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AN IMPROVED SIDE VIEW FACE AUTHENTICATION USING WAVELETS AND NEURAL NETWORKS

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ABSTRACT
This paper proposes a side-view face authentication method based on Discrete Wavelet Transform (DWT) and Neural Networks. A subset selection method that increases the number of training samples and permits subsets to preserve the global information is presented. The authentication method can be summarized to have the following steps: profile extraction, wavelet decomposition, subset splitting and Neural Network verification. This method takes the advantage of wavelet's localization property in both frequency and spatial domains, while maintaining the generalized properties of Neural Network.

I. INTRODUCTION
Biometric identification procedure is focused around the principle physical trademark that fits itself to biometric identification. Face Recognition is a paramount feature keeping in mind the end goal to defeat the issues of today's reality. It is pertinent to a few true applications like observation, verification human/machine interface and video surveillance.

Facial recognition catches the facial qualities of one's face wherein the attributes incorporate the position of the eye socket and the separations of the principle bones and features of a face. Of the different biometric distinguishing proof routines, face recognition is a standout amongst the most adaptable, working actually when the subject is unconscious of being checked.

However research level in this field is still adolescent. Face Recognition vigorously relies on upon the specific decision of features concentrated by the classifier. Typically begins with to determine an ideal subset of features under some particular criteria from a given set of features and after that endeavours to prompt high characterization execution with the desire that give comparable execution that can likewise be gotten on future trials utilizing novel and unseen test information.

The earliest works on this subject were made in the 1950's in psychology [1]. They came attached to other issues like interpretation of faces, emotions or perception of face gestures.

Engineers started to show interest in face recognition in the 1960's. One of the first researches on this subject was Woodrow W. Bledsoe. In 1960, Bledsoe, along other researches, started Panoramic Research in Palo Alto, California. During 1964 and 1965, Bledsoe, along with Charles Bisson and Helen Chan, worked to recognize human faces on using computers [2]. Because the funding of these researches was provided by an unnamed intelligence agency, little of the work was published. He continued his researches later at Stanford Research Institute [2]. Bledsoe designed and implemented a semi-automatic system. He described most of the problems that even 50 years later Face Recognition still suffers; variations in head rotation, illumination, facial expression and facial aging. Researches continues there research, trying to measure subjective face features such as ear size or distance between eye and ear. In 1973, Fischler and Elschanger tried to measure similar features automatically [3]. Their algorithm used local template matching and a global measure of fit to find and measure facial features.

The aim of this paper is to implement a side-view face authentication method based on discrete wavelet transform and Neural Network classifier.

II. SIDE VIEW FACE RECOGNITION
The flow diagram of the proposed methodology is demonstrated in figure 1.

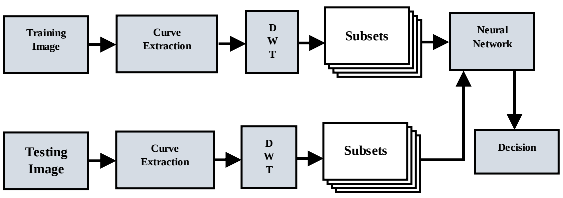

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Figure 1: Flow diagram of the proposed approach

A head unit which often makes use of just a couple of examples intended for training can be planned to people that involve a lot of people. Because with this rationality, the suggested technique can be developed.

The outline curve from the side-view face can be initially taken out. At that point discrete wavelet transform (DWT) can be connected to break the curve. At that point the wavelet coefficients tend to be element right few subsets where Neural Network models tend to be developed. The actual subsets which manipulate the coarse-to-fine composition involving DWT enable us all to cope with the matter involving limited training samples. The actual examining images feel the same system plus the option is manufactured through the Neural Network model which has been prepared off-line before the use.

Curve Extraction

The structure with the deal with face profile needs to be centred regarding even more assessment. From the start, diagnosis connected with is carried out towards profile images. We choose the Sobel edge detector for the process considering that the technique of hysteresis thresholding with the identifier is exceedingly suited to recognizing image structure although ignoring the actual uninterested edges in the particular images. Following edge can be discovered, profile arrangement will be done. The essential regarded the actual tactic can be that the nose tip could be the majority of regular and also easily become fiducial point with people face profile regarding affirmation as well as acceptance. If the nose tip is available, some sort of line may be driven on the nose tip towards lower-jaw in ways that the line can be digression towards mouth, as mentioned in figure 2.

Figure 2: Curve extraction and alignment

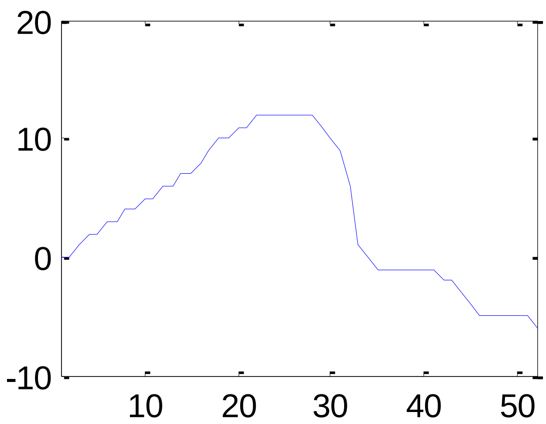

Figure 3: Converting curve to vector representation

In this process, the many curves taken out of profile images usually are initially revolved counter clockwise by means of taking the person faces right. If the person faces left simply horizontally flip the image before the rotation. Then the profile is mapped to the complex plane for functional illustration. Demonstrating the curves by means of unstable quantities makes it possible for people transforming the full necessities advantageously by means of improving the many targets your necessities by a complex amount, which represents the rotation. The particular rotation arrangement is carried out so that line interfacing the forehead and chin points is the real

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axis, the center point of the line is the new origin, and the line uniting the nose tip to the origin is the imaginary axis. The curve profile from the temple to the jaw is utilized as a part of the later process as the side-perspective face curve. After the pivot, the curve ought to be standardized to a consistent length, and afterward be mapped again to real numbers.

DWT based Feature representation

Discrete wavelet transform (DWT) is applied to the signal, which can be described by the following equation:

$$x(t) = \sum_{n=-\infty}^{\infty} C_{0,n}\varphi_{0,n}(t) + \sum_{k=0}^{\infty}\sum_{n=-\infty}^{\infty} d_{k,n}\psi_{k,n}(t)$$

(1)

Here in our application, $x(t)$ represents the profile, $\psi_{k,n}(t)$ represents the family of wavelets obtained by shifting, which is represented by n, and stretching, which is represented by k. The relationship between $\psi_{k,n}(t)$ and the "mother wavelet" $\psi(t) \in \mathcal{L}_2$ can be described as follows:

$\psi_{k,n}(t) = 2^{-\frac{k}{2}}\psi(2^{-k}t - n), \quad k, n \in Z$ (2)

In (1) and (2), $C_{0,n}$ and $d_{k,n}$ represent the wavelet coefficients of approximate and detail description of the signal, respectively which can be expressed as:

$$C_{0,n} \le \varphi_{0,n}(t), x(t) \ge \int_{-\infty}^{\infty} \varphi_{0,n}(t), x(t)dt,$$

$d_{k,n} \le \psi_{k,n}(t), x(t) \ge \int_{-\infty}^{\infty} \psi_{k,n}^{*}(t), x(t)dt$ (3)

The set of wavelets with $n \in Z$ at some fixed scale k describes a particular level of "detail" in the profile curve. The wavelets describe more "detailed" information as k becomes smaller. The DWT thus can produce a multi-resolution description of a profile curve. The proposed approach takes the advantage of such property.

The benefits of symbolizing this user profile by means of wavelet coefficients are the following: a. we can easily stand for this profile by a significantly smaller variety of data; b. this wavelet has localization capability inside both frequency along with spatial domains as the conventional frequency representation employing Fourier transform can easily simply always be correct in single domain, although advances within the different. The particular time-frequency localized property entitles this wavelet coefficients to be able to localize this profile necessities within the spatial domain making sure that we all know which in turn coefficient symbolizes which in turn perhaps the profile necessities. This kind of localization capability may enable all of us to pick out this applicable subsets in a very much more logical means when compared with employing different transformation techniques.

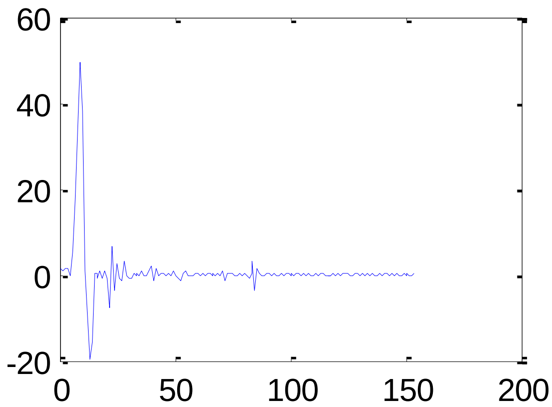

Figure 4: Wavelet coefficients of one profile curve

Figure 4 indicates the actual wavelet coefficients of a particular person in our database. We have utilized Daubechies some (D4) wavelet intended for DWT. Each profile curve will be decomposed in addition to displayed by means of 154 wavelet coefficients, that the first age 14 coefficients are in the actual estimated amount, and then some details degrees having age 14, 23, 37 in addition to 67 coefficients, respectively.

Subsets Selection and Evaluation Using Neural Network

Using different wavelet levels, we construct the coefficient subsets for each sample as follows:

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$Subset\ 1: approximate$
$Subset\ 2: approximate + detail\ 1$
$Subset\ 3: approximate + detail\ 1 + detail\ 2$
$\ldots\ldots. \quad \ldots\ldots.. \quad \ldots\ldots....$
$Subset\ M: approximate + detail\ 1 + detail\ 2 + \cdots \ldots\ldots. detail\ (M-1)$ (4)

There are M subsets for each one sample and M is dictated by the length of the profile curves and what number of levels the wavelet change is performed and utilized. Here in our methodology M equivalents to 4. Inside the previously mentioned approximation which signifies the particular coarsest level of a wavelet decomposition of a curve in the image, while detail M shows diverse levels of points of interest. As the value of M increases, more points of interest are added to a subset, which delivers a higher determination representation of the side-view. In every subset we utilize the same coarser level coefficients from the past subsets.

Figure 5 represents how we split each sample into subsets and train their corresponding outputs.

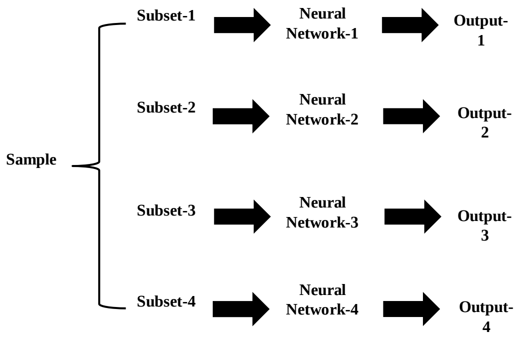

Figure 5: Subsets splitting

In the middle of the training process, a set of wavelet coefficients of each one training profile will be given. They will be part into four subsets portrayed prior. A Neural Network which comprises of numerous multiple outputs develops for every subset. The number of outputs in each Neural Network can be different and is selected case by case. Typically the more outputs are used, the better results as well as longer training and testing time are expected. So there is a trade-off between performance and computational efficiency. Once the increasing of the number of outputs results in little or no increasing of better performance, Neural Network outputs are considered sufficient.

In the middle the testing methodology, we perform precisely the same operation to the testing example: separate the side face curve, figure out the wavelet coefficients by DWT, split the coefficient vector into four subsets by the same measures depicted above, and place them into the relating Neural Network. In each Neural Network, the corresponding output will cast a vote to the result label. At long last, a choice is made by gathering and summing up the votes threw casted by each output in each Neural Network. The result will be utilized for the final decision making on authentication.

Neural Networks Architecture

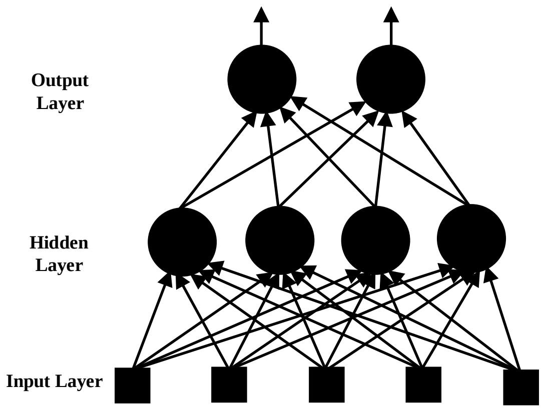

Figure 6: An example of a simple feed forward network

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Feed-forward ANNs (Figure 6) as the name implies allow signals to travel in one way only; from input to output layer. There is no feedback loops or recurrent loops i.e. the output of any layer will not affect that output of the same layer. Feed-forward ANNs is also tend to be a straight forward networks that is associated with inputs outputs. They are highly used in pattern recognition and classification. Figure 6 depicts the functionality of feed forward neural network.

III. SIMULATION AND RESULTS

Figure 7: Test image-1, Face with nose-tip, chin and forehead

Figure 8: Extracted Face Edge for test image-1

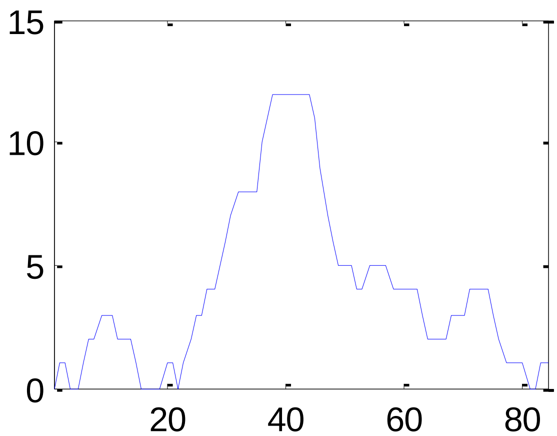

Figure 9: Face profile for test image -1

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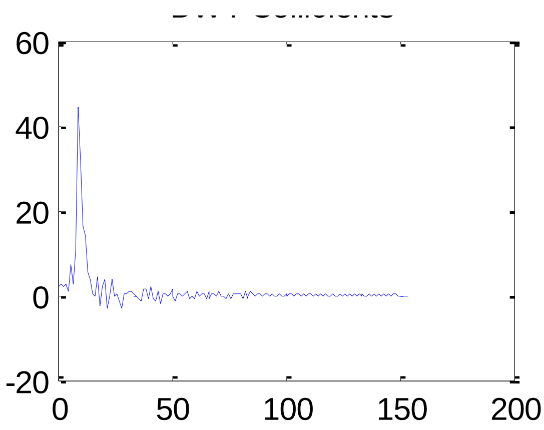

Figure 10: DWT coefficients for test image -1

Since, the length of face profile is 128, so here we have applied the DWT of the length of 128 using DB4 wavelets. If the length of face profile is less than 128 then the frequency domain interpolation is used to make it 128. Figure 10 shows the DWT coefficients for the test image-1. Then the Neural Network classifier is trained on the basis of DWT coefficients. Same process is continued for another test image as shown in the following figures:

Figure 11: Test image-2, Face with nose-tip, chin and forehead

Figure 12: Extracted Face Edge for test image-2

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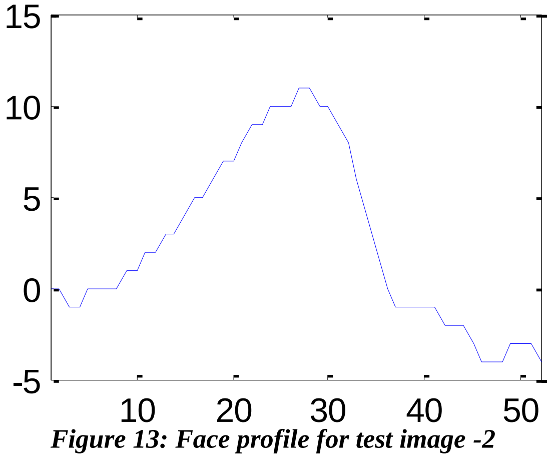

Figure 13: Face profile for test image -2

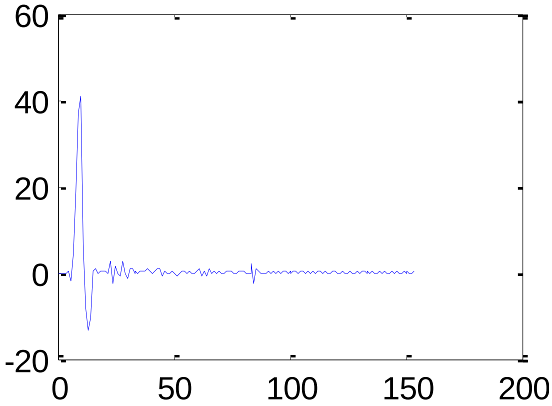

Figure 14: DWT coefficients for test image -2

Figure 14 shows the DWT coefficients for the test image-2. Then the Neural Network classifier is trained on the basis of DWT coefficients.

IV. CONCLUSION

This research work proposes a novel side-view based face authentication technique using DWT and Neural Network. The side-view face contours are first extracted from the profile image. After that we apply DWT to the extracted features. Then we use the corresponding wavelet coefficients as the feature vector for each face. For effective authentication by Neural Network, we split the vector into several subsets each of which contains some global information which is represented by the coarsest wavelet coefficients plus some finer and local information of the face. In composing the subsets, the coefficients at the coarser level are given higher weights. Then Neural Network is applied to the subsets. In the experiment, the proposed method reached the highest accuracy of 96%.

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