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Signature Extraction and Recognition from Bank Cheque Image

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Abstract*: Automatic signature extraction and recognition from document images is an open research problem. Signature verification is of two types; static and dynamic, and has two approaches; writer dependent and writer independent. Signature verification system in case of bank cheque image should essentially be an error prone system to elude the fraudulent transactions. In this work, a three layer signature verification system is proposed, which is writer independent and offline signature verification system. Graphometrical and FAST features are extracted from the signature images and are given as inputs to the classification algorithms. The proposed signature verification model is a combination of three classification algorithms; artificial neural network, Gaussian mixture model and image matching models, to circumvent the fraudulent transactions. The overall performance accuracy of proposed process is 99%.

Keywords: Signature verification, document analysis, artificial neural network.

I. INTRODUCTION

Signature verification is the technique used by financial institutions, banks, intelligence agencies and high profile institutions to validate the identity of an individual, by comparing the given signature with the available database signature and checks the authenticity. In this study we are extracting the signature from the handwritten bank cheques and verifying the authenticity of provider. Automatic signature verification is the open research problem in pattern recognition and digital image processing areas. Signature verification is broadly classified into two types depending on the acquisition methods, static (offline) verification and dynamic (online) verification systems. In online verification system, a digital tablet is used as an acquisition device to acquire the signature. The behavioral patterns of user can be extracted such as pressure, pen inclination, time taken to sign, etc. In offline verification system a digital image of signature is provided to the system and signature features has to be extracted.

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It is challenging to verify the signature due to lack of dynamic information and copious of the research work done in the offline signature verification to attaining a better feature representation for signature.

One of the major problem in the offline signature verification is the finding of the given query signature is a genuine or not. There are two main approaches for this problem, writer dependent and writer independent approaches. In writer dependent approach, a training set of genuine signatures of the user is provided to train the classifier. At test time, the distance vector is calculated between the query signature and the signature from trained database and accordingly classified as a genuine or a forgery by writer dependent classifier. In writer independent approach, the classifier is trained by a training set of genuine and forgery signature samples. At the test time, the difference vector is calculated between the query signature and the signature from reference database and accordingly classified as a genuine or a forgery by writer independent classifier. Forgeries are mainly classified in three types; they are random, casual and skilled forgeries. In random forgery, the forger has no information about the user. In casual forgery, the forger has information about user name but not about signature. In skilled forgery, the forger has details about user and his signature. The random and casual forgeries can be easily detected by simply comparing the signatures. The skilled forgeries are hard to detect because they have greater resemblance to the genuine signature.

In case of bank cheque, signature is the pivotal aspect to authorize the financial transactions. Signature verification system should essentially be an error prone system to elude the fraudulent transactions. In this study, a three layer signature verification system is proposed, which is writer independent and offline signature verification system. Initially, a handwritten localization process is used to localize the signature from the bank cheque image. Next, the signature is segmented from the digital image by using appropriate structure based segmentation technique. Pre-processing is performed on the segmented image such as noise elimination, morphological dilation and connected component analysis for appropriate depiction of the signature in feature extraction phase. Graphometrical and FAST features are extracted from the signature images and are given as inputs to the classification algorithms. The proposed signature verification model is a combination of three classification algorithms; artificial neural network, Gaussian mixture model and image matching models, to circumvent the fraudulent transactions.

II. RELATED WORK

In the last few decades, several methods have been developed to effectively implement the offline signature verification system. But still the immaculate classification model is the open research problem. Hafemann et al. [1] presents the literature review on signature verification systems and analyses the recent advancements in the field. The state of art of signature verification from the three decades is presented in [2-4]. Fifteen signature verification systems have been studied by Shah et al. [5], based on the different classifiers and feature extraction methods, and also discussed the strengths and limitations of all the systems. Many authors proposed signature verification systems that train and test on only genuine signatures. Some authors train on genuine and forgery signatures and test on different forgery signatures. Some authors train on genuine signature set and test on genuine and forgery signatures for identification purposes. Most work in the literature [6-7] did not use the skilled forgeries for training. Many classification methods have been tested for classifying the forged signatures and genuine signatures but generally neglected the disguised signatures (signature from original person with variations in signature) apart from initial research [2] and in local and global feature comparative methods [8].

Various features have been extracted from signature in the process of signature identification and signature verification processes. Geometric features [9], graphometric features [10], texture features [11], directional features [12], wavelet features [13], Curvelet transform features [14], Histogram of oriented gradients (HOG) features [15], Local binary patterns (LBP) features [6], and many other features have been extracted and utilized in the models. Many classifiers, that are using now a days for signature verification process, such as Hidden Markov Models (HMM) [16], Artificial Neural Networks (ANN) [17], Multiple Perceptron models [18], Support Vector Machines (SVM) [19], Elastic Image Matching [20], Euclidian distance classifiers [21], Deep Neural Networks (DNN) [22] and other machine learning classification algorithmic models.

III. RESEARCH METHODOLOGY

The proposed signature verification process consists of five significant steps:Signature localization on the bank cheque image, Segmentation of signature fragment, Pre-processing of segmented signature image, Extracting features of signature, and three layered signature verification model.Figure1 shows the flow diagram of proposed signature verification process. We are using our own processed database of cheque images, due to security concerns. We have collected 2000 signature images from 50 people, and each person signature has 20 original, 5disguised (variable signature from same person), 5 causal, 5 random and 5 skilledforgery signatures.

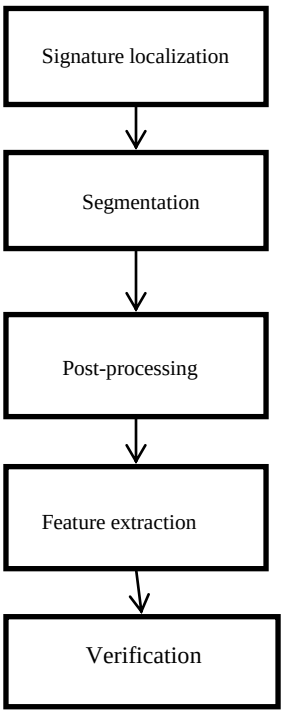

Fig.1 Proposed signature verification process

Signature localization:

Signatures can be considered as a behavioral biometric and which are handwritten. Signature comprises of provider handwritten behavior, hence it can be localized by the handwritten localization techniques. There are several methods addressed in literature for localizing the handwritten areas on document images. Here we are considering the method based on the connected components approach. The gray image of signature is used in this process. The connectivity of pixels based on the gray levels of image. Handwritten areas comprises of different gray level because of different color utilization compared to plain cheque.The band pass filter is used to obtain the handwriting portions. Signature has peak value of gray level in histogram and hence it's very prominent to localize the signature with four connectivity structure element.The figure2 shows the localization of signature from a cheque image.

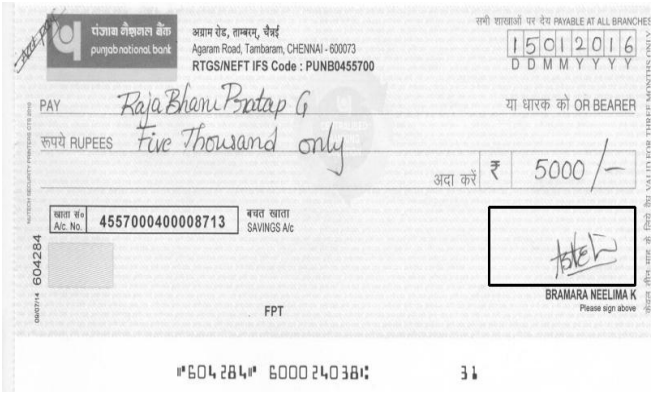

Fig.2 Signature localization on bank cheque image

Segmentation:

The bank cheque format is standardized and the structure consists of regularized positions of each section. From the localization the signature is detected as the handwriting area and further its segmentation is promising by using the geometric position of it in the cheque image. The geometric positions are adjusted according to the connecting elements of localization. The horizontal and vertical positions are adjusted according to the top and bottom most, and first and last pixels of signature connecting component. The figure3 shows the signature segmented image from given cheque image using geometric positions.

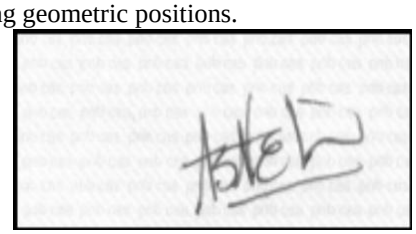

Fig.3 Segmented signature image

IV. DISCUSSION

Pre-processing:

The segmented signature image preprocessed to eliminate the noise and unnecessary areas. The size of the signature image is normalized for further processes. The 3x3 median filters are used to eliminate the noise and the complex background from signature image. The morphological dilation is applied on the noise free signature image for full connectivity of signature component. Then, the skeletonization is applied to get the skeleton structure of the signature. Signature be made up of various minute parts, such as dot, symbol, special marks, which represents the behavioral aspect of person. The special precaution is taken to minimize the loss of respective parts while eliminating the unnecessary components. The dilation process benefits in these situations even though skeletonization is performed on the image.

Feature Extraction:

The researchers [1-22] extracted numerous and variety of features of signature. In our work, we extracted the graphometrical features and features from accelerated segment test (FAST) from the signature. There exists nearly sixty graphometric features in handwriting analysis, some of them are static features and some are dynamic features. Writer independent offline signature verification is a static process, hence the static features and pseudo-dynamic features are considered in this system. The graphometrical features that can be applied on the signature are- calibre, proportion, minimal graphics, spacing, base behavior, pixel density, pixel distribution, axial slant, progression, form, entry strokes, end strokes, and orient to base line. Calibre is the ratio of height and width; proportion refers to regularity of signature; minimal graphics represents fragments such as i dots, comma, special symbols, etc; spacing defines the space placing between strokes, characters and words in signature; angle of inclination of text with respect to an imaginary horizontal line is described by base behavior; pixel density defines the number of black pixels in signature image with rectangular grid partition; pixel distribution explains the width of the stroke progressed in which direction; axial slant is used to realize the behavior and direction of signature; progression used to define the significant stroke of each cell and its direction; form is the pictographic depiction of the writing movement; entry stroke and end stoke are the gestures of the character in the signature; orient to baseline simply defines the vertical relationship between writing and baseline. Out of these features we used the nine features; height, width, calibre, minimal graphics, spacing, pixel density, axial slant, form and orient to baseline.

Recognition model:

A three layered hybrid signature recognition model is constructed with the extracted features by the combination of three classification methods. The feature vector obtained from the feature extraction phase is given to the artificial neural network, Gaussian mixture model and direct matching algorithmic models and combined the results to verify the signature. We have proposed a signature dataset of 2000 signature images from 50 people, and each person signature has 20 original, 5 disguised (variable signature from same person), 5 causal, 5 random and 5 skilled forgery signatures. The artificial neural network is trained on the proposed signature data and yields the performance accuracy of 98.6%. On each signature image Gaussian mixture model responds with accuracy of 98.3%. Template matching is the pattern verification technique, performed on test signature across database and matching accuracy of 99.1%. Hence, the overall signature recognition performance accuracy of proposed three layered hybrid signature recognition model is obtained as an average of 99%.

V. CONCLUSION

Signature is the pivotal aspect to authorize the financial transactions. Signature verification system should essentially be an error prone system to elude the fraudulent transactions. In this study, a three layer signature verification system is proposed, which is writer independent and offline signature verification system. Initially, a handwritten localization process is used to localize the signature from the bank cheque image. Next, the signature is segmented from the digital image by using appropriate structure based segmentation technique. Pre-processing is performed on the segmented image such as noise elimination, morphological dilation and connected component analysis for appropriate depiction of the signature in feature extraction phase. Graphometrical and FAST features are extracted from the signature images and are given as inputs to the classification algorithms. The proposed signature verification model is a combination of three classification algorithms; artificial neural network, Gaussian mixture model and image matching models, to circumvent the fraudulent transactions.The overall signature recognition performance accuracy by an average is 99%.

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