtained by without loss of important information of RGB signature. By taking a weighted sum of R, G and B components result a grayscale signature.

$$I_{gray} = 0.2989 \times R + 0.5870 \times G + 0.1140 \times B \qquad (1)$$

From the above equation, it is clear that the coefficient of G (Green) component is more than that of R (Red) and B (Blue) components. It is because of the fact that human eye is more sensitive to green light than the red and blue ones. Therefore, in order to balance intensity of grayscale signatures as in RGB ones, the weighting coefficient for G component is more [Solomon and Breckon (2011)].

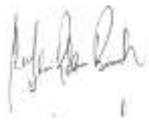

Fig. 2: A grayscale signature

### 2.3 Contrast stretching

It is an operation which is performed to improve the intensity of an image. Consider a grayscale signature with upper and lower intensity limits [$G_{max}$ , $G_{min}$] and T be a transformed signature with stretching limits [$T_{max}$ ,$T_{min}$]. Let T = F(G) be a transformation function which operates as follows [Lee (2008), pp: 120] [Chanda and Majumder (2005), pp: 90-91]:

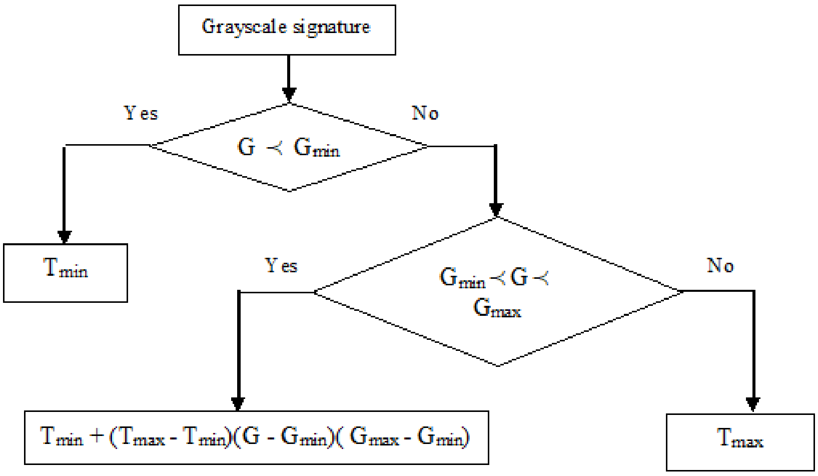
Grayscale signature
Yes
No
$G \prec G_{min}$
$T_{min}$
Yes
$G_{min} \prec G \prec G_{max}$
No
$T_{min} + (T_{max} - T_{min})(G - G_{min})( G_{max} - G_{min})$
$T_{max}$

Fig. 3: Flowchart for Contrast Stretching

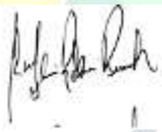

Fig. 4: Contrast stretched signature

### 2.4 Conversion from grayscale to binary

To convert a given grayscale signature to a binary one, we have first selected a default threshold value within the range [0,1] (where numerals 1 and 0 represent white and black colors respectively). Then the transformation function starts to operate by comparing the threshold value with the luminance of given grayscale signature as follows. Here, threshold value and luminance are indicated by thresh and lum respectively and B(x,y) is for binary signature [Lee (2008), pp: 123].

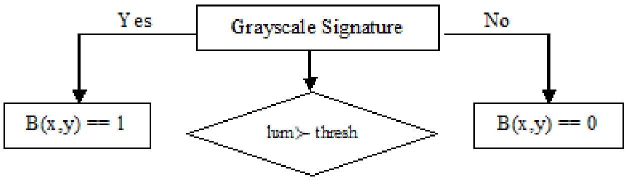

Fig. 5: Flowchart for transformation of binary signature

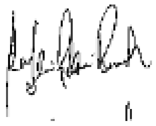

Fig. 6: A binary signature

### 2.5 Complement binary signature

Here, the logical operator "NOT" is implemented with binary signature's matrix such that a complement binary signature can be obtained. If $\overline{B(x,y)}$ is the complement binary signature then the transformation function alters colors of the transformed signature as given below:

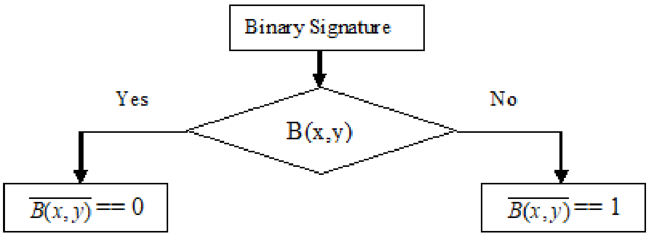

Fig. 7: Flowchart for transformation of complement binary image

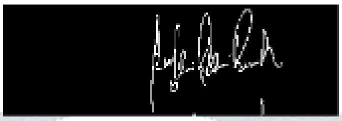

Fig. 8: A complement binary signature

### 2.6 Removal of redundant bordering components

Sometimes, a signature may appear with redundant components that present in bordering area of the specified signature. Appearance of such components in a signature may influence on system's performance. Signifying the bordering components as b_com, below we have given a flowchart for removal of redundant bordering components from a signature.

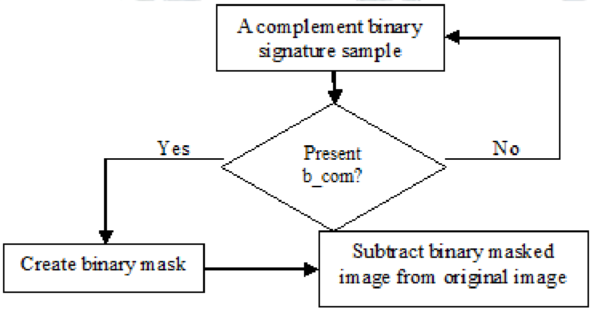
A complement binary signature sample
Present b_com?
Yes
No
Create binary mask
Subtract binary masked image from original image

Fig. 9: Flowchart for removal of redundant bordering components from a signature

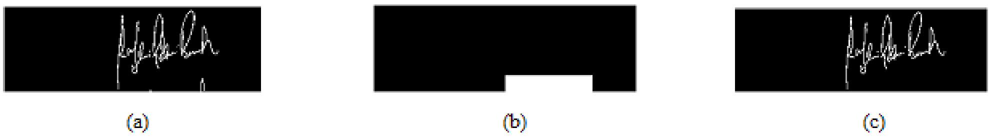

Fig. 10: (a)A signature with redundant bordering components, (b) After masking (c) Removal of redundant bordering components

### 2.7 Removal of involuntary scratches

Sometimes, the fast writing speed of a signer may produce scratches marks or ink dots on a signature. We have removed such involuntary small components such that a clean and clear signature can be obtained. Suppose, $p_{org}$ be the number of pixels of unwanted marks or dots and $p_{thresh}$ is taken as selected threshold value. Following flow chart provides a transformed signature without having unwanted small components.

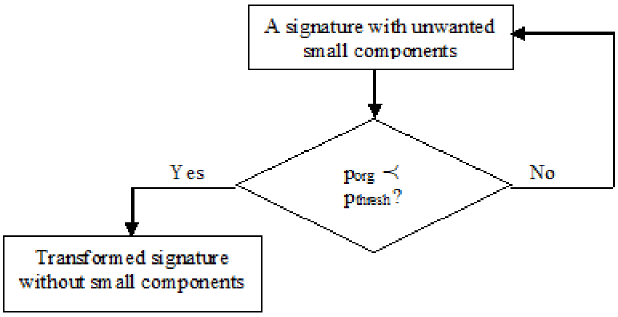
A signature with unwanted small components
$p_{org} \prec p_{thresh}$ ?
Yes
No
Transformed signature without small components

Fig. 11: Flowchart for removal of involuntary scratches

(a) Before

(b) After

Fig. 12: Before and after removal of unwanted small objects from a signature

### 2.8 Adjustment of signature's spaces

Even after the application of Photoshop software, some spaces of the concerned signature images still remain as unnecessary and hence we have discarded those spaces which are not covered by the specified signature. To perform such adjustment, we have followed the signature image horizontally and vertically to detect the first and last rows with white pixels. This will give us indices about the first and last rows as well as columns with white pixels along their respective directions. Suppose, $[h_{first}, h_{last}]$ be the indices of desired rows along horizontal direction and $[v_{first}, v_{last}]$ be the indices of desired columns along vertical direction. This means that $[h_{first}, h_{last}]$ and $[v_{first}, v_{last}]$ are horizontal and vertical ranges within which the signature is to be confined. Therefore, I $(h_{first} : h_{last}, v_{first} : v_{last})$ will be the resultant signature with rows $(h_{first} : h_{last})$ and columns $(v_{first} : v_{last})$.

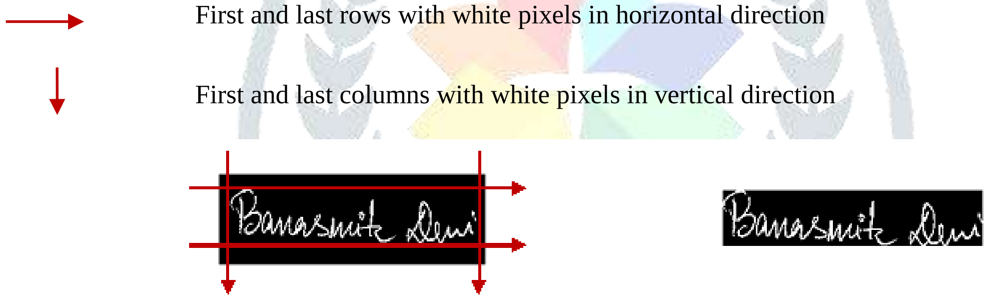
First and last rows with white pixels in horizontal direction
First and last columns with white pixels in vertical direction

Fig. 13: Before and after adjustment of uncovered spaces of signature

### 2.9 Adjustment of signature's baseline

The imaginary line on which the signature takes its position is a baseline of a signature. Again, angle between the baseline and imaginary horizontal line is the skewed angle. During signing process, a signer assumes an arbitrary baseline. Among the signatures, the trend of a baseline varies with respect to imaginary horizontal line. A rough sketch of directions of baseline with skewed angles is illustrated in fig. 14 [Bunke and Wang (1997)] [Zeeuw (2006)] [Mahanta and Deka (2013)].

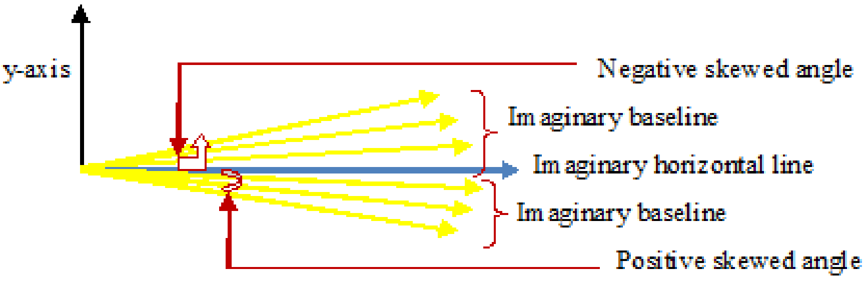

Fig. 14: A rough sketch of negative and positive skewed angles of signatures

The variation of skewed angle generates three different skewed signatures like negative, zero and positive skewed signatures as depicted below.

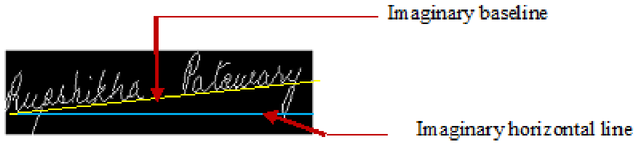

Fig. 15: Negative skewed signature

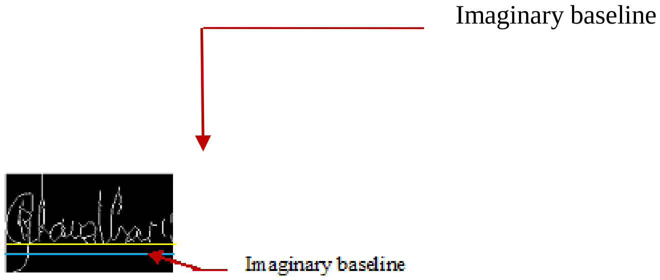

Fig. 16: Zero skewed signature

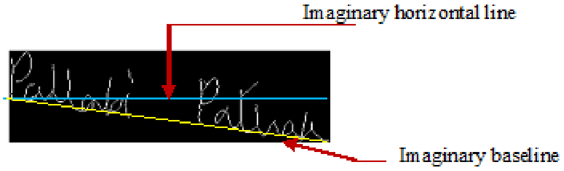

Fig. 17: Positive skewed signature

To reduce the skewed angle especially in case of negative and positive one, applied steps are given below:

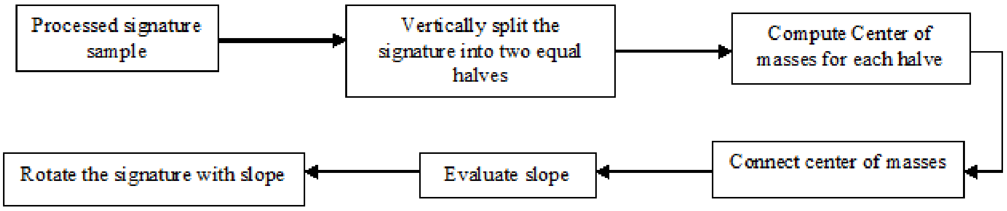
Processed signature sample
Vertically split the signature into two equal halves
Compute Center of masses for each halve
Connect center of masses
Evaluate slope
Rotate the signature with slope

Fig. 18: Steps for adjustment of baseline of signatures

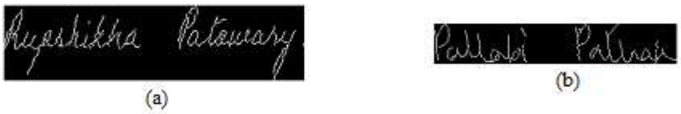

Fig. 19: After adjustment of (a) negative skewed and (b) positive skewed signature

## III. Conclusion

In image preprocessing, a signature sample has to posses several steps to reach its final processed image. But depending on nature and quality of images, number of processed steps may vary among the signatures samples. The same set of preprocessing steps can also be applied in other application areas of signature like bank cheque, LIC form.

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