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SIGNATURE VERIFICATION USING PCA AND GEOMETRIC FUNCTIONS

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Abstract: Signature is now serving as importants of personal verification tool for most of the commercial transactions in the era of information technology which emphasizes the need for an automatic verification system. It can be performed either offline or online based on the application. The later use dynamic information of a signature captured at the time the signature is obtained, where as offline systems work on the scanned image of a signature. In this paper we present a method for offline verification of signatures using a set of simple shape analysis based on the scanned images. Offline signatures are worked by having some geometric functions or shaping's, center of gravity, shaped angle and aspect ratio. This signature verification will be used for finding the forgery signatures with compares of original signature by using PCA (Principal Component Analysis) method and geometrical features.
Keywords: Offline Verification, Geometric Features, PCA, Aspect Ratio, Signature Verification

1. INTRODUCTION

Biometrics can be categorized as behavioral and physiological. Handwritten signature belongs to behavioral biometric. In most of the places, the verification is done manually either by a person who is familiar with the signature or by matching it against a few signature templates handwritten. Signature verification can be classified into offline and online signature recognition system. Between the two, the later is more reliable because of its higher efficiency in terms of accuracy and time. However, the other systems cannot be ignored, since its applicability and ease of use are more in comparison to online systems in many parts of the world. There are many approaches, but our approach contains four major phases for verifying a signature. These are Data gathering, Preprocessing, Training, and Testing as shown in Figure 1. Training is a phase in which we will find correlation between a features of signature then we find the mean and deviation from correlation values and save them in database. Testing is done to test the input image is correct or forged.

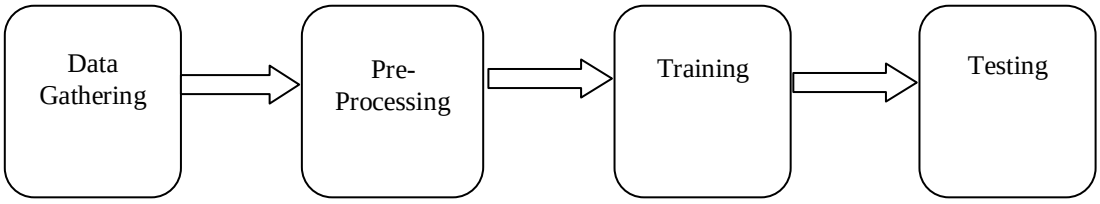

Figure 1. Block diagram of handwritten signature verification system

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The desired plan of work is based on the standard data set and training data set collected from people. In this method signatures were collected in different styles which were signed in handwriting as shown in Figure 2.

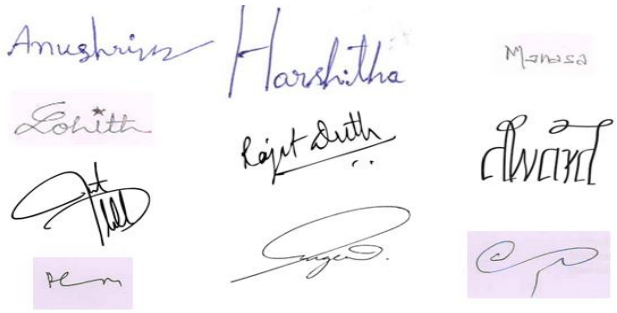

Figure 2 Standard Datasets

Figure 3 Datasets of original signature

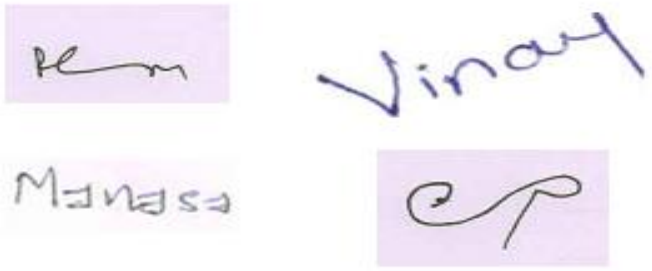

Figure 4 Datasets of fake signature

In this work original handwritten signature from the members and fake handwritten signatures from other members were collected, for every signature as shown in Figure 3 and 4 respectively, we perform the pre-processing steps for noice removal. For every signature we find the geometrical features of the objects such as area, height, width, aspect ratio, standard deviation, mean, kurtosis and skewness and also compares the values of the each signature degree of sloping by finding the angles from orientation values using PCA.

In this work we focus on two signature verification techniques that have been defined such as,

1. Boundary based technique.
2. Principal Component analysis based technique

1.1 Boundary based technique

Boundary based technique focuses mainly on signature boundaries of different components which spread into a number of components due to space between each letter. Boundary based technique represents shape features such as height, width,

area, aspect ratio, standard deviation and skewness of signature image more clearly as compared to area based technique. It is fast in processing and needs less computation than area based technique.

1.2 Principal Component analysis based technique

PCA method focuses mainly to compress the components and finding the values for each component. It represents component features such as major axis length, minor axis length, eccentricity and orientation of signature components. It is clearly finding the angle of components by having the orientation value of the signature. It is fast in processing and computes the angles between signatures.

Whereas boundary based technique focuses mainly on object boundary. It represents shape of the signature component more clearly as compared to area based technique. Due to fast processing and easy computation, it is widely used in real time and practical applications. We consider just the boundary based technique.

2. LITERATURE SURVEY

We have reviewed the literature to solve the problem of Signature verification. Signature verification was done by collecting the testing signatures which were taken by handwritten signatures. In banking system approximately 10% -15% of daily clearing needs the signatures to be verified for the reasons such as a technical fault or the cheque above the floor limit etc. This often involves returning the cheques to the branches where the signature mandates are held, which is a time consuming and costly process.Signature verification systems aim to confirm the identity of a person based on their signature[1], that is, they classify signature samples as "genuine" (created by the claimed individual) or "forgery" (created by an impostor). In offline (static) signature verification, the signatures are acquired after the signature writing process is completed, by scanning a document containing the signature. This is in contrast with online (dynamic) signature verification, where the signature is captured directly on a device (such as a pen tablet), and therefore the dynamic information of the signature is available, such as the velocity of the pen movements. The lack of dynamic information in the offline case makes it a challenging problem, and much of the effort in this field has been devoted to obtaining a good feature representation for signatures[2]. Biometric Online Signature Verification[3] describes a complete biometric algorithm for signature verification based on three stages. Signature is normalized by means of a pre-processing. Later, the captured signature is aligned with its template by applying a DTW algorithm. From this aligned signature the most relevant features are extracted and used as input to a GMM model, whose output is used to confirm or deny the user's identity. This paper also shows the design of an embedded system for implementing this signature. Learning features for offline handwritten signature verification using deep convolutional neural networks[4] proposed different formulations for learning representations for offline signature verification. They showed that features learned in a writer-independent way can be very effective for signature verification, improving performance on the task, compared to the methods that rely on hand-engineered features. Handwritten Signature Verification using Instance Based Learning[5] have proposed method for verifying off-line handwritten signature. They have used an Instance Based Learning algorithm, the method which has an advantage of small database storage. They have proposed different phases through which we are able to identify the forgery in handwritten signature. Enhanced Signature Verification and Recognition using Matlab[6], This paper presents neural network for authentication and verification of individual signature. Neural networks are highly reliable when trained using a large amount of data. This paper helps in detecting the exact person and it provides more accuracy of verifying signatures. They achieved 85 -100% efficiency for various test data. In a authors study on Handwritten Signature[7], have given some preliminary concept about signature analysis. A comparative study of offline and online signature is also discussed. Lastly they try to focus on some of the available approaches for offline signature verification. The efficiency of a signature verification system depends on each and every stage like preprocessing, feature extraction and selection of classifier. A well preprocessed image should be fed to the system in order to extract features. Features that are to be extracted depend on nature and pattern of signature. The same set of features may not be preferable to both simple as well as cursive letters, to attain an efficient result. Since among the three types of forgeries, detection of skilled forgery is a crucial task, hence selection of classifier(s) is also an important job. A signature may not be readable for all the time due to presence of flourishes. Since the pattern of a signature may vary from person to person from normal signature to cursiveness. [8]Presents a method for offline signature verification and recognition by using MLP neural network that used four features; eccentricity, skewness, kurtosis, and orientation, which can be extracted by image processing. [9]In this paper an attempt has been made to analyze various methods for offline signature verification. [10]Present implementation of off-line signature recognition and verification system, which is based on moment invariant method, ANFIS, Pairwise distance (pdist) and Kmeans. Another method presents a method for verifying handwritten signatures by using a Neural Networks (NN) architecture [11]. Offline signature verification scheme[12] is based on selecting 60 feature points from the geometric centre of the signature and compares them with the already trained feature points. The classification of the feature points utilizes statistical parameters like mean and variance. [13]Have proposed a method for a tutorial on Principal Components Analysis. This tutorial is designed to give the understanding of the PCA method is a useful statistical technique that has found applications in fields such as image compression and face recognition, and is a common technique for finding patterns in data of high dimension. PCA is a technique is useful for the compression and classification of data. The purpose is to reduce the dimensionality of a data set (samples) by finding a new set of variables, smaller than the

original set of variables that nonetheless retains most of the samples information. Finally we can conclude that there is no method to prove 100% Signature verification[14-21].
From the above literature review, it is found that there is no perfect method to give perfect solution to solve the problem of signature verification. Hence, we propose a new method called signature verification using PCA and geometric functions based method to overcome the problems of the existing methods.

3. PROPOSED METHOD

In our proposed method, we identified the fake signatures by using PCA and geometric functions. As shown in Figure 5 first we take the original image of RGB image as the input. The input is like different signatures which are collected from different people. We have used different available datasets and took training datasets of original signatures from original member and took fake signatures from other people. The input RGB signature image is converted into a grayscale image and preprocessing activities such as noise removal are done using median filter method. Various geometrical approaches are used to describe the objects using global and local descriptors such as mean, standard deviation, kurtosis, skewness and circularity.

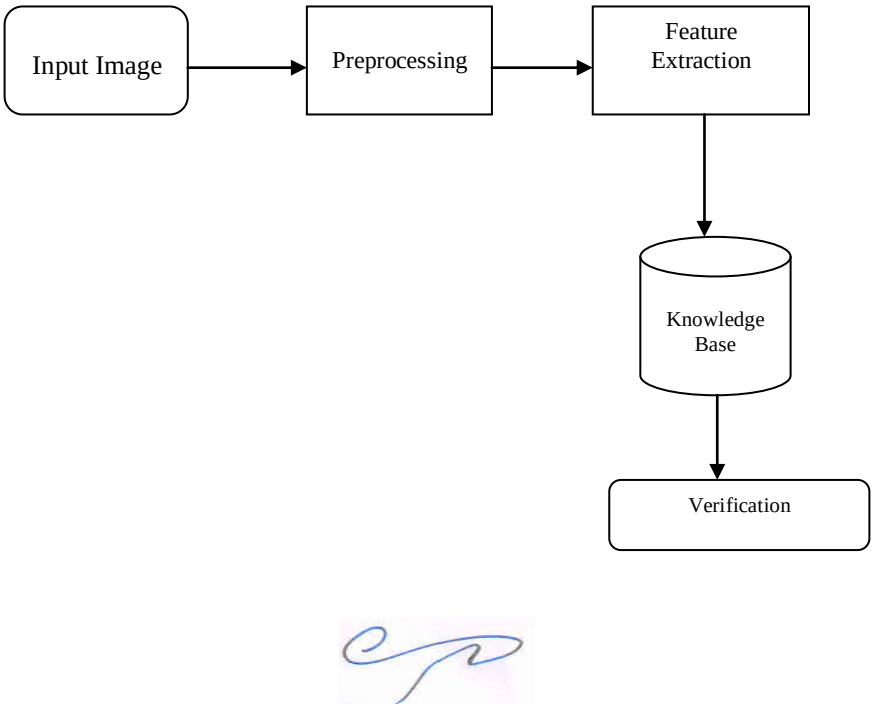

Figure 5. General steps for Signature verification

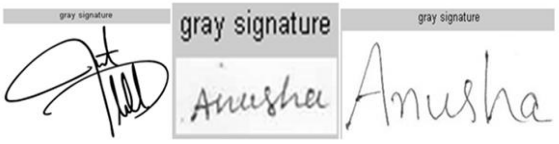

Figure 6. Gray scale images

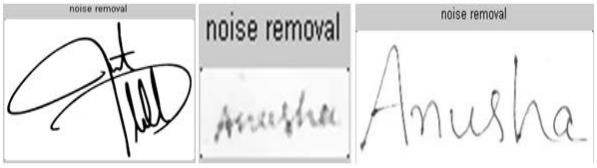

Figure 7. Noise removal images

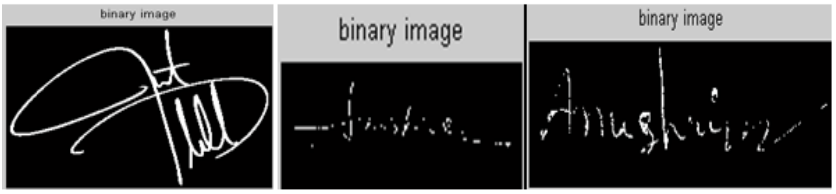

Figure 8. Binary images

Figure 9. Connected components

Figure 10. PCA method

We propose PCA to compute angle for each signature block to find the direction of the signature. The reason to use PCA is that PCA gives accurate principal axis for the signature objects that have regular shape. The method feeds x and y coordinates of pixels to PCA to compute angle for each block as the angle is computed based on Sobel edges corresponding to pixels in the signature block. The Sobel edge map is obtained by performing Sobel edge operator on the input signature image.

4. EXPERIMENTAL RESULTS

More than 335 sample signatures were collected in two different categories, in the datasets we have collected original signatures samples from original people and fake signatures from other people. In order to prove the accuracy of our proposed recognition system, more test signatures were considered, for each type of signature in the system domain and used to test the system with various training signature images which are of different styles, shapes and pressure. Table 1 shows the system is convincible to say that the system is robust enough and able to recognize any input signature images that are being captured in any conditions.

Table 1. Proposed method acceptance and rejection rate

Nature of Signature	No. of Samples	Acceptance Rate	Rejection Rate
Original	335	97.6	2.4
Forged	335	96.0	4.0

5. CONCLUSIONS AND FUTURE SCOPE

This paper presents how original and forged signature are identified by finding the angle orientation and geometrical feature which is done by first principal components method. Our goal is to identify the fake signatures with different analysis techniques. The matching of the signatures are recognized by having the values of the orientations(PCA) and other geometrical features. Hence we have developed simple and efficient feature distinguish image technique. Signatures of the different styles are compared and thus we have showed that presented features achieved the good performance in terms of acceptance rate and rejection rate. In future work may be concentrated on integrating the various factors like change in different styles of signatures and individual object and signature quality of the pressure on different images can be considered, also one can concentrate on finding the additional features to improve the verification process. Further one can test the improved method for various styles of signature identification and verification.

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