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Writer-dependent Offline Signature Verification Using SVM Classifier

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Abstract: ***The handwritten signature verification system can be writer dependent (WD) or writer independent (WI). Usually, the signature verification systems use WI approach, but practically it has some issues like a large number of references. The proposed system is WD which overcomes the drawbacks of WI systems. Here the Support Vector Machine (SVM) classifier is used for training the signature and it requires a lesser number of reference signatures. This system uses Stationary Wavelet Transform (SWT) based Gray level co-occurrence Matrix (GLCM) feature generation method. The verification is based on the SVM training process, and it uses all the information available in the signatures. So the number of reference signature required is very less. The experimental results show that the accuracy and efficiency of the proposed system are much better than the existing methods and the SVM classifier decides either the signature is accepting or rejecting by using a limited number of reference signatures for a large number of writers.***

Keywords: Signature verification, WI, WD, SVM, SWT

1. Introduction

Hand-written Signature verification (HSV) is the main criteria for personal identity authentication. In biometric systems, the HSV is widely used, since it is used as a legal means for personal identity authentication in administrative, financial and institutional purposes. It is also a complex biometric application because of the variations occur in handwriting. The main limitations of the HSV system are the Intra writer variability and the Inter writer variability. Intra writer variability means the variations in the handwriting of a single person and Inter writer variability is the variability in handwriting between writers. The main factor is that the handwriting of each person has unique characteristics, but sometimes it can be same. That is the relevancy of HSV in biometric systems. The HSV is more complex because of the behavioural aspect of handwriting. Two similar signatures do not mean that it is written by the same person and two different signatures do not mean that it is written by two different persons. Also, a person can skillfully reproduce the signature of another person. These are the main factors which make the HSV more complex.

In [1] Assia Hamadene and Youcef Chibani presented a WI system with a lesser number of references. It uses contourlet transform-based directional code co-occurrence matrix feature generation method. Where the verification is based on a unique threshold value estimated through feature dissimilarity measure. The relevance and practical applications of HSV like biometrics are derived in [2]. The variations between and within handwritings and writers are analysed. It is done through three main steps, data collection, feature extraction, and statistical analysis to establish the discriminative power of handwriting. Here the computational and conventional features are extracted and the identification and verification models are used for identifying and verifying the signature [3]. A forensic document examination approach is used for the feature extraction and identification [4]. When compared with online signature verification, the off-line system is difficult to design and it has some limitations. Mainly there are two issues, one is regarding the feature extraction and the other one is about the use of an ensemble of classifiers to reduce the false acceptance [5]. The classification of the signatures mainly based on two aspects, one is based on a threshold value that is called as Nave Bays method (NB) and the other is based on a distance probability distribution which uses Support Vector Machine (SVM) [6]. The number of genuine samples required to train the signature in an offline signature verification system is limited from 4 to 6. The classifiers like Neural Network, Hidden Markov model and Support Vector Machines need a substantial number of samples at the training phase [7]. The writer identification is done by using an information retrieval model [8]. The features like mean, standard deviation, variance and entropy are extracted and the classification is based on these features. The SVM classifier is used to train the signatures and then identifying that the signature is genuine or not. In section 2 describes the system overview and in section 3 the feature generation based on SWT is explained. In section 4, presents the WD offline HSV system using SVM classifier. In section 5 describes the experimental results of the proposed system. In section 6 the comparison of the existing and proposed methods. Finally in section 7 presents the conclusions, applications and future work.

2. System Overview

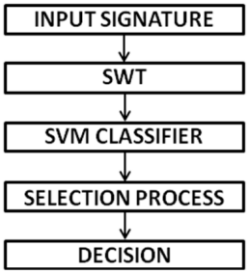

Figure 1: System Overview

The input signature is divided into sub-bands by using SWT. The number of sub-bands is limited to 4 to 6. Then calculating the coefficients of each sub-band and selecting the sub-band with a maximum value of coefficients. The features like entropy, standard deviation, mean and variance of the selected sub-band is extracted and the directional features are extracted by using Gray level co-occurrence matrix (GLCM). Then combining the extracted features into a single matrix and undergoes normalisation. The normalised features are used for classification by using SVM classifier. Which trains the samples with the questioned signature. Then identifying and verifying the signature according to the classifier values after training the image.

3. Feature Generation based on SWT

Feature extraction of the input signature is the main step involved in the WD offline signature verification system using SVM classifier. For that, the input signature is divided into four sub-bands. Then the coefficients of each sub-band are calculated and taking the sum of coefficients.

Figure 2: The four sub-bands

From the four sub-bands selecting one which has the maximum value of coefficients. The features like standard deviation, mean, variance and entropy are extracted and the directional features also extracted by using GLCM. GLCM is the combination of different pixel values in an image or the distribution of the co-occurring pixel values. It is used for a series of texture calculations.

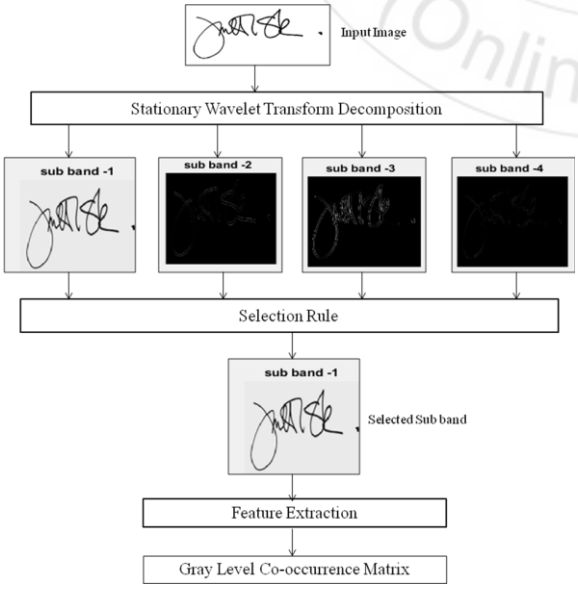

Figure 3: Example of generating the GLCM from SVM classifier

4. Proposed Writer Dependent HSV System Using SVM Classifier

The Writer Dependent HSV system using SVM classifier has performed the verification of signatures by training the input signature with the reference signatures. The HSV systems are mainly two types, Writer Dependent and Writer Independent, and it can be offline or online. This system is an offline system where the verification is done by training the input signature with the reference signatures.

Figure 4 showing the working of the system. Initially extracting the RGB components of the input image and converting it into a Gray level for making the format of input signature same as that of the reference signature. Then the input signature is divided into a number of sub-bands. Here it is divided into four sub-bands, and calculating the coefficients of each sub-band. For selecting one sub-band from these four, calculating the sum of coefficients and selecting the one with a maximum value of coefficient by comparing each other. Then the features of the selected sub-band are extracted, that is the mean, variance, standard deviation and entropy, and the directional features by using GLCM. The feature vector is produced by using these features, and the size of the feature vector should be maximum to reduce the computational complexity. For that the feature vector undergoes normalisation. The normalised feature vector is then trained by using SVM classifier.

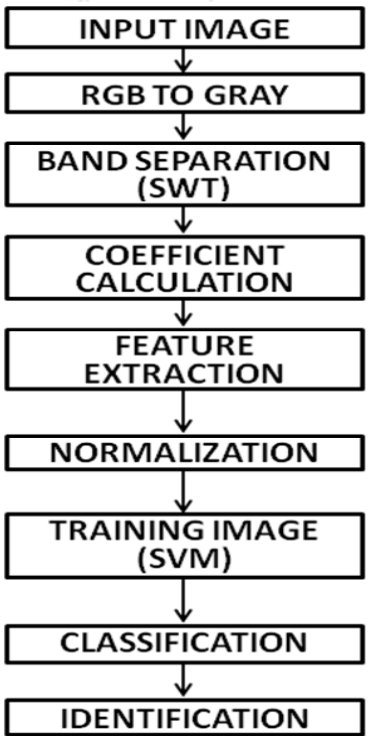

Figure 4: Working of the Offline Writer Dependent HSV System Using SVM Classifier

The SVMs are the supervised learning models with associated learning algorithm, which analyses data used for classification. Here the SVM classifier performs classification after training the image and identifying the signature in accordance with the value get from classification, that is either the signature is recognised or not.

4.1 Stability of the System

The stability of the proposed system is determined by using the False Acceptance Rate (FAR) and the False Rejection Rate. Where FAR is the rate of falsely accepted signatures and the FRR is the rate of falsely rejected signatures even if it is genuine. By using these parameters, calculating the Half Total Error Rate (HTER).

$$HTER = \frac{FRR + FAR}{2}$$

The HTER is used to estimate the stability parameter.

5. Experimental Results

MATLAB R2015b is used as the implementation tool. A signature is given as the input to the system. Where the samples are stored in the database. The number of reference signatures is less compared to the existing systems, and the size of the feature vector is the minimum to reduce the computational complexity.

The input signature is converted from RGB to gray level to combine the format of input signature with the reference signature. Then the input image is divided into sub-bands and the sub-band with a maximum value of the coefficient is selected. The normalisation is done after extracting the features of the sub-band. Figure 5. shows the before and after normalisation values of feature values and number of features.

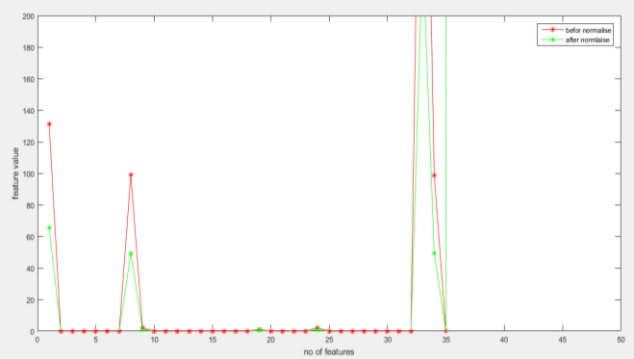

Figure 5: Comparison plot before and after normalisation

6. Comparison

The existing system is the offline HSV system using Feature Dissimilarity Thresholding. It is a Writer Independent system, where the verification based on the threshold value. The proposed system is a Writer Dependent system using SVM classifier for verification.

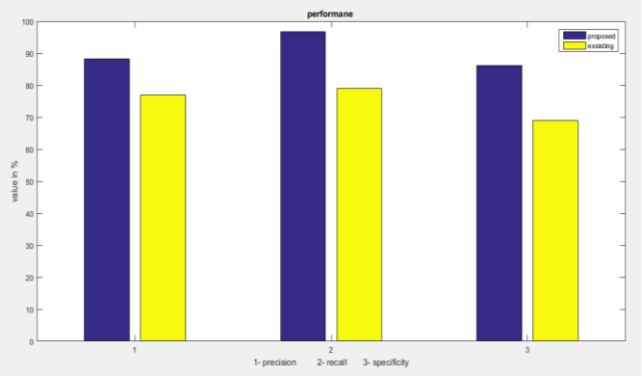

Figure 6: Comparison plot of the existing and proposed system

Figure 6. shows the comparison of these two systems and it is clear from the figure that the proposed system has better characteristics than the existing system and the size of reference signatures is less.

7. Conclusion

From the comparison and the simulation results, it is clear that the HSV system using SVM classifier has better verification result and accuracy than the existing system using Feature Dissimilarity Threshold. The number of reference signatures used is very less compared to the other systems and the system is very simple and efficient. It can be used for so many applications like administration and financial purpose, institutions, etc. Future work is focused on the extraction of more features like pressure and speed of handwriting when writing the signature.

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