MODIFIED: NEW IMPROVED MULTIMODEL BIOMETRIC RECOGNITION SYSTEM: TAKING EAR AND RETINA AS BIOMETRIC TRAITS

Shishhir kant tyagi[1], Dr. jay kumar[2], Dr. Niraj singhal[3]

[1, 3]Department of computer science, Shobhit University Meerut, India.
[2]Department of computer science, RGEC Meerut, India.
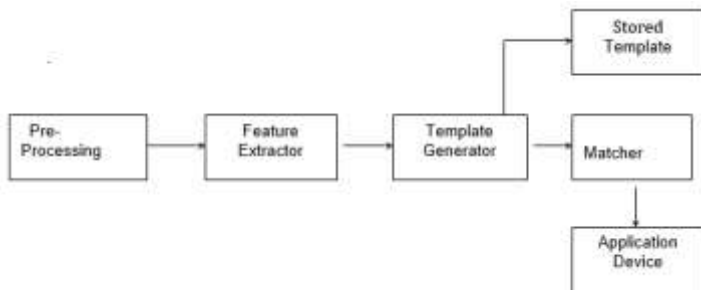[1]shishirtyagi22@gmail.com, [2]jay_rgec@rediffmail.com, [3]sonia_niraj@yahoo.com

Abstract: Biometric is a unique, measurable physiological or behavioural characteristic of a person and finds extensive applications in authentication and authorization. Fingerprint, palm print, iris, voice, are some of the most widely used biometric for personal identification. To reduce the error rates and enhance the usability of biometric system, multimodal biometric systems are used where more than one biometric characteristic are used. In this project it is proposed to use EAR and RETINA as biometric traits. For EAR image processing: Force Field Transformation and Force Field Feature Extraction algorithm is used while in case of Retina: Discrete Cosine Transformation and Feature Extraction algorithm is used. Normalized features which are obtained from both algorithms are then fussed using Feature Level Fusion Technique and stored in the database. For identification, the procedure which is followed for enrollment is used and then matching is done.
Key Words: biometric trait, force field transformation, discrete cosine transformation, feature vector, feature level fusion.

I. INTRODUCTION

A biometric system is essentially a pattern recognition system which recognizes a user by determining the authenticity of a specific anatomical or behavioral characteristic possessed by the user. Several important issues must be considered in designing a practical biometric system. First, a user must be enrolled in the system so that his biometric template or reference can be captured. This template is securely stored in a central database or a smart card issued to the user. The template is used for matching when an individual needs to be identified. Depending on the context, a biometric system can operate either in verification (authentication) or identification mode.

Figure 1.1 General Biometrics

Biometric techniques are used in various fields, few of them are: Wireless biometrics for high end security and providing safer transactions from wireless devices like PDA's, etc., Applications of biometrics technology in identifying DNA patterns for identifying criminals, etc., Biometrics airport security devices are also deployed at some of the world's famous airports to enhance the security standards. Apart from this lot of more fields also exist where biometric techniques used.

II. RELATED WORK

A. Multimodal Fusion for Biometric Person Authentication

This paper given by Emdad Hossain et al., [2] proposes a novel multimodal fusion approach based on PCA-LDA processing for person identification from low resolution surveillance video with cues extracted from gait and face biometrics. The experimental evaluation of the proposed scheme on a publicly available database showed that the combined PCA-LDA face and gait when fused is either hierarchal or holistic fusion, can lead to powerful identity verification that can capture the inherent multimodality in walking gait patterns and ascertain the identity from low resolution surveillance videos.

B. Ear Identification System

Biometric recognition systems are inquired to solve security problems in networked society recently. Uniqueness of ear shape and its robustness in spite of increasing age has attracted researcher's attention. This paper given by Ava Tahmasebi et al., [1] an appropriate biometric system is presented based on local-Gabor features which effectively extract appropriate features bring along dimensionality reduction. Subsequently the KNN classifier is applied. Experimental results show the effectiveness of proposed method which brings both higher recognition performance and higher speed benefits.

C. Human Identification Based on Fusion

Single modality biometric recognition system is often not able to meet desired system performance requirements. Several studies have shown that multimodal biometric identification systems improve the recognition accuracy and allow performances that are required for many security applications. In this paper given by Norhene Gargouri et al., [6] the author has developed a multimodal biometric recognition system which combines two modalities: face and fingerprint. For face trait, they build features based on Gabor Wavelet Networks (GWN), while Local Binary Patterns (LBP) is used for fingerprint traits. Experimental results affirm that a weighted sum based fusion achieves excellent recognition performances, which out performs both single biometric systems.

D. Comparative Evaluation of Feature Level Based Fusion Schemes for Multimodal Biometric Authentication

This paper given by Waheeda Almayyan et al., [7] proposes a novel fusion technique using iris-online signature biometrics at feature level space. The biometric features are extracted from the preprocessed image of the iris and the dynamics of signatures. They propose different fusion schemes at feature level. In order to reduce the complexity of fusion scheme, they adopt a Binary Particle Swarm Optimization (BPSO) procedure which allows the numbers of features to be significantly reduced while highlighting the difference between classes. This paper examines how the accuracy will be improved as several biometric data are integrated in an identification system. Results show a significant improvement in performance when classification performed at feature fusion level.

E. Localization of Ear Using Outer Helix Curve of the Ear

This paper given by Saeeduddin Ansari et al., [16] proposes an efficient approach for localization of ear from an arbitrary 2-D side face image with varying background. Outer helix curves of ears moving parallel to each other are used as feature for localizing ear in an image. Using Canny edge detector edges are extracted from the whole image. These edges are segmented in convex and concave edges. From these segmented edges expected outer helix edges are determined after eliminating non-ear edges. Final outer helix edge of an ear is constructed using expected outer helix curves. Decision is made on a constructed curve whether it belongs to outer helix of ear or not. This technique is implemented on IITK, India database containing 700 samples. Accuracy of localization is more than 93%.

F. A Novel Biometric Technique Benchmark Analysis for Selection of Best Biometric Modality and Template Generation Method

A biometric security is a technique by means of which digital contents are protected by a cryptographic key generated from the biometric features of a person like Retina, Iris, Fingerprint, Face, Voice and so on. Normally the digital contents like documents are protected by a cryptographic key generated from a unique password. The process in irreversible, i.e. the key can be generated from the password but not the vice versa. Passwords are relatively easy to hack almost of the users keep their personal information like date of birth as password and also password length has a limit as human beings cannot remember a password of significantly large length. Hence guessing the password of a user, whose significant information is available, is easier. Therefore off late lot of emphasis has been given to biometric features. Biometric features of no two people are same. For example the finger prints or the face of any two people differ. Hence if a template (alphanumeric or binary representation of features from a biometric data) is selected for the key generation than cracking them for accessing information becomes significantly difficult. But as with every advantage comes certain limitations also. The keys are not time invariant. Templates tends to change based on the data acquisition, or with time. For example the finger prints or palm prints changes with ages. Iris, retina and face features changes with change in light intensity during the acquisition phase. Fingerprint features changes with change in the orientation of the finger while scanning. In a classic authentication problem, such variability's can be easily dealt with by keeping a threshold for the acceptance of the features. Such acceptance threshold is not applicable for the case of biometric templates. Even slightest of the variability in the templates changes the generated key, therefore causing a high false rejection rate. Hence in this work we analyze the most accepted biometric features and techniques for key generation and propose the most invariable technique in terms of data acquisition invariability. The work analyzes Iris, Face, Fingerprint and Palm prints for analysis of the biometric template generation and key generation form the templates. Further a unique benchmark analysis technique is proposed by Raikoti Sharanabasappa et al., [10] for quantifying the quality of a biometric model or features.

G. Enhancement of Multi-Modal Biometric Authentication Based on IRIS and Brain Neuro Image Coding

The proposed method given by Dr.T.Karthikeyan et al., [11] describes the current forensics and biometrics in a modern approach and implements the concept of IRIS along with brain and resolves the issues and increases the strength of Digital Forensics Community. It has enormous features in biometrics to enhance diverse security levels. A new method to identify individuals using IRIS Patterns with the brain wave signals (EEG) is proposed. Several different algorithms were proposed for detecting, verifying and extracting the deterministic patterns in a person's IRIS from the Eye. The extracted EEG recordings form the person's brain has proved to be unique. Next we combine EEG signals into the IRIS patterns a biometric application which makes use of future multi modal combination architecture. The proposed forensic research directions and argues that to move forward the community needs to adopt standardized, modular approaches for person identification. The result of each authentication test is compared with the user's pre-recorded measurements, using pattern recognition methods and signal-processing algorithms.

H. Feature-Level Fusion of Fingerprint and Finger-Vein for Personal Identification

Multimodal biometrics based on feature-level fusion is a significant topic in personal identification research community. In this paper given by Jinfeng Yang et al., [12] a new fingerprint-vein based biometric method is proposed for making a finger more universal in biometrics. The fingerprint and finger-vein features are first exploited and extracted using a unified Gabor filter framework. Then, a novel supervised local-preserving canonical correlation analysis method (SLPCCAM) is proposed to generate fingerprint-vein feature vectors (FPVFVs) in feature-level fusion. Based on FPVFVs, the nearest neighbourhood classifier is employed for personal identification finally. Experimental results show that the proposed approach has a high capability in fingerprint- vein based personal recognition as well as multimodal feature-level fusion.

I. Multibiometric Systems: A Comparative Study of Multi-algorithmic and Multimodal Approaches

In this paper given by Mohammad Imrana et al., [13] present a comparative analysis of Multi-algorithmic and Multimodal approaches. We have used palmprint and face as biometric traits and other popular subspace algorithms (PCA, FLD, and ICA). Subsequently, the different combinations of algorithms are also evaluated in our experiment. The multi-algorithmic

approach achieves incremental results where as multimodal approach yields far improved results. Hence Complimentary information available through multimodal approach always performs better than multi-algorithmic approach which mainly builds on supplementary information.

J.A New Force Field Transform for Ear and Face Recognition
The objective in defining feature space is to reduce the dimension of the original pattern space yet maintaining discriminatory power for classification. To meet this objective in the context of ear and face biometrics the authors Hurley et al., [14] proposes a novel force field transformation that had been developed, in which the image is treated as an array of Gaussian attractors that act as the source of a force field. The directional properties of the force field are exploited to automatically locate a small number of potential energy wells and channels that form the basis of a characteristic feature vector. Here, we generalize the analysis, and the stock of applications.

K. *Wavelet-DCT based image coder for video coding applications*
This paper given by Chai Beng Seow et al., [15] proposes a good application of DCT. Discrete cosine transform (DCT) is widely used in intraframe compression to compress the current frame of a video source. With little differences between frames, interframe compression uses the subsequent frame to compress the reference frame, by performing subtraction. The subtraction output (difference image) is fed into the intraframe coder for still-image compression. However, DCT cannot compress difference image efficiently, since it is Discontinuous Tone Image (DTI) and the algorithm should be improved. Wavelet-DCT is a novel algorithm that uses forward discrete wavelet transform (DWT) to compute DCT. A SIMULINK model for an intraframe coder is developed and tested. Then, a wavelet-DCT block is coded using MATLAB and used to replace the conventional DCT block. In the study, on one hand, experiment is conducted on difference image for conventional intraframe coder; on the other, the same difference image with Wavelet-DCT based intraframe coder. The results prove that wavelet-DCT has greater compression for difference images. This is possible since the algorithm allows discarding insignificant DWT coefficients or more popularly known thresholding the DWT coefficients while computing the DCT. We then conclude Discrete cosine transform (DCT) is widely used in intraframe compression to compress the current frame of a video source. With little differences between frames, interframe compression uses the subsequent frame to compress the reference frame, by performing subtraction. The subtraction output (difference image) is fed into the intraframe coder for still-image compression. However, DCT cannot compress difference image efficiently, since it is Discontinuous Tone Image (DTI) and the algorithm should be improved. Wavelet-DCT is a novel algorithm that uses forward discrete wavelet transform (DWT) to compute DCT. A SIMULINK model for an intraframe coder is developed and tested. Then, a wavelet-DCT block is coded using MATLAB and used to replace the conventional DCT block. In the study, on one hand, experiment is conducted on difference image for conventional intraframe coder; on the other, the same difference image with wavelet-DCT based intraframe coder. The results prove that wavelet-DCT has greater compression for difference images. This is possible since the algorithm allows discarding insignificant DWT coefficients or more popularly known thresholding the DWT coefficients while computing the DCT. We then conclude that wavelet-DCT is capable compressing difference images at higher compression in video coding applications. That wavelet-DCT is capable compressing difference images at higher compression in video coding applications.

III. PROPOSED WORK
A. *Retinal Image Processing*
1. *Anatomy of Retinal Image*
The retina is the light-sensitive tissue that lines the inside of the eye. The retina functions in a manner similar to film in a camera. The optical elements within the eye focus an image onto the retina of the eye, initiating a series of chemical and electrical events within the retina. Nerve fibers within the retina send electrical signals to the brain, which then interprets these signals as visual images.
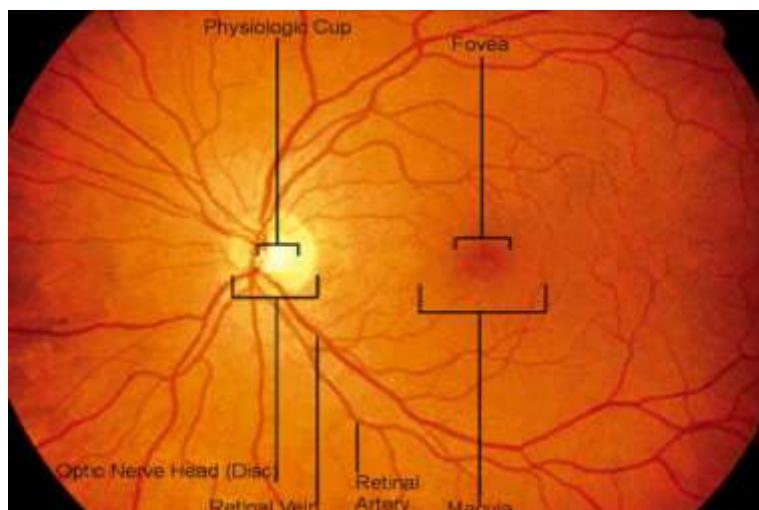

Figure 3.1.1 Retinal image

2. Discrete Cosine Transformation (DCT)

Like other transforms, the Discrete Cosine Transform (DCT) attempts to decorrelate the image data. After decorrelation each transform coefficient can be encoded independently without losing compression efficiency. This section describes the DCT.

3. The One-Dimensional DCT

The most common DCT definition of a 1-D sequence of length N is

$$C(u) = \alpha(u) \sum_{x=0}^{N-1} f(x) \cos\left[\frac{\Pi(2x+1)u}{2N}\right] \qquad (5)$$

for $u = 0,1,2,\ldots,N-1$. Similarly, the inverse transformation is defined as

$$f(x) = \sum_{u=0}^{N-1} \alpha(u) C(u) \cos\left[\frac{\Pi(2x+1)u}{2N}\right] \qquad (6)$$

for $x = 0,1,2,\ldots,N-1$. In both equations (5) and (6) α(u) is defined as

$$\alpha(u) = \begin{cases} \sqrt{\dfrac{1}{N}} \\ \sqrt{\dfrac{2}{N}} \end{cases} \qquad (7)$$

It is clear from (5) that for $u = 0, C(u=0) = \sqrt{\dfrac{1}{N}} \sum_{x=0}^{N-1} f(x).$

Thus, the first transform coefficient is the average value of the sample sequence. In literature, this value is referred to as the *DC Coefficient*. All other transform coefficients are called the *AC Coefficient*. To fix ideas, ignore the f(x) and *α* (*u*) component in (5). In accordance with authors observation, the first waveform (*u* = 0) renders a constant (DC) value, whereas, all other waveforms (*u* = 1,2,…,7) give waveforms at progressively increasing frequencies. These waveforms are called the *cosine basis function*. Note that these basis functions are orthogonal. Hence, multiplication of any waveform with another waveform followed by a summation over all sample points yields a zero (scalar) value, whereas multiplication of any waveform with itself followed by a summation yields a constant (scalar) value. Orthogonal waveforms are independent, that is, none of the basis functions can be represented as a combination of other basis functions.

4. The Two-Dimensional DCT

The 2-D DCT is a direct extension of the 1-D DCT case. The 2-dimensional DCT of an image f (i, j) for i, j = 1,........., N can be defined by equation (8) and equation (9)

$$f(u,v) = \frac{1}{\sqrt{2N}} c(i) c(j) \sum_{x-1}^{N} \sum_{y-1}^{N} \cos\left[\frac{(2x+1)i\Pi}{2N}\right] \cos\left[\frac{(2y+1)i\Pi}{2N}\right]$$

$$c(u) = \begin{cases} \frac{1}{\sqrt{2}} & if u = o \\ 1 if u > 0 \end{cases}$$

(8), (9)

The 2-D basis functions can be generated by multiplying the horizontally oriented 1-D basis functions with vertically oriented set of the same functions. Again, it can be noted that the basis functions exhibit a progressive increase in frequency both in the vertical and horizontal direction. The top left basis function of results from multiplication of the DC component with its transpose. Hence, this function assumes a constant value and is referred to as the DC coefficient.

5. Feature Vector Extraction for retina

Retinal image processing is the first step of this project. In this a retinal image as shown in Figure 1.3 is selected from the database [8]. The selected retinal image is passed to the 'Template Locator' as input which locate the optic disc of that particular retinal image. It reduces the size of the image for further processing. After getting the optic disc DCT function is called which will generate the retinal features. Normalize these features by calling 'Normalization' function. The normalized output is our required features.

B. Ear Image Processing

1. Anatomy of Ear Image

Ear image processing is the next step. An ear is selected from the database [9]. The selected ear image is cropped in such a manner so that antihelix and intertragic notch must be present as shown in Figure 1.4. According to the 'author' [10] every person have different antihelix and intertragic notch. The selected image is given as input to the 'Energy Transform' function which will generate a 64x64 matrix where each element gives the energy of selected ear image. By calling 'Normalization' function the output is normalized.
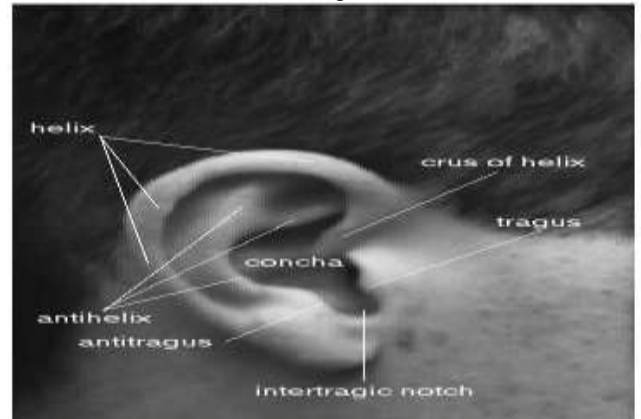

Figure 3.1.2.1 Ear Image

2. The Force Field Transform (FFT): For ear image processing force field transform is applied.

FFT provides the mathematical foundation for the new transforms and establishes some useful properties. The transforms are defined and are shown to be linear transformations and to be invertible under certain circumstances. The basic concepts underpinning the transforms and the mathematics used to describe them can be found in various introductory works on physics and electromagnetic.

The energy field equations are first introduced, and then it is shown how a potential energy surface is composed of a summation of elementary potential functions corresponding to isolated pixels. The energy surface is then used to define potential wells and channels. An explanation is offered as to why the energy surface has an underlying dome shape, which

in turn gives the force field an advantageous centric property. It is shown that force can also be viewed as the gradient of energy, thus allowing the force field to be calculated by differentiating the energy field, and also allows some properties established about one to be generalized to the other. Although the fields can be derived by direct application of the defining equations, it is shown that treating the process as a convolution, and using the Convolution Theorem to perform the calculation in the frequency domain, can gain a considerable speed advantage. The question of transform invertibility is considered before rounding off the section by establishing some invariant properties and analyzing sensitivity to noise.

3. *Potential Energy Transform Definition*
The image is transformed by treating the pixels as an array of *N* particles that act as the source of a Gaussian potential energy field. It is assumed that there is a spherically symmetrical potential energy field surrounding each pixel, where $E_i(\mathbf{r}_j)$ is the potential energy imparted to a pixel of unit intensity at the pixel location with position vector $\mathbf{r}_j$ by the energy field of a remote pixel with position vector $\mathbf{r}_i$ and pixel intensity $P(\mathbf{r}_i)$, and is given by equation (1).
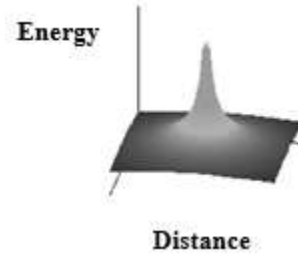
$$\mathrm{F}i(rj) = P(rj)\left(\frac{ri-rj}{(ri-rj)^3}\right) \qquad \textbf{(1)}$$

where the units of pixel intensity, energy, and distance are arbitrary, as are the co-ordinates of the origin of the field. It should be noted that the energy field is notional and is not intended to model the propagation of light or anything else. If an exploratory unit intensity test pixel is moved around in the energy field generated by a given pixel, energy will be exchanged if the net effect is to change the distance of the test

pixel from the given pixel. Thus the field consists of concentric rings of equal potential energy known as equipotentials. If the test pixel moves to a different location on the same equipotential ring, no energy is exchanged. If it moves to a different equipotential, an amount of energy will be exchanged equal to the difference in energy between the two rings.

4. *Potential Energy Function*
The potential energy function of a single isolated pixel looks like the shape shown in Figure 3.1.2.4
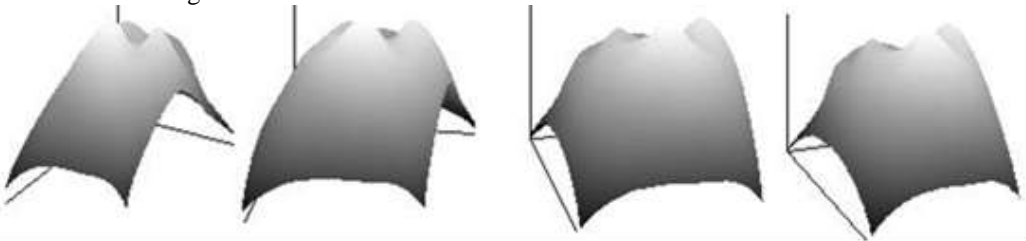

Figure 3.1.2.4 Potential Energy Function

Horizontal cross sections of the potential function correspond to equipotential rings and vertical cross sections correspond to the 2-dimensional double-sided $1/r$ inverse function shape.

5. *Potential Energy Surface*
Now to find the total potential energy at a particular pixel location in the image, the scalar sum is taken of the values of the overlapping potential energy functions of all the image pixels at that precise location. Figure 3.3 shows energy surface of an ear image viewed from different angle.

Figure 3.1.2.5 Energy Surface for an Ear Viewed From Below the Lobe

This summation is then carried out at each image pixel location to generate the complete transformation, which is a smoothly varying surface due to the fact that the underlying potential functions have smooth surfaces. The result of this process for the energy transform for an ear image is shown in Figure 3.3, where the same surface has been depicted from a variety of different perspectives below the lobe

6. *Potential Wells and Channels*
The potential surface undulates, forming local peaks or maxima, with ridges leading into them. These peaks are called potential energy wells since, by way of analogy, if the surface were to be inverted and water poured over it, the peaks would correspond to small pockets where water would collect. Notice that the highest of the three obvious peaks in Figure 3.3 has a ridge that slopes gently towards it from the smaller peak to its left. This corresponds to a potential energy channel, because to

extend the analogy, water that happened to find its way into its inverted form would gradually flow along the channel towards the peak.

7. *Dome Shape Explanation*
It can be noticed that the energy surface has an elongated dome shape, which is modulated by the channels and wells; it looks like a small mountain with a few peaks and ridges. The reason for the dome shape can be easily understood by considering the case where the image has just one grey level throughout. In this situation, the energy field at the centre would have the greatest energy share because test pixels at that position would have the shortest average distance between themselves and all the other pixels, whereas test pixels at the edges would have the greatest average distance to all the other pixels, and therefore the least total energy imparted to them. This is illustrated in Figure 3.4
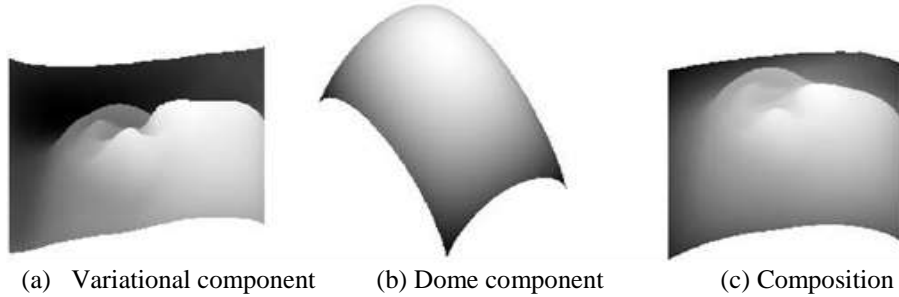
(a)   Variational component   (b) Dome component   (c) Composition
Figure3.1.2.7 Energy Surface as a Sum of Components

It is the mean value component that gives the energy surface its dome shape and the variation component that modulates this basic shape causing peaks and ridges. The dome shape leads to automatic feature extraction, since by way of the water analogy once again, water when introduced at the edge of the dome shape would always flow towards the centre, finding its way into the channels on the way, and eventually ending up in one or other of the wells.

8.   *Forces as Gradient of Potential*
Associated with the scalar energy field there is a vector force field and the fields are related by the fact that the force at a given point is equal to the additive inverse of the gradient of the potential energy surface at that point. This relationship, shown in Equation (**2**), allows the force field to be easily calculated by differentiating the energy field, and allows some conclusions drawn about one field to be extended to the other.

$$F(r) = -grad(E(r))$$

9.   *Force Field Transform Definition*
The force field can also be defined directly with its own set of equations. The defining equations are more complicated than those of the energy field but the concept is more intuitive. The image is transformed by treating the pixels as an array of *N* mutually attracting particles that act as the source of a Gaussian force field. In a similar way to Newton's Law of Universal Gravitation, the pixels are considered to attract each other according to the product of their intensities and inversely to the square of the distances between them. Each Pixel is assumed to generate a spherically symmetrical force field so that the force Fi(rj) exerted on a pixel of unit intensity at the pixel location with position vector rj by a remote pixel with position vector ri and pixel intensity P(ri) is given by equation (3)

$$\text{F}i(rj) = P(rj)\left(\frac{ri-rj}{(ri-rj)^3}\right) \qquad (3)$$

The force field is calculated as explain in the Figure 3.5
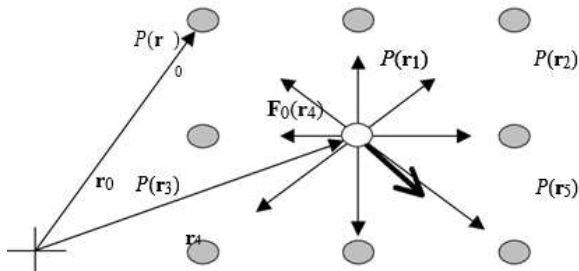

Figure 3.1.2.9 Force Field Calculations at the Centre of A 3x3 Pixel Image

The total force **F**(r$_j$) exerted on a pixel of unit intensity at the pixel location with position vector **r**$_j$ is the vector sum of all the forces due to the other pixels in the image and is given by equation (4)

$$\text{F}i(rj) = \sum_{i=0}^{N-1} 1\, P(rj)\left(\frac{ri-rj}{(ri-rj)^3}\right) \qquad (4)$$

10.   *Force Field Feature Extraction*
Ear image processing is the next step after Retinal image processing of this project. In this an ear image as shown in Figure 1.4 is selected from the database [9]. The selected ear image is cropped such that the resultant image is of size 64x64 and includes antihelix and intertragic notch. It reduces the size of the image for further processing. After getting the ear ROI 'Energy Transform' function is called which will generate the ear features. Normalize these features by calling 'Normalization' function. The normalized output is our required features.

(2)

C.   *Fusion of the Extracted Features*
In multimodal biometrics more than one biometric modality is used.

1.   *Types of Fusion*
Sensor Level Fusion: In this we combine the biometric traits coming from sensors like Thumbprint scanner, video camera, Iris scanner etc, to form a composite biometric traits and process. Although fusion at such a level is expected to enhance the biometric recognition accuracy.

Feature Level Fusion: In feature level fusion signal coming from different biometric channels are first preprocessed, and feature vectors are extracted separately, using specific fusion algorithm we combine these feature vectors to form a composite feature vector. This composite feature vector is then used for classification process. Concatenating the feature vectors extracted from face and fingerprint modalities are an example of a multimodal system.

Matching Score Level: Here rather than combining the feature vector, it is processed and individual matching score is found, then depending on the accuracy of each biometric channel extracted features can be fused at matching level to find composite matching score which is then sent to the decision module. Currently, this appears to be the most useful fusion level because of its good performance and simplicity.

Decision Level Fusion: Each modality is first pre-classified independently. The final classification is based on the fusion of the output with different modalities. In this approach, a separate is taken for each biometric type at a very late stage. This technique is least powerful.

2. *Fusion of Ear and Retinal Features*
Obtained features from retinal image processing and ear image processing are fused using feature level fusion. In this project addition rule is used for feature level fusion. Features obtained from both ear and retinal image processing are added and stored in the database for further processing.

IV. PROPOSED ARCHITECTURE

Figure: Block diagram

Figure: gives over all architecture of the system which is developed and implemented in this project. According to the architecture given in Figure the whole process is divided into following three categories.

A. *Multi Modal Biometric Systems*
A biometric system that uses more than one biometric modality in a verification identification system is knows as multimodal biometric system.
The aim of multimodal biometric system is to reduce one or more of the following:
• False Acceptance Rate (FAR)
• False Reject Rate (FRR)
• Failure to Enroll Rate (FTE)

FAR
The probability that the system incorrectly matches the input pattern to a non-matching template in the database. It measures the percent of invalid inputs which are incorrectly accepted. In case of similarity scale, if the person is imposter in real, but the matching score is higher than the threshold, and then he is treated as genuine that increases the FAR and hence performance also depends upon the selection of threshold value.

FRR
The probability that the system fails to detect a match between the input pattern and a matching template in the database. It measures the percent of valid inputs which are incorrectly rejected.

FTE
The accuracy of multimodal biometric system is usually measured in terms of matching errors and image acquisition error. Matching error consists of false match rate (FMR) where an imposter is accepted and false non-match rate (FNMR) where a genuine user is denied access. Image acquisition comprise of failure-to-enroll (FTE) and failure-to-acquire (FTA).
The working of multimodal biometric system is shown in Figure 1.2:

Figure4.2 Multimodal Biometrics

V. SIMULATION RESULTS
In this work MATLAB 7.8.0(R2009a) is used. The work is coordinated by taking test images as input and then processed it by corresponding functions, fuse the features obtained from ear image processing and retinal image processing, save these fuse matrices into database it creates the entire training database and then it calls the matching function to match the desired images. The work is divided into following eight steps, these are -
➢ Taking Input Test images.
➢ Selecting Optic Disc by 'Template Locator' algorithm.
➢ Selecting region of interest (ROI) for ear image processing.
➢ Applying DCT function to Optic Disc for feature extraction.
➢ Applying 'Energy Transform' function to the selected portion of the ear image.
➢ Normalizing the output of previous two operations.
➢ Fusing the normalized features and storing it in the database
➢ Matching with the input subject.

Taking Input Test images
The input images are read using 'imread' function. The Matlab code for selecting input of ear image and retinal image is given below.

```
% Selecting input for ear image
  function [img] = roi()
  [file path] = uigetfile('*.*','Select ear image');
  filename = strcat(path,file);
  img1 = (imread(filename));
  end
% Selecting input for retinal image
  function [img] = roi()
  [file path] = uigetfile('*.*','Select retinal image');
  filename = strcat(path,file);
  img1 = (imread(filename));
  end
```
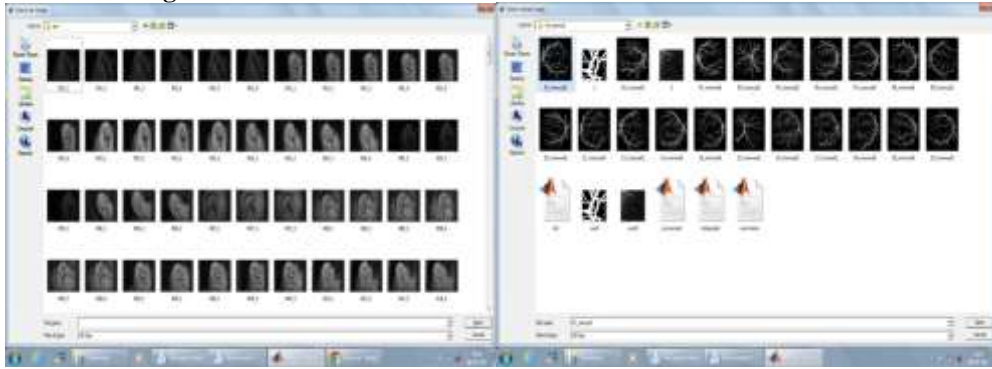
Snapshot of Ear And Retinal Image

Figure 5.1.1 Selecting Ear and Retinal Images from the Database

Selecting Optic Disc by 'Template Locator' algorithm

The optic disc is located by calling 'Template Locator' algorithm. This algorithm takes retinal image as input and produces optic disc as output. It is explained on the basis of following coding and snapshots.

```
% Template locater
function [ image_out, d ] = analyze( )
[file path] = uigetfile('*.*','Select retinal image');
filename = strcat(path,file);
image_in = (imread(filename));
seg_x = 63;
seg_y = 63;
[x,y]=size(image_in);
x_pos=1;
y_pos=1;
max_count=0;
for i=1:x-seg_x
    for j=1:y-seg_y
        current_count=get_max(image_in,i,j,seg_x,seg_y);
        if current_count>max_count
            x_pos=i;
            y_pos=j;
            max_count=current_count;
        end
    end
end
p=1;
q=1;
for i=x_pos:(x_pos+seg_x)
    for j=y_pos:(y_pos+seg_y)
        image_out(p,q)=image_in(i,j);
        q=q+1;
    end
    p=p+1;
    q=1;
    figure(1),imshow(image_out);
end
end
```

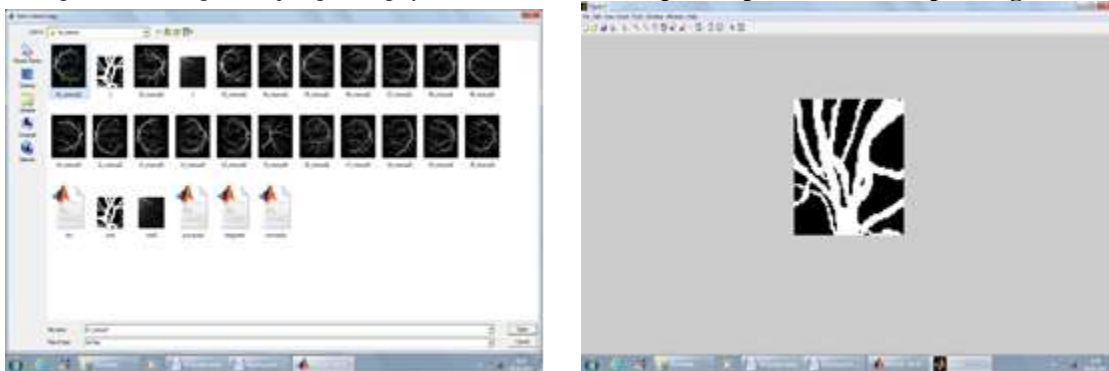**Output: Optic disc corresponding to the retinal image**

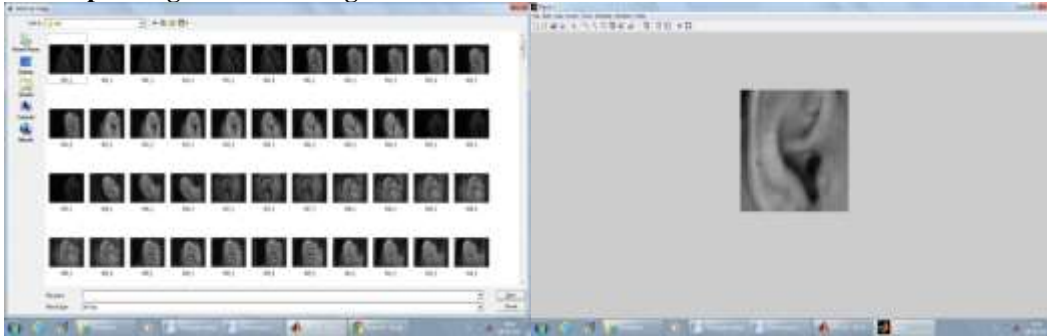**Figure 5.1.2 Optic Disc Corresponding to the Retinal Image**

Generating region of interest (ROI) for ear image processing

The required region of interest is generated by cropping the ear image. The cropped ear image is taken as input and this produces required ROI image which is used for further processing. It is explained on the basis of following coding and snapshots.

```
%generating ear ROI
function [img] = roi()
[file path] = uigetfile('*.*','Select ear image');
filename = strcat(path,file);
img1 = (imread(filename));
img = imcrop(img1,[115 60 120 100]);
img = imresize(img, [64,64]);
[p,q]=size(img);
figure(1),imshow(img);
```

Output: Ear ROI corresponding to the ear image

Figure 5.1.3 Ear ROI Corresponding to the Ear Image

Applying DCT function to Optic Disc for feature extraction

The Discrete Cosine Transform of the optic disc is generated by calling dct2 (image) function. It will take optic disc as input and generate corresponding transformed image which will be used for fusion. It is explained with the following coding and snapshots.

%Discrete Cosine Transform
function [d] = DCT()
d = dct2(analyze());
figure(1), imshow(d);

Output: DCT image corresponding to the optic disc

Figure 5.1.4 DCT Image Corresponding to the Optic Disc

Applying 'Energy Transform' function to the selected portion of the ear image

According to 'Energy Transform' each pixel is treated as point mass and distance between two nearest pixels is unity. On applying Newton's classical theory of gravitation we will get energy of the selected ROI of the ear image. Again it is better explained on the basis of following coding and snapshots.

```
% Energy Transform
function [e,I,D,i] = energy()
[file path] = uigetfile('*.*','Select ear image');
filename = strcat(path,file);
img1 = (imread(filename));
img = imcrop(img1,[115 60 120 100]);
img = imresize(img, [64,64]);
[p,q]=size(img);
e = zeros(p,q);
for i = 1:p
  for j = 1:q
   for x = 1:p
    for y = 1:q
      I = (double(img(x,y)));
      D = (double(sqrt((x-i)^2+(y-j)^2)));
     if(x == i && y == j)
       e(x,y) = 0;
     else
       e(x,y) = (e(x,y) + I/D);
       end
    end
   end
  end
end
%i = uint8(255*mat2gray(e(x,y)));
%save(['d:/work/test.txt'], 'test' , '-ASCII');
%figure(1),imshow(e);
end
```

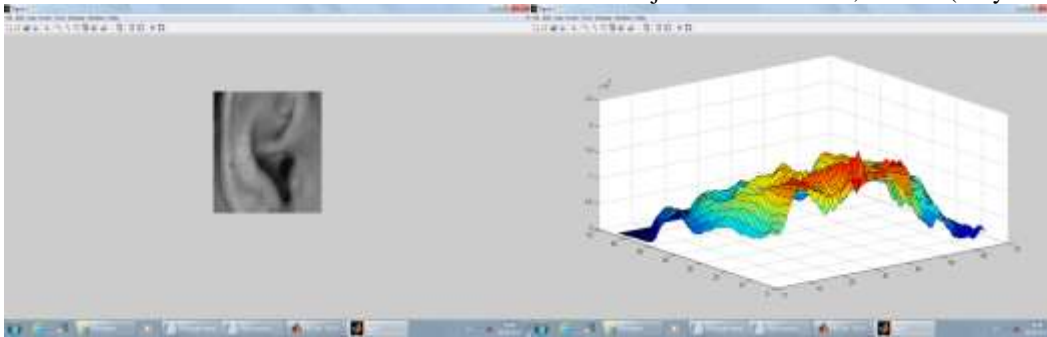**Output: Transformed Energy Corresponding to the Ear Image**

Figure 5.1.5 Transformed Energy Corresponding to the Ear Image

Normalizing output of previous two operations

Since from previous steps it is observed that the output of Transform Energy and DCT functions are different, it is to be normalized. Normalization is performed by following command.

Normalized image = double(255*mat2gray(image));

Fusing the normalized features

Normalized features obtained from the previous step are fused by calling addition function.

Let the features obtained from the DCT be 'x' and by Energy Transform be 'y'. Then

Output: Result of test subject

$Z = x + y$;

Where Z is the fused data which will be stored in the database by using following command

Save (['d:/work/Z.txt'], 'Z' , '-ASCII');

Matching with the test subject

The test image traits are processed till previous steps.

Let the generated fused variable be 'test'. To check whether this subject is registered with the database or not, call the compare function, if this function generates matching result then the given subject is registered otherwise the subject is fake or not registered with the database.
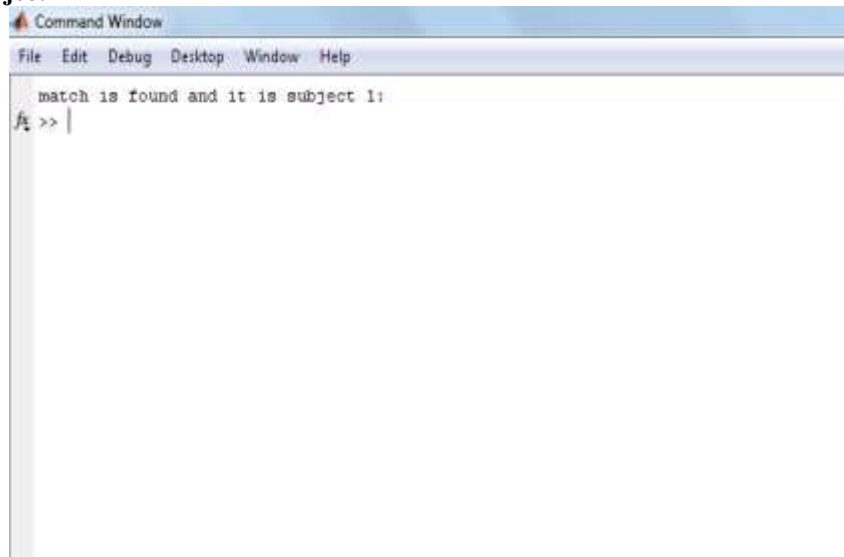

Figure 5.1.5 Result of Test Subject

VI. RESULTS

In this project ear database [8] and retinal database [9] is used. Ear database is having 125 different subjects while retinal database is having 10 different subjects. For testing 10 subjects were taken. Out of those 10 subjects each one is having different numbers of ear images which are slightly different in terms of rotation and background illumination and for retinal image only one image corresponding to each subject is available.

On the basis of experiment performed we are getting 100% match of the test subject

VII. CONCLUSION

This work is focused on fusion between Retinal optic disc and ROI of ear image. Here 10 subjects have been taken with different numbers of ear images corresponding to a subject and one retinal image of each subject. Extracted features have been used to fuse. The operation gives an efficient result for person identification. This experiment gives results with 100% accuracy. In this work some consideration has been done which can be improved later on. The considerations are:

➢ In ear each pixel is treated as point mass and distance between two nearest pixel as unity.

➢ The ear images used in this project are without occlusions.

REFERENCES

[1] Ava Tahmasebi, Hossein and Homayoun-Nasab, "An Ear Identification System Using Local-Gabor Features and KNN Classifier," Machine Vision and Image Processing (MVIP), 2011 7th Iranian(IEEE) Digital Object Identifier: 10.1109/IranianMVIP.2011.6121570 Publication Year: 2011 , Page(s): 1 - 4.

[2] Emdad Hossain, Girija Chetty, "Multimodal Face-Gait Fusion for Biometric Person Authentication", Embedded and Ubiquitous Computing (EUC), 2011 IFIP 9th International Conference(IEEE) on Digital Object Identifier: 10.1109/EUC.2011.52 Publication Year: 2011 , Page(s): 332 - 337

[3] H.J.Baeand S.H.Jung, "Image Retrieval Using Texture Based on DCT", Proc. of the international conference on Information and communications security, vol.2pp.1065-1068, 1997.

[4] http://www.telepatologia.es/9ECT/presentations/Gloria_Bueno.pdf

[5] Jiang,j.,Armstrong and G.C.Feng, "Direct Content Access and extraction from JPEG compressed images,Pattren Recognition", pp.1-9,2001.

[6] Norhene GARGOURI AYED, Alima DAMAK MASMOUDI and Dorra SELLAMI MASMOUDI,"A New Human Identification Based on Fusion Fingerprints and Faces Biometrics Using LBP and GWN Descriptors" Systems, Signals and Devices (SSD), 2011 8th International Multi-Conference (IEEE) on Digital Object Identifier: 10.1109/SSD.2011.5767482 Publication Year: 2011, Page(s): 1 − 7.

[7] Waheeda Almayyan, Hala S. Own, Hussein Zedan," A Comparative Evaluation og Feature Level Based Fusion Schemes for Multimodal Biometric Authentication" Hybrid Intelligent Systems (HIS), 2011 11th International Conference (IEEE) on Digital Object Identifier: 10.1109/HIS.2011.6122074 Publication Year: 2011 , Page(s): 22 − 27.

[8] www.mathwork.com

[9] www.isi.uu.nl/Research/Databases/DRIVE/

[10] Raikoti Sharanabasappa, Dr Sanjaypande, "A Novel Biometric Technique Benchmark Analysis for Selection of Best Biometric Modality and Template Generation Method" International Journal of Biometrics and Bioinformatics (IJBB), Volume (5): Issue (2): 2011.

[11] Dr.T.Karthikeyan, B.Sabarigiri, "Enhancement of Multi-Modal Biometric Authentication Based on IRIS and Brain Neuro Image Coding" International Journal of Biometrics and Bioinformatics (IJBB), Volume (5): Issue (5): 2011.

[12] Jinfeng Yang, Xu Zhang, "Feature-Level Fusion of Fingerprint and Finger-Vein for Personal Identification" Pattern Recognition Letters (Elsevier) 33 (2012) 623–628.

[13] Mohammad Imran, Ashok Raob, G Hemantha Kumara, "Multibiometric Systems: A Comparative Study of Multi-algorithmic and Multimodal Approaches" Procedia Computer Science (Elsevier) 2 (2010) 207–212.

[14] Hurley, D.J., "A new force field transform for ear and face recognition", Image Processing, 2000. Proceedings. 2000 International Conference (IEEE) Volume: 1 Page(s): 25 - 28 Vol.1.

[15] Chai Beng Seow, "Wavelet-DCT based image coder for video coding applications", Intelligent and Advanced Systems, 2007. ICIAS 2007. International Conference (IEEE) Page(s): 748 – 752.

[16] Saeeduddin Ansari, Phalguni Gupta, "Localization of Ear Using Outer Helix Curve of the Ear", Proceedings of the International Conference on Computing: Theory and Applications (ICCTA'12) 0-7695-2770-1/07.