Journal of Engineering Sciences

Vol 11, Issue 6,June/2020
ISSN NO:0377-9254

ARTIFICIAL INTELLIGENCE BASED BIOMETRIC IMAGE FUSION

Alwin Anuse *[1], Rupali Kute[2] , Mousami V. Munot[3] and Abhijeet V. Chitre[4]

[1,2]*School of ECE, Dr. Vishwanath Karad MIT –World Peace University, Pune, India.*
alwin.anuse@mitwpu.edu.in

[3]*Dept of E&TC, Pune Institute of Computer Technology, SPPU, India*

[4]*Dept of E&TC, Vishwakarma Institute of Technology, Pune, SPPU, India*

Abstract— **This paper investigates the field of image fusion which comes beneath the banner of data fusion. The more detailed information is obtained in Image fusion by integrating information contained in different images. The fusion work can be carried out at three levels: pixel level, feature level and the decision level. In the research presented in this paper, pixel level fusion is proposed by decomposing images into wavelets and combining the associated coefficients using fuzzy logic. Discrete Wavelet transform is been used to reconstruct the final image. Palm print and finger print images are also fused at feature level. Fingerprint features such as minutiae, Euclidean distances and angles between them are computed. Feature level fusion is achieved by enhancing the images using Gabor filters followed by feature extraction**

***Keywords* — Pixel level fusion, Feature level fusion, Palm print, Fingerprint, Gabor filter.**

1. INTRODUCTION

Image fusion comes below the area of data fusion. The idea of data fusion was once introduced for military fields in the 1970s [1]. With the intention to get the most efficient operational effects, the brand new weapon methods normally use many sensors. The concept of data fusion is broadly utilized in image processing. There are lots of fusion approaches within the multi-source images fusion.

The image fusion strategies are divided into three categories: pixel, feature and decision level. It provides a mechanism to fuse more than one image giving single representation. Such algorithms create fused image without creating inconsistencies.

The contributions of this paper are:

- A novel feature level fusion of fingerprint and palm print images using Discrete Wavelet Transform and Gabor showing promising results in the classification task.
- Decision level fusion of palm print [13, 14] and fingerprint images suggesting it to be a best approach for classification using biometric modalities.

2. ARTIFICIAL NEURAL NETWORK (ANN)

Artificial Neural Network (ANN) is an information processing system loosely modeled on human brain. Human brain is made up of billions of biological neurons which collectively work together in the decision making process. Analogous to biological neuron, ANN's uses artificial neuron for processing the information. Every artificial neuron receives input vector 'x' which is weighted. Fig 1 indicates a feed-forward neural network in which neurons are structured in layers and connections are established only from previous layer to next one. It is the simplest form of ANN as information is only processed in one direction.

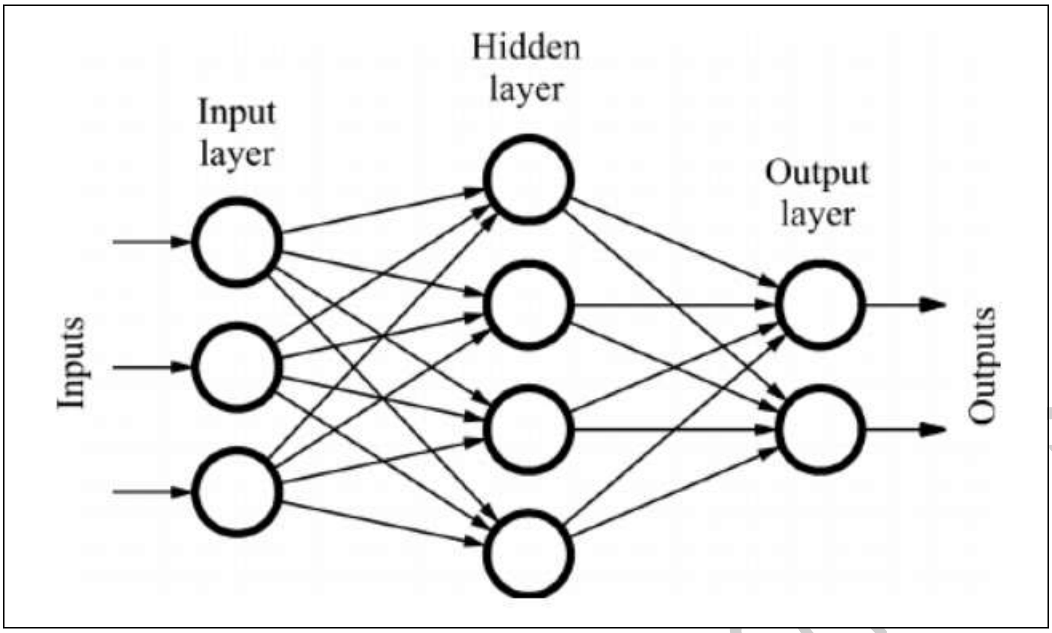

Fig 1. A sample Feed-forward Neural Network (source: https://deepai.org/)

Minutiae features are extracted from finger print and palm print images [4,5,6 ,13]. These features are used to train feedforward neural network using backpropagation algorithm. A backpropagation algorithm works in three phases.

- The first phase which is called feedforward phase of the algorithm involves forward pass of the input vector to the output layer neurons.
- In the second phase of the algorithm, an error is calculated comparing the feedforward output with the target output.
- In the third phase, an error is calculated comparing the feedforward output with the target output. In the third phase the error is back propagated and a factor proportional to the error is used to update the weights on the hidden and output layer neurons.

Training continues till the termination criteria set is reached. A termination criterion is also called as stopping criteria, which is either the number of epochs or the acceptable error set during the training phase.

3. IMAGE FUSION AND WAVELETS

Acquired original image data are directly fused on pixel by pixel basis in pixel level image fusion. Detailed information is provided by pixel level image fusion method which is not provided by other fusion methods [3]. The result of a pixel level image fusion is an image which is more intuitive for human beings. Pixel level image fusion does the core task of vision enhancement. Same scene of multisource images is fused together in this method. The common methods of pixel level image fusion are weighted average method, selection and the weighted average combined method.

To gain detailed representation of the query images, feature level fusion is used to integrate the attributes /features of different images. Images of the same object grabbed by different sensors can vary depending on their calibration, resolution and accuracy. Feature level fusion of such images reduces the amount of storage space required and gives essential and important characteristics of the images.

Decision level fusion creates a single decision from multiple biometric systems. The outputs of multiple biometric system may be combined into single decision by using AND, OR gates are majority voting rule.

Wavelet transform gives the representation of the non-stationary signal in terms of scaled and translated copies of a finite length waveform. Harr wavelet happens to be a discontinuous waveform whereas daub and bi orthogonal wavelets are continuous waveforms. Depending upon the kind of photosensitive material used in the sensors, they have different frequency sensitivity. Multi resolution representation for registered images from each sensor with good frequency localization is given by wavelet transform. When two images are to be fused, the absolute values of details in sub

Vol 11, Issue 6,June/2020
ISSN NO:0377-9254

band decomposition of two input images are compared and higher value is picked. The edges represent high frequency information in the images. The images with edges, when fused using modulus maxima, selection gives good fusion results. During reconstruction one may select approximation coefficients from one of the sub bands that represent image better at low frequency [3]. In this research, 1st level wavelet decomposition of images is done, also while reconstructing some wavelets are used. Performance comparison of these wavelets is done for same image

3.1. ALGORITHM FOR PIXEL LEVEL IMAGE FUSION

i. Decompose the images into sub-bands like approximate, diagonal, horizontal and vertical using discreet wavelet transform (DWT).

ii. Estimate the contribution of every coefficient to the fused image. If x is the coefficient in a given sub-band A of first image, define a fuzzy membership function $\mu_0(x)$ as ,

$$u0(x) = \frac{abs(x)}{\max(abs(x))}$$

iii. Fuzzy logic function $\mu 1(x)$ of second relation is defined as,

$$\mu 1(x) = \frac{\log(p(x))}{\min(\log(p(y)))}$$

where, *p(x)* is the probability of the coefficient *x* in sub-band A.

iv. Using fuzzy relations, calculate the importance of each coefficient.
$A(x) = \mu_{0\cap 1}(x) = \min(\mu_0(x), \mu_1(x))$

v. For the coefficient y having the same spatial position with coefficient x, in the sub-band A of the second image, one can get the fuzzy membership functions of two relations $\mu 0(y)$ and $\mu 1(y)$.

vi. Fuse three sub-band coefficients using every coefficients $\mu_{0\cap 1}(x)$ or $\mu_{0\cap 1}(y)$. The fused coefficient *z* is calculated as

$$z = \frac{xA(x) + yA(y)}{A(x) + A(y)}$$

vii. After every coefficient has been processed, the inverse wavelet transform is applied to reconstruct the fused image [1].

3.2. ALGORITHM FOR FEATURE LEVEL IMAGE FUSION USING DISCRETE COSINE TRANSFORM (DCT)

The palm print database used in this work is acquired from IIT-Delhi Palm-print Database [10]. Total of 25 different palms are selected to test the algorithm. The steps of the algorithm are:

i. The original image of size *150 x 150* is resized to size of *64 X 64* and is called as resized ROI [9].

ii. The algorithm divides the image into four non overlapping parts around center point.

iii. The 2-D transform is applied on each sub-image separately. The DCT coefficients are then grouped into different nine frequency bands (blocks) [7,8,9].

iv. For each block calculate the standard deviation. Features are calculated from four sub images forming a feature vector of *36 (4 X 9=36)* which is used in enrollment as well as matching phase.

v. The feature vectors of several users are given to the back propagation network for training.

3.3. ALGORITHM FOR FEATURE LEVEL IMAGE FUSION USING DISCRETE WAVELET TRANSFORM (DWT) AND GABOR FILTER

The palm print images are smoothen using Gaussian low pass filter. The ROI of each image sized is 150 x 150 pixels.

i. The palm-print images are decomposed into lower resolution representation using wavelet transform

ii. The palm print images are filtered using a bank of 2D Gabor filters in different directions to highlight characteristics and remove noises [12,4]

iii. The filtered images are normalized.

iv. Combine the normalized LL sub-band (approximate sub band) images and divide it into non overlapping blocks of size $m \times n$ pixels.

Journal of Engineering Sciences
Vol 11, Issue 6,June/2020
ISSN NO:0377-9254

The normalized images are fused as shown below:

F	P
P	F

Fig.2. Arrangement of normalized images

v. Fi: normalized LL sub-band of fingerprint image at index i. Pi: normalized LL sub-band of palmprint image at index i.

vi. The resulting magnitude is converted to a scalar number by calculating its standard deviation value. The size of each block is carefully chosen, so that no repeated feature is extracted [12].

vii. A sub-Gabor features vector is extracted from each image, by calculating the standard deviation of each dotted-line-block as shown in Fig 3.

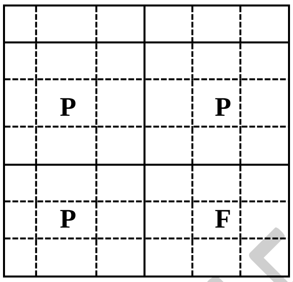

Fig.3. Sub-Gabor feature is obtained by calculating the standard deviation of each dotted-line-block (m×n pixels).

viii. The feature vector is given to train the back propagation network for performing matching .

4. RESULTS

Visible image and infrared images were fused using pixel level fusion method.Fig4, 5 and 6 illustrate the results.

Fig. 4 Visible image

Fig. 5 Infrared Image

Fig 6 Fused Image

4.1. FEATURE LEVEL AND DECISION LEVEL FUSION RESULTS

Initially the network was tested on the basis of the samples on which the network was trained. Later, salt and pepper noise was added to test it shown in Figure 4. At certain level of noise the classification of the sample failed and the level was 0.08. Similarly, the same testing process was applied to the palm print images. The classification / identification rate obtained by this approach is 88% for 25 user system. Dataset had 500 images (20 per user). In the training phase 60 percent images were used and testing set had 40 percent images.

Fig 4. Input image with Salt & Pepper Noise image

Table 1 and 2 represent identification rate for with and without fusion method.

Vol 11, Issue 6,June/2020
ISSN NO:0377-9254

Table 1. Identification Rate without fusion

Sr. No	Algorithm	Biometrics	
		Fingerprint	Palm-print
1	DCT	88 %	91%

Table 2. Identification Rate with fusion

Sr. No	Algorithm	Biometrics (Fingerprint and) Palm-print
1.	DCT (Decision level)	90%
2.	DWT and Gabor (Feature level)	95 %

5. CONCLUSION

Identification rate of individual biometrics is less compared to the fused approach (DWT and Gabor) . DWT and Gabor approach is able to maintain the discriminating information which required for identification in the features after fusion because of that the identification rate is more. The approach proposed in this research is generic and can be used to with any biometrics.

REFERENCES

[1] Zhu Mengyu, Yang Yuliang, "A New Image Fusion Algorithm Based on Fuzzy Logic", International Conference on Intelligent Computation Technology and Automation.

[2] Youshen Xia, Mohamed S. Kamel, "Novel Cooperative Neural Fusion Algorithms for Image Restoration and Image Fusion", IEEE Transactions on Image Processing, Vol. 16, No. 2, February 2007.

[3] Chaveli Ramesh, T. Ranjith, "Fusion Performance Measures and a Lifting Wavelet Transform Based Algortihm for Image Fusion", ISIF 2002.

[4] Josef StrŐm Bartůněk, "Minutiae Extraction from Fingerprint with Neural Network and Minutiae based Fingerprint Verification", Master‟s Thesis, Blekinge Tekniska HŐgskola.

[5] Jayant V Kulkarni, Jayadevan R, Suresh N Mali, Hemant K Abhyankar, and Raghunath S Holambe, "A New Approach for Fingerprint Classification based on Minutiae Distribution", International Journal of Computer Science 1;4 2006

[6] Anil Jain, Salil Prabhakar and Sharath Pankanti, "Matching and Classification: A Case Study in Fingerprint Domain", PINSA, 67, A, No. 2, March 2001, p 223-241.

[7] A. K. Jain, Fundamentals of Digital Image Processing, Englewood Cliffs, NJ: Prentice-Hall, 1989

[8] T. Amornraksa and S. Tachaphetpiboon, "Fingerprint Recognition using DCT Feature," Electronic Letters, Vol. 42, No.9, 2006.

[9] Manisha P. Dale, MES's College of Engineering, Pune, India, "Texture Based Palmprint Identification Using DCT Features", 2009 Seventh International Conference on Advances in Pattern Recognition.

[10] IIT-Delhi Palmprint V1.

[11] Ross, A., Jain, A.K., (2003). "Information Fusion in Biometrics", Pattern Recognition Letter, 24 (13), pp. 2115-2125.

[12] Yong Jian Chin, Thian Song Ong, "Integrating Palmprint and Fingerprint for Identity Verification", 2009 Third International Conference on Network and System Security.

[13] A.K. Qin, P.N. Suganthan, "Personal Identification System based on Multiple Palm-print Features", ICARCV 2006.

[14] Moussadek Laadjel, Ahmed Bouridane, Fatih Kurugollu, "Palmprint Recognition using Fisher-Gabor Feature Extraction", ICASSP 2008.