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MULTIMODAL BIOMETRIC SYSTEM BASED ON FUZZY LOGIC AND GENETIC ALGORITHM

N. Jeevitha, K. Krishneswari and A. Swathi
Department of Computer Science and Engineering, College of Engineering, Coimbatore, Tamilnadu, India
E-Mail: Jeevitha.in@gmail.com

ABSTRACT

In this paper a novel technique for multimodal biometric system based on fingerprint and palm print is proposed. The proposed system combines features of palm print and fingerprint using an appropriate fusion scheme. In order to avoid redundant as well as irrelevant features, it is necessary to select an optimal subset of features from a larger set. The main issue of choosing a suitable feature set is to achieve high recognition rate. The proposed system employs genetic algorithm to select discriminating features which provides more robust solution. The similarities between the templates are identified by Euclidian distance. The performance of the system was evaluated using a publicly available dataset. The result obtained has shown significant improvement in the recognition rate.

Keywords: multimodal biometrics, fusion, fingerprint, palm print, fuzzy logic.

INTRODUCTION

Biometric is used to acknowledge a person and it is derived from a Greek word Biometric. The word bio and metric together derive a meaning as life measurements, which are taken from the individual person then examined and stored in the database to confirm the authenticity of a person. Biometric system can be classified as multi sensor, multi algorithm, multi instance, multi sample and multimodal [1]. Multi sensor biometric system fuses multi spectral images captured at different resolution and by different biometric sensors to acquire richer and complementary information to produce new fused image. Multi algorithmic systems apply different algorithms on a same biometric trait to improve the matching performance and multi instance system uses multiple instance of a same body trait. In multi sample system multiple samples of the same biometric trait is captured with the help of single sensor to provide the complete representation of underlying trait.

The proposed system relies on multimodal biometric using the fingerprint and palm print. It surmounts some of the limitations of unimodal biometric system. Multiple modalities of a same person are taken for identification. Identification or verification of a person in multimodal biometric system is handled by his or her physiological (retina, fingerprint, palm print, palm vein, ear, facial theorem, etc…) or behavioral (gait, signature, keystroke dynamics, etc…) traits. In this paper, a multimodal biometric system relies on palm print and fingerprint features for recognition is proposed. The fingerprint is used for identification and authentication over a long period of time because of its uniqueness and non contradictory nature. A mark made by a pressure of friction ridges present in the finger is called as fingerprint. It is unequal, detailed, and arduous to modify. Three levels of features are present in fingerprint [2]. Figure-1 shows the features present in fingerprint. Level one has ridge flow and pattern of skin, level two has ridge path and minutiae, level three has dimensional edge shape and pore details. First and second level features are mainly used to construct biometric system. Third level feature is effectively used for liveness detection technique. The palm print contains more distinctive features than fingerprint. It contains lines with some specific pattern and surface with some unique pattern which can be captures using a low level resolution device. Figure-2 shows the features present in palm print.

Figure-1. Features present in fingerprint.

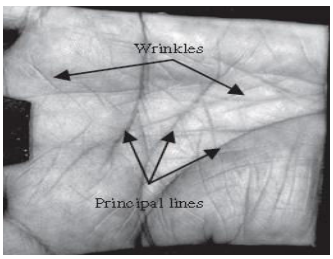

Figure-2. Features present in fingerprint.

RELATED WORK

Multimodal biometrics based recognition having large scope in different areas and it is more popular. Yong Jian, *et al* [3] proposed a recognition system based on fingerprint and palm print. They enhanced the multimodal image using Short Time Fourier Transform and Gaussian low pass filter then 2D Gabor filter was used to extract the features. LL subband images are achieved through wavelet transform based decomposition to reduce the computational complexity. Normalization is applied on filtered images and feature level fusion is applied where the results showed were achieved an equal error rate of 0.91%. Anil K.Jain and Meltem Demi Kus [4] proposed a palm print matching system by extracting features of palm print. The proposed system used Gabor filters and Active contour Model to match a full or latent input image to a full palm print database. The Experimental results showed a matching accuracy of 98.9% at an FAR or 0.01% for full to full palm print matching

Maneesh kumar Sharma [2] proposed a system which combines fingerprint, face and iris. The proposed system used third level features of fingerprint to prevent the attacks. The proposed mechanism applies Mexican hat wavelet transform to the original image, to obtain a pore position. It enhanced the ridges and pores using Gabor filter with linear addition of wavelet applied image and ridge enhanced image. Pores were extracted by applying thresholding. The experimental results obtained the improvement of performance in 20% as compared to level two and level one features with Equal Error Rate of 4.9%. Nagesh, *et al* [5] used palm print and face features to increase the authentication and robustness of system. Both the features of palm print and face vectors created independently from query measures. The final authentication was made by fusion at matching score level architecture. The experimental results showed that the multimodal system yields accuracy more than 98%.

MATERIALS AND METHODS

In this paper it is proposed to fuse palm print and fingerprint features. The proposed system involves Registration and confirmation phase. Each phase has preprocessing, feature extraction, feature fusion and selection stages as depicted in Figure-3. Fingerprint and palm print preprocessing can significantly increase the quality of input images and improve result in later processing stages. Image details are intensified or reduced by different filter operations which lead to easier and faster evaluation. The proposed system uses the median filter to reduce noise in the image and preserves the step edges. Median filter is a non linear digital filtering technique it consider each pixel in the image in turn and looks at its neighbor (window) to decide whether or not it is representative of its surroundings. Median of neighborhood pixel is calculated by sorting all the pixel values of it. The pixel value is replaced with the median of neighboring pixel value instead of taking mean. Below equation shows the function of median filter.

$$\text{med}\{I, Z\} = \text{median}\{I(Q)\}$$
$$Q \in \text{supp}(Z + P)$$

I- monochrome (1-band) image and Z define a neighborhood of arbitrary shape of each pixel location, P = (*r*,*c*), in I. The ouput value at p is L(m) where m=(n/2)+1.

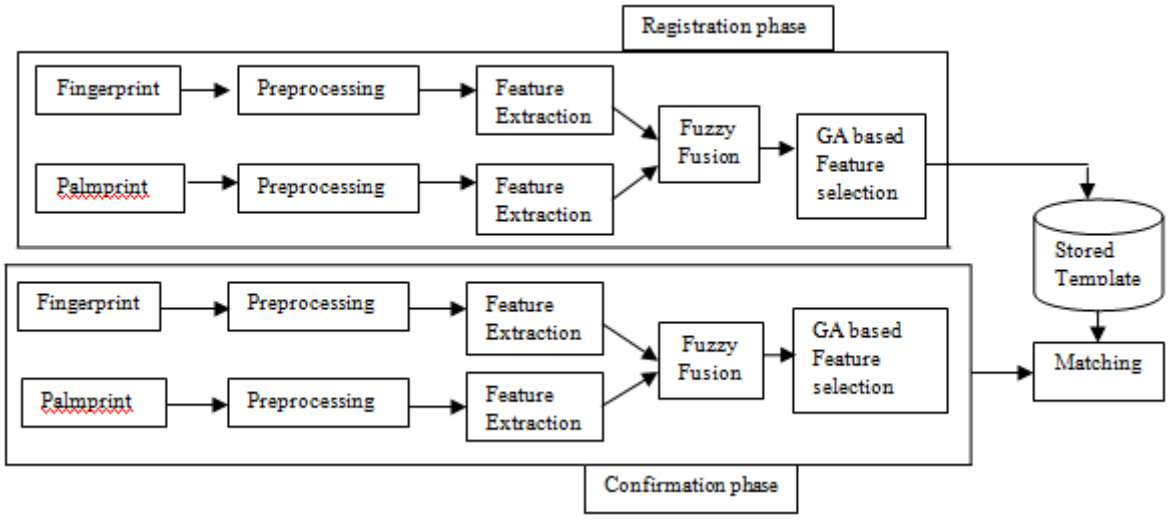

Figure-3. Architecture of the proposed system.

Features from the filtered images are extracted through 2D Gabor filter which are extensively used for feature extraction. Gabor filters are tunable band pass, multi-scale and multi-resolution filter that have selectivity for orientation, spectral bandwidth and spatial extent. They have responses similar to that of the human visual cortex

(first few layers of brain cells) thereby, satisfying even the lower most bound of the time-spectrum resolution. Because of this good spatial and frequency localization, Gabor filters are extensively used for texture segmentation. The impulse response of the Gabor filter is defined by a harmonic function multiplied by a Gaussian function. It is mathematically given by the equation

$$G(x, y) = g(x; y)* \exp(2\pi if(x \cos(\theta) + y \sin(\theta))$$

Where

$$g(x; y)=(1/2\pi\sigma^2)(\exp(-(x^2+y^2)/2\sigma^2)$$

In the equation the parameter f and θ represent the frequency and the orientation of the sinusoidal signal respectively and g(x, y) is the Gaussian function with scale parameter σ. The f, θ and σ constitute the parameter space of Gabor filters where a large value of f results in spurious creases and smaller values unite two nearby creases. Large values of σ result in the smoothing of lines and creases but better suppression of background noise. On the other hand, smaller values of σ are prone to background noise and generated spurious lines. The Gabor filter used in this work has four five scales (σ = {2; 4; 8; 16; 32}) and six orientations (θ=0º; 30º; 60º; 90º; 120º; 150º; 180º). The output is shown in the below Figure.

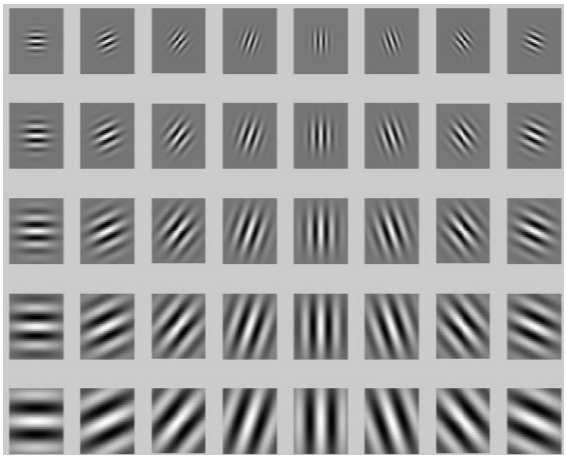

Figure-4. Real part of Gabor features.

These selected features are fused using fusion module that combines the feature set extracted through gabor. The proposed system uses fuzzy logic based fusion. Figure-5 shows the architeture of fuzzy logic. [8] It has three steps fuzzification, applying fuzzy rules, and defuzzification. Different types (Boolean logic, Grade, Triangular, Reverse grade magnitude, Trapezoidal, nonlinear) of membership functions are available, these functions are used to mapping the crisp input into predefined fuzzy sets. At the second step it combines the input in some logical manner using set of rules to produce degree of membership of fuzzy set. In this work the sugeno is applied. Defuzzification is the process of converting results from fuzzy rules to get a number as output.

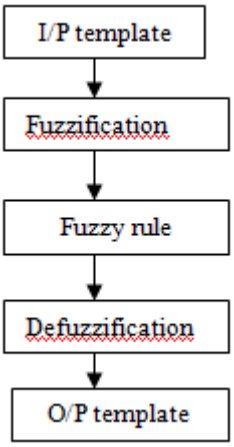

Figure-5. Architecture diagram of fuzzy logic.

Fused template may contain irrelevant features which can decrease the percentage of idetification or verification of a person. From this fused templates discriminating features are selected by genetic algorithm, it is evolutionary and population based optimization technique.It is iterative procedure that creates new population from solution candidates through genetic functions such as crossover and mutation. [7] Genetic algorithm begins with a set of initial solutions called as population. Solution from one population are taken and used to form a new population which is better than old one. Best fittest solutions are selected to form new solution. It is continued untill some desired population is achieved. The genetic algorithm, in population of n individuals, with fitness f, the selection function is a probability function given as

$$P_s(x_i) = \frac{f(x_i)}{\sum_{k=1}^{n} f(x_i)}$$

On population $\{x_1,\ldots\ldots,x_n\}$

In order to identify a person as a real or imposter, matching is performed in the confirmation phase between stored and extracted template. In the Proposed system uses matching based on Euclidian distance. It is a weight function which calculates the distance between the points (x1, y1) and (x2, y2), it is depicted in the below equation.

$$\sqrt{(x1 - x2)^2 + (y1 - y2)^2} = C$$

The templates are matched and the decision is made based on the threshold.

RESULT AND DISCUSSIONS

The proposed system is validated on the palm print and fingerprint obtained from CASIA and FVC 2002 DB4B dataset. The palm print and fingerprint of 10 users with 5 samples each were taken for verification. The sample image is shown in Figure-6.

Figure-6. Sample palm print and finger print image.

The obtained images were filtered for noise removal using median filter and the region of interest is extracted. The extracted Gabor features are fused using fuzzy based fusion method. The genetic algorithm is employed for feature selection and the parameters used in GA are shown in Table-1. It iteratively updates a population of individuals and in each iteration the individuals are evaluated using fitness function.

Table-1. Factors used in GA.

Factor	Value
Population size	40
No. of generations	20
Encoder mechanism	Binary
Cross over	Two point cross over
Cross over probability	0.8
Mutation	Uniform mutation
Mutation probability	0.01
Selection type	Rank selection

A new generation is obtained by selecting a best individual from the current generation. The poorly performing individuals die out, as in "survival of the fittest".

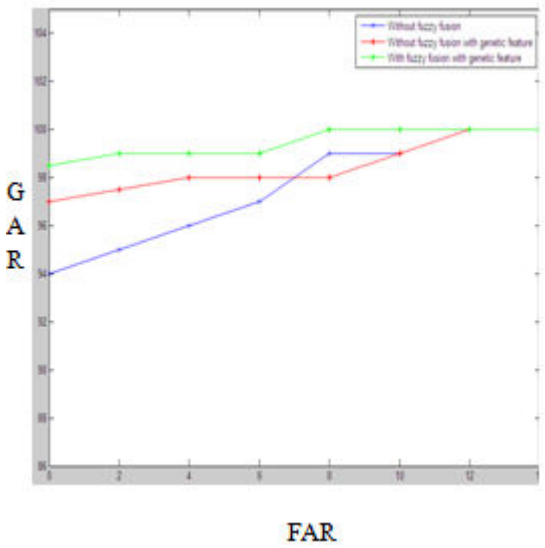

Figure-7. ROC for the proposed system.

Table-2. Accuracy obtained for proposed system.

Technique	GAR of 2 % interval with FAR of 90 % confident interval
Without fuzzy fusion	94.25
Without fuzzy and with genetic	96.50
With fuzzy and genetic	99.18

CONCLUSIONS

In this paper it was proposed to investigate the efficiency of feature fusion technique for multimodal biometrics. A novel feature fusion scheme was proposed with genetic feature selection. Publicly available dataset were used for both palmprint and fingerprint in this work. Gabor features were extracted from both palm print and fingerprint. The extracted features were fused and discriminating features were selected to improve the recognition rate. The experimental results had proved that feature fusion and selection improved the accuracy of the multimodal system.

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