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Research paper

A combine approach of preprocessing in integrated signature verification (ISV)

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Abstract

For last few decades, signature verification is an important area of research. Recently, integrated signature verification (ISV) comes in a play, in which dynamic and static both signatures verified for the forgery [2]. In integrated signature verification system, initial start with a data acquisition stage which can be done from both handwritten and with the use of stylus. Then next step is pre-processing of the signature to make the image noise free and easy to extract. Third and most important step that is the feature extraction. In this step we find that images have different types of features such as local, global, geometrical, and statistical and projection. Last and Final step, which is a crucial step on which the whole system depends that is the verification, where the forgery factor has been found in terms of FAR, FRR, EAR to calculate the performance of the system. Many techniques and filters have been already used to remove the noise in the signature verification system. We proposed a system on integrated pre-processing of the signature. While scanning the signature, some noise is added, which gives the blur image for feature extraction. To improve the system performance and fine feature extraction, we develop a system for integrated pre-processing. In addition, current methods used for features extraction and approaches used for verification in signature systems are also presented. In conclusion, we suggest some encouraging ideas to be incorporated in the future.

Keywords: *Signiture verification; Offline signature; Online signature; FAR; FFR.*

1. Introduction

In the past few decades, owing to security concerns, verification of a person has become an essential. Passwords and PIN no. are the simplest technique of the person identification. But the major drawback is that it can be forgotten.Due to significant development in the area of authentication and verification, biometric system has been introduced. Biometric authentication is based on something behavioral and physical traits of human. In Greek words, [1] the term biometric is a bio (life) and metric (to measure). In the physical terms, users have to perform the actionssuch as fingerprint, palm-print, iris, retinabased for his/her authentication. On the other hand, in the behavioral type, data can be collected from speech, keystroke dynamics and handwritten signatures to perform the desired action for the authentication.
Signature verification is a special process of authenticating person based pen moments and pressure on handwritten signatures [5] Signature verification is categorized in two static and dynamic.

a) Dynamic: - which is also known as online signature. Signatures are signed on pressure digitizer that captures the dynamic information of the signature, which are helpful in extract signature's information such as x, y coordinates, time and pressure.
b) Static: - which is also known as offline signature. Signatures are signed with pressure on paper that collect the static information of an image. This information is required to extract the various features from the image like pen up, pen down trajectories etc.

Now days, most researchers focus on the on-line signature verification because it gives better accuracy results. In our work we present the integrated signature pre-processing system based on both offline and online signature. The major challenge in our work is to find out the filter to remove the noise from the signature at the pre-processing stage. It is an initial stage of signature verification and which affects the normalization steps and overall system performance. This integrated system improves the system performance by 10% with regards to the initial stage, we verify the incorporation of pen-ups, pen downs duration increases the verification. The advantage of our system is: accepted by society, it is user-friendly, non-invasive, acquisition hardware for both online and offline has become ubiquitous which is inexpensive finally, a signature can be easily changed whenever required. The existing work of the system was assessed on either offline or on onlinesignatures [5], where the single approach is used for noise removal. But the proposed work refers shortlyas offline and online verification.

1.1. Types of noises in signature

Different type of noises enters in the signature and so many filters are available to reduce. Some of them are described below:

2. Salt pepper noise

It is an impulse type of noise which is entered in the signature image while transmitting. It is also called as the data transmission error. [10] In another words (in the sense of pixels), salt and pepper noise means that are high frequencies, so for salt noise the values of this noise type is high (255 ... 200), and for the pepper

noise the values of this noise type is low (5 ... 0). Median filter is the best filter to remove this noise from the image.
The probability density function (PDF) of salt and pepper noise is: [8].

$$P(k) = \begin{cases} p_a \text{ for } k=a \\ p_b \text{ for } k = b \\ \text{otherwise } 0 \end{cases} \quad (1)$$

In eq. (1) where p (k) is the densities,
a and b are the non-negative Lebesgue-integral function.
If, b>a, gray-level b appears as a light dot in the image. Else a appears as light dot.
If either p_a or p_b is 0, the impulse noise is called unipolar.
If, the probability is equal to zero, than impulse noise values look similar to Salt and Pepper particle randomly distributed over the signature image. Due to this reason, impulse noise is also called Salt and Pepper (Shot and Spike) noise.

3. Gaussian noise

This uneven noise is distributed over signal. Every pixel in the noisy image is the addition of the correct pixel value and a random Gaussian distributed noise value. [14] When the signature is collected from different source then the Gaussian noise is added to the image. For example sensor noise caused by poor illumination or high temperature or transmission.
Gaussian noise has a form: [25]

$$p(z) = \frac{1}{\sqrt{2\pi}\sigma} e^{-(z-\mu)^2/2\sigma^2} \quad (2)$$

Above described noises are most commonly found in the signature image.To reduce the above noise various filters are already being used. [11]

a) Linear filters: Remove noise by convolving the original image with a mask that represents a low-pass filter or smoothing operation. These filters work perfectly but do not prevent the details of the signature images.
b) Non-linear filters: it produces the non linear output and main point is it preservers the details of the signature which are helpful at the time of extraction. , which are further classifieds into different categories.

Here we show some previously used filter to remove the noise. Different authors used different filters in pre processing.

Author	Signature	Noise	Type of filter
Simon Teo(2005)	Online	Salt &pepper, Gaussian and marginal	Low pass median filter
Deepti (2007)	Online and offline	Spurious pixel, and signal noise	Mean and median filters
TansinJahan (2015)	Offline	Luminance and color	Adaptive filtering
Basheer Mohamad Al-Maqaleh (2016) [22]	Offline	Median Noise	Gaussian filters, Average filter
Proposed	Offline and offline	Salt pepper Gaussian and signal	Modified filter

The above table concluded that while pre-processing in signature verification, different filters have been already used to remove the noisesin online and offline signature separately. But if we develop an integrated pre-processing system, it saves time and cost of the verification process. We proposed an integrated system which has modified filter that is used for both offline and online signature.

2.1. Offline pre-processing techniques

An original image cannot be used directly for the feature extraction. The hand written signature might have certain noise, while signing a document.The following pre-processing techniques are given below:

1) Conversion: firstly image is converted into gray to binary image in order makes readable form.
2) Thinning:Morphological operations can be used for thinning of signature. The objective of thinning is to remove the thickness differences of pen and makes the signature one pixel thick.
3) Normalization: this helps in reducing the unwanted fluctuations from the signature. After normalization, all signature images have the same dimensions as in size, time and duration. [25]

a) Size: signatures are presented on three components; horizontal, vertical, and pen pressure.

$$Z(tn)' = \frac{zt_n - z_{min}}{z_{max} - z_{min}}, \quad (3)$$

$$(Z = x, y, p)$$

Nis the total number pen point position of signature.

b) Location: where the center point of image calculated from
c) Trajectory of barycenter: barycenter is used to reduce the unwanted variation of signatures motion. Trajectory of barycenter calculated from the center point of the signature and two adjacent pen point positions.

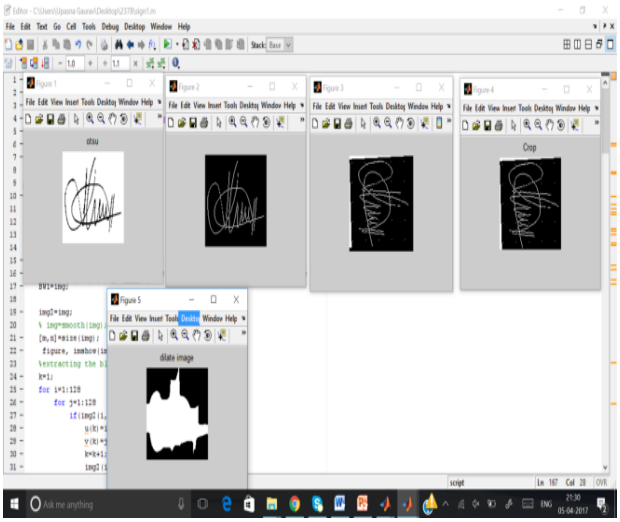

Fig. 1: Offline Signature Pre-Processed.

1) Noise removal: to eliminate the noise from the signature. A different type of noises different techniques has been used.
2) Smoothing: The image is exposed for the feature extraction. Smoothing is used to perform the removal of noises like Gaussian and other additional noise from the signature, to make the image clearer for extraction.
3) Binarization: is the conversion of this grayscale image into the back and white luminance elements.

Offline Dataset: 10 users signatures out of which 20 genuine and 20 forged. Remove noise from offline signatures are more challenging task.

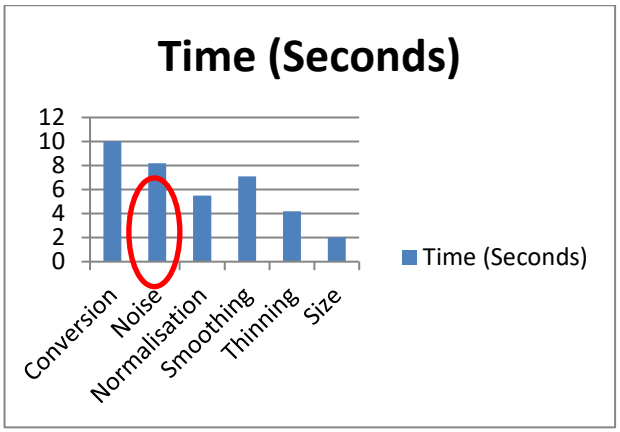

Fig. 2: Graphical Representation of Pre-Processing of Offline Signature.

Above figure depicts the techniques for offline pre-processing. And we found that,it takes approx. 10 sec to reduce the noise using a mean filter which is more than the rest of other factors of the signature.

2.2. Online pre-processing techniques:

Signatures have been taken using digitizer at that time, noise enters with the signature. Online noise is different from offline noise. Some online pre-processing techniques for the signature image described below:

1) Rotation: rotate a signature in clockwise and anticlockwise direction to compute every angle of that image. Fig: 1 shows the sample image of rotation at an angle of +60 degrees.

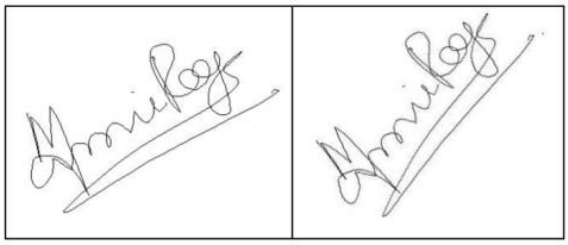

Fig. 3: Rotation of Signature.

2) Translation: some users have small signature, some have very large, it is difficult to capture the edge points of all the signatures. To avoid this problem, translation of signature image comes, in which image is cropped to remove the additional background from an image. In other words trim the background canvas.

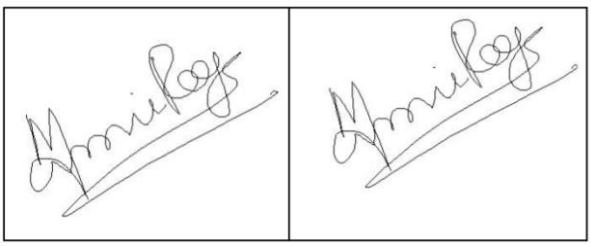

Fig. 4: Translated Image 40px by X Axis and 10px By Y Axis.

3) Scaling: in this the signature image is scaled according to the height and width. In other terms, images are resized as per the defined size. Scaling ration is calculated:

Scaling Ratio: Size of reference signature
Size of tested signature

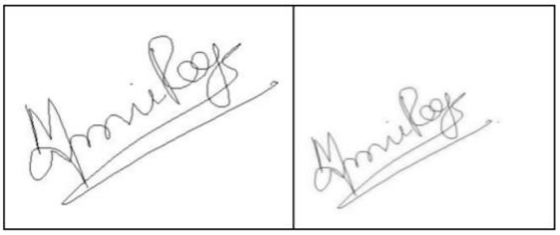

Fig. 5: Scale Down Signature.

4) Noise removal: to eliminate the noise from the signature. A different type of noises present in the signature image. And different types of filters have been used.

From the previous research and the above defined parameters of pre-processing, it is clear that noise is only parameters which is available in both signatures weather the dynamic or static. This step makes the image clear to read and also enhance the some features from the image to be extract. One important point is it makes the signature similar as per their height, width, angle and other areas also.

Online Dataset:

As we all know that online signatures have less error rate as compared to the offline signatures. We found that online signatures also have some noise which is responsible for the error rate. In the graph, it is clearly shown that due to the presence of noise in the signature, there is an increase in time for the pre-processing.

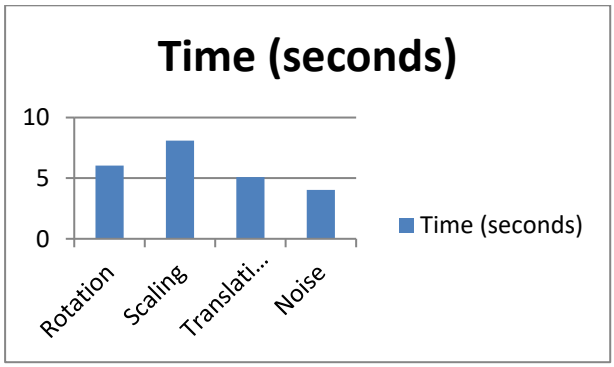

Fig. 6: Graphical Representation of Pre-Processing of Online Signature.

In above fig. time taken to reduce noise using Gaussian filter is approx. 4 sec.

4. Prior work

Signature verification is a well-researched area where many researchers have already studied. Verification system based on feature selection and their decision methods. There are more than 100 features present in the signature image, which can be extracteda local as well as global features.

Aman Chadha et.al (2011) [21] presented their work on the RST i.e rotational, scaling, translation in the online signature verification system. They found that large variations in the Rotation-Scaling, Translation (RST). S. Kaisar et.al (2008) [11] proposed their paper on Tolerance based Arithmetic Mean Filtering Technique to remove salt and pepper noise from the forged signature image. Two new features added to the existing Arithmetic Mean filtering technique. The proposed technique provides much improved results than the existing filtering techniques of mean and median. The value of Peak Signal to Noise Ratio (PSNR) is much higher as compared the existing mean filtering techniques.B.Schafer et.al (2009) [20] described combination of feature extraction and obtained a satisfactory measure of similarity. They achieved success rate of approx. 84.1% using the local threshold.S. Zafar et.al (2009) described a novel method for signature verification. Certain features were combined to develop a verification function for the authentication of signatures. Therefore, a preprocessor was used to remove noise. Elaheh et.al 2010

[15] proposed method for identification and verification of offline signature using Support vector machine and contourlet transform. They achieved 4.5% of error in Persian and Turkish signature set. A. Farahmand et.al (2013) [10] showed that the document images may be impure with the noise present during transmission, scanning or conversion to digital form. They categorized all the noises which were present in the image, by identifying their features and also search appropriate methods for noise removal. The paper reviewed noises that pierced in scanned document images and discusses some noise filtering techniques to removal. Md.T.Jahan et.al (2015) [6] proposed pre-processing in offline handwritten signature verification process. They found that, if a signature was pre-processed appropriately, it leads to a better result for both signature verification/ matching and reduces the forgery factor. They proposed analgorithm to accurate the alignment of the raw signature which can be used at the pre-processingstage to achieve better results in the signature verification process. Nan Li et.al (2016) [27] described an authentication of signatures on mobile device. They collected coordinates, pressure, contact area and other biometric data on touch screen smart phone. The experimental result on 42 persons' dataset shows that four algorithms have satisfactory performance on Chinese signature verification, and Adaboost has obtained error rate of 2.375%. P. Dhayarkar et.al (2017) [26] proposed system to increase the security in banking environment using offline signature verification. Various methods are used for classification such as HMM, SVM, NN. In the system, support vector machine and hamming distance measurement are used for signature verification.

It is concluded that researchers used different algorithms and techniques for pre-processing the signature image. For noise removal, low pass filter, media filters and adaptive filters are mainly used.

5. Proposed work

The proposed system has two types of signature (Online and Offline) from different users; all have to be preprocessed before move to the feature extraction stage.

Integrated Pre Processing:

Noise depends on the mean and median value of pixel stored. It can be cleared using connected component analysis by choosing the variable threshold T. In our integrated system, value of T selected for offline and online signature. In pre-processing following steps have to follow:-

Our Proposed algorithm:

I-Set of signatures, b- binary image, n-normalized image, E-Edges if an image

Step 1: An input dataset (offline & Online) of real time signatures where, I > 0

Step 2: Conversion of input signature I (gray scale image) into binary image, I_b

Step 3: Apply morphological operation on I_b

If I_b<0, then go to step 1

Step 4: normalized the image I_b converts to I_n where I_n is an normalized image

Step 5: to remove noise from signature;

Apply Improved Canny Detection Gaussian algorithm using Sobel filter: Shokhan (2014) [23], [24]

Step 6:

i). Binary image I_b of edges (E).

ii). A (1, 2…sb) ←sub-images of Ib;

iii). For Ib =1: sb

Do

S ← S+A (i);

iv). Threshold ← S, M (i) ← mean a (i);

v). σ ← f(M(i),S);

vi). C (i) ← Canny (A (i), σ, threshold);

E← reconstruction{C (1), C (2)... C(S)};

Step 7: Calculate the Mean square error (MSE) from I_b to calculate the performance.

Step 8: last convert image I_b to image I.

Flow Chart: below fig: 7 describes the flow chart of proposed algorithm

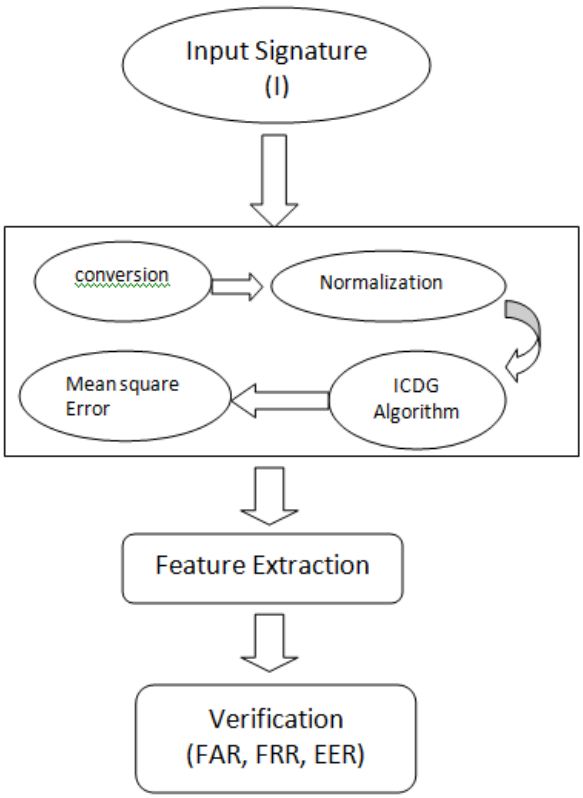

Fig. 7: Flow Chart of Proposed Algorithm.

From below representation, it is clear that Modified filter lowers the noise factor from the signature. Integrated pre-processing reduces the total time taken to extract the 7 seven factors. Previously time taken for pre-processing of offline and online signatures is more than 1 min. From our modified filter, it reduces to less than 30 seconds.

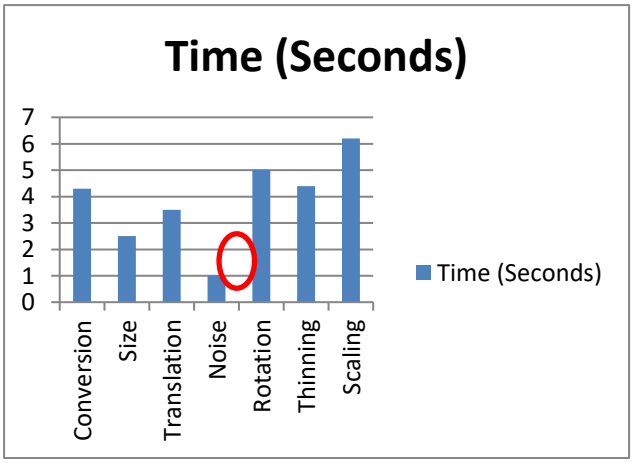

Fig. 8: Graphical Representation of Pre Processing of Integrated Signature Verification.

6. Conclusion

This research paper shows the work on integrated pre-processing in signature verification system. An algorithm is designed for linear and non-linear noises which are present in offline and online signatures. Improved canny edge detection algorithm filtered the noise from signature and also reduce the time taken to verify the

original signature. The value of FAR, FRR, EER will also decrease by 2% and makes our system reliable and robust. In conclusion, we suggest some encouraging ideas to be incorporated in the future.

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