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

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ABSTRACT:
Biometric is a unique, measurable physiological or behavioral 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.

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.

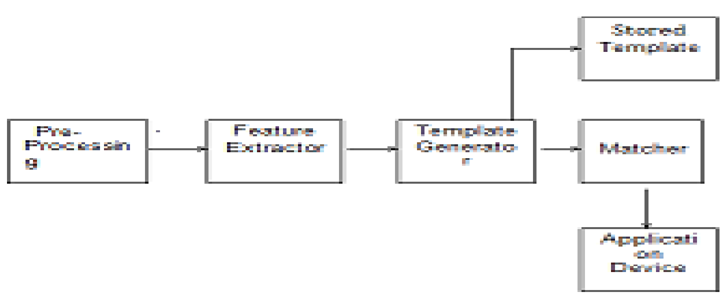


Figure 1.1 General Biometrics

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 use

RELATED WORK:

Currently, most of the people in the world use the smart card or PIN number for a security system. But these systems are not fully protected from the intruder. So the scientist developed many other security system using cryptographic concepts but all security system is based on cryptographic concept. Cryptographic concept also has some loopholes and may hack by different intruders. So scientist used human body trait as a security trait and developed unimodal and multimodal biometric system.

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.

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.

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.

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.

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%.

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.

PROPOSED ARCHITECTURE:

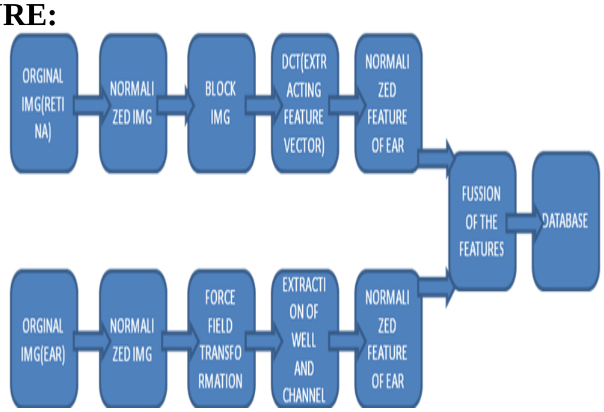


Figure:1.2 Block diagram

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.

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.

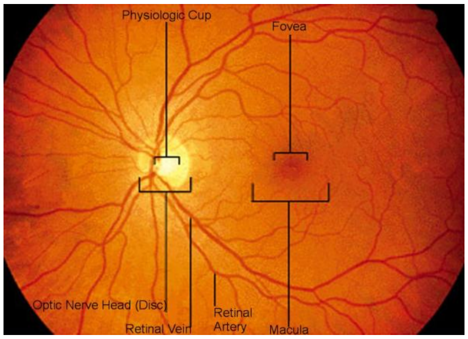


Figure 1.3. Retinal image

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 .

THE ONE-DIMENSIONAL DCT:

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

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

for u = 0,1,2,…,N −1. Similarly, the inverse transformation is defined as

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

for x = 0,1,2,…,N −1. In both equations **(5)** and **(6)** α(u) is defined as

$$\alpha(u) = \begin{cases} \sqrt{\frac{1}{N}} \\ \sqrt{\frac{2}{N}} \end{cases} \quad \textbf{(7)}$$

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

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)

(8)
$$f(u,v)=\frac{1}{\sqrt{2N}}c(i)c(j)\sum_{x=1}^{N}\sum_{y=1}^{N}\cos\left[\frac{(2x+1)i\prod}{2N}\right]\cos\left[\frac{(2y+1)i\prod}{2N}\right]$$

(9)
$$c(u)=\begin{Bmatrix}\frac{1}{\sqrt{2}}ifu=o\\ 1ifu>0\end{Bmatrix}$$

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.

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.

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.

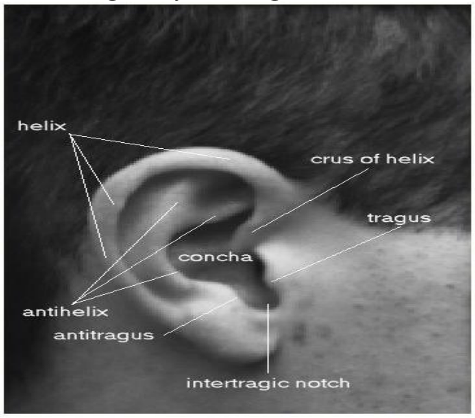


Figure 1.4 Ear Image

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.

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).

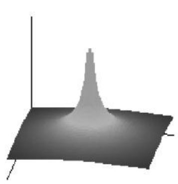
$$F_i(rj) = P(rj)\left(\frac{ri-rj}{(ri-rj)^3}\right) \quad \textbf{(1)}$$

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.

POTENTIAL ENERGY FUNCTION:

The potential energy function of a single isolated pixel looks like the shape shown in Figure 1.4

energy



distance

Figure 1.5. 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.

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.

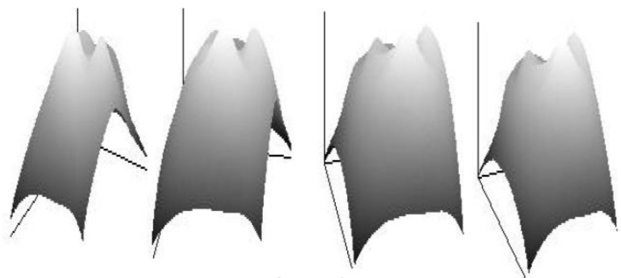


Figure 1.6 Energy Surface for an Ear Viewed From Below the Lobe

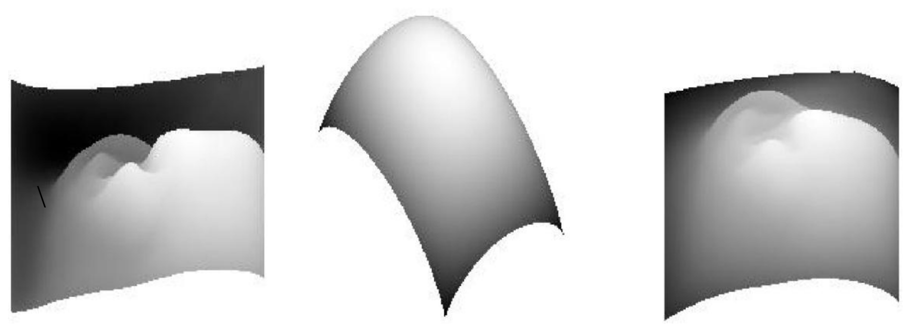
This summation is then carried out at each image pixel location to generate the complete transformation, which is a smoothly varying surface due to the fact that the underlying potential functions have smooth surfaces. The result of this process for the energy transform for an ear image is shown in Figure 1.4, where the same surface has been depicted from a variety of different perspectives below the lobe

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 1.3 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.

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 1.4



(a) Variational component (b) Dome component (c) Composition

Figure 1.7 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.

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.

$$F(r) = -grad(E(r)) \qquad \textbf{(2)}$$

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)

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

The force field is calculated as explain in the Figure 1.5

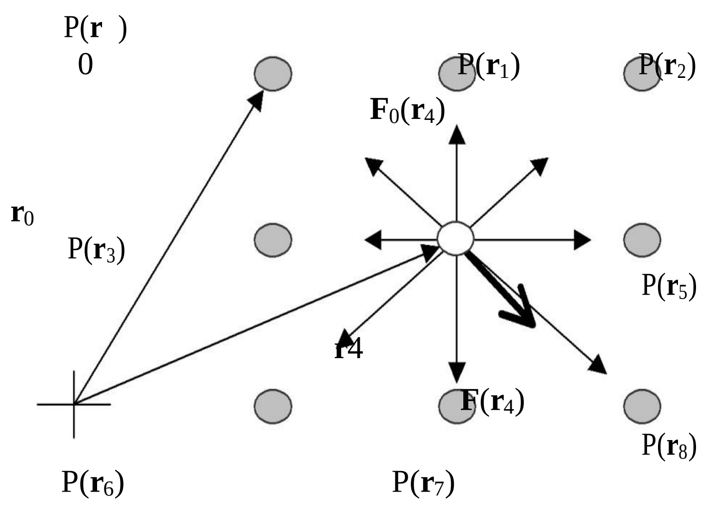


Figure 1.8 Force Field Calculations at the Centre of A 3x3 Pixel Image

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

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

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.

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.

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.

SIMULATION RESULTS:

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:

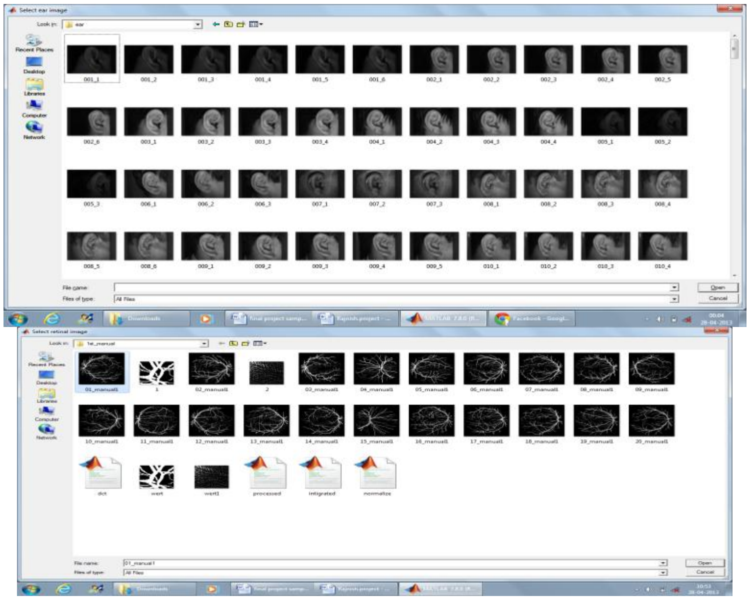


Figure 1.9 Selecting Ear and Retinal Images from the Database

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:

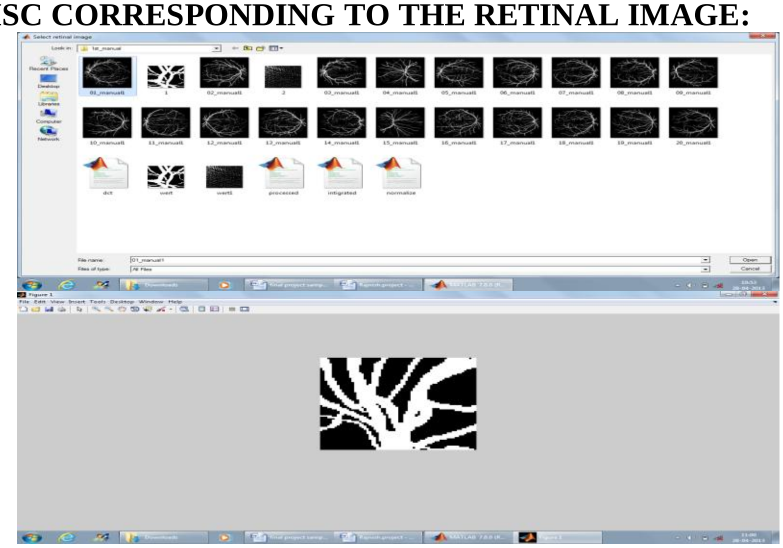


Figure 1.10 Optic Disc Corresponding to the Retinal Image

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:

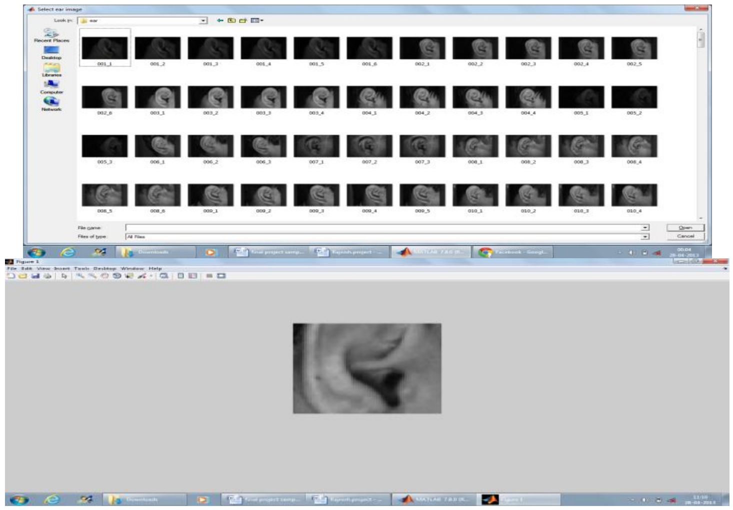


Figure 1.11 Ear ROI Corresponding to the Ear Image

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:

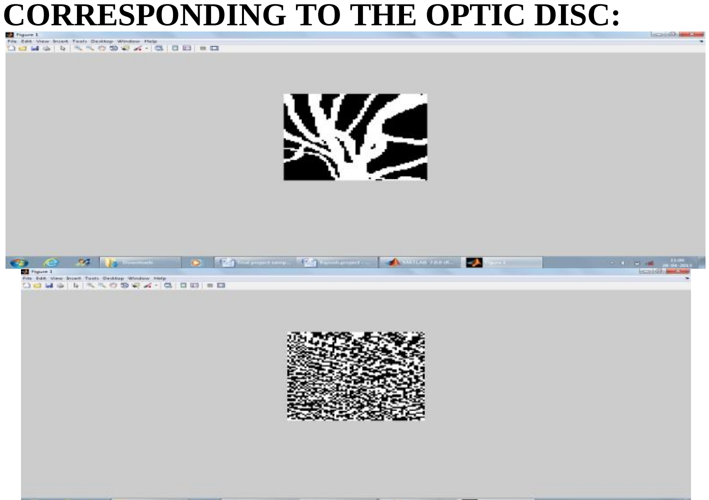


Figure 1.12 DCT Image Corresponding to the Optic Disc

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:

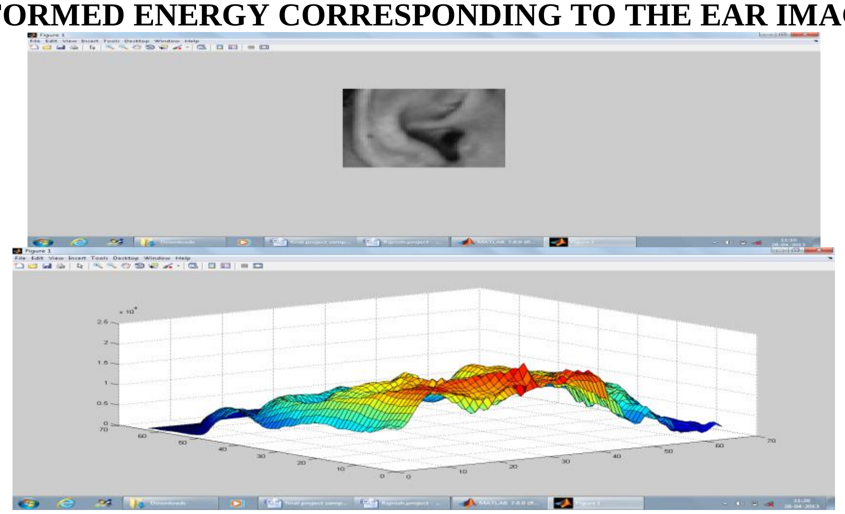


Figure 1.13 Transformed Energy Corresponding to the Ear Image

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

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.

OUTPUT: RESULT OF TEST SUBJECT:

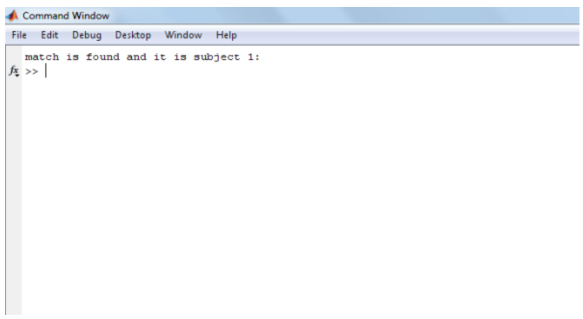


Figure 1.14 Result of Test Subject

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:

1. In ear each pixel is treated as point mass and distance between two nearest pixel as unity.
2. The ear images used in this project are without occlusions.

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