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Ear Biometrics for Automatic Index Segmentation Using Canny Edge Detection

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***Abstract*-A biometric system is essentially a pattern recognition system which uses a Specific physiological or behavioral characteristic of a person to determine their identity or verify a claimed identity. An Ear biometrics for automatic index segmentation algorithm for grayscale image is proposed by applying canny edge detection, distance metric, Euclidian distance and Pythagorean Theorem. In this paper, we have performed the identical to ear image, comparison of the different applied models being currently used for the ear image modeling, processing the details of the algorithms, methods and finally tracking the error and limitation from the input database for ear identification.**

Keywords-Ear Biometrics, Image Acquisition, Edge Detection, Distance Metrics, Segmentation of Ear

I. Introduction

Biometrics is material or behavioral characteristics that can be used for human identification. For example, many a times identity of a person needs to be proven like, to use an ATM, entering an organization, e - commerce, to gain access. There are several conventional means for personal identification which include passports,keys, tokens, access cards, personal identification number (PIN), passwords. It can be lost, stolen or duplicated, and passwords, PINs can be forgotten, cracked or shared. These drawbacks cause a great loss to the concerned. i.e. uniqueness, universality, permanence and collectability.The growing demand for new techniques in the field of biometrics, Ear biometric is proving to be one of the most promising among various reliable biometrics (e.g.: iris, retina,...). Ear as a biometric has a certain advantage over other biometrics.Nowadays the observation of characteristics is astandard technique in forensic investigation and has beenused as evidence in hundreds of cases. The strength ofthis evidence has, however, also been called into questionby courts in the Netherlands. In order to study thestrength of ear prints as evidence, the Forensic Earidentification Project (FearID) was initiated by nineinstitutes from Italy, the UK, and the Netherlands in2006. In their test system, they measured an Equal ErrorRate (EER) of 4% and came to the conclusion that earprints can be used as evidence in a semi-automatedsystem.

II. Related Works

Iannarelli, (1989), [1].Ear Identification, Forensic Identification Series, Paramount Publishing Company, Fremont, California, The use of the ear for human identification began with the development of the Iannarelli System. This system is based upon 12 geometric measurements of the ear. Nadler& Smith (1993), [2] proposed the fundamental problem of pattern recognition is to identify an object as belonging to a particular group. Pattern recognition assumes that objects associated with one group are more closely related to one another (i.e., share similar features) than with objects in different groups. Therefore, to determine which group an object belongs in necessitates first identifying the features of a certain object, which is the pattern, and then determining which group those features are most likely to represent, which is recognition. Rettberg et al. (2007),[3] proposed the process may be divided into two fundamental tasks, according to: the description task generates attributes of an object using feature extraction techniques, and the classification task assigns a group label to the object based on those attributes with a classifier.

Li & Jain (2009), [4] proposed have acknowledged that variations can cause the accuracy of an identification system to drop considerably. Such a decline may be caused by natural processes or presentation issues, news, and fundamental inadequacies of biometric sensing techniques As a result; Li & Jain (2009),[4] recommend the need to improve current biometric algorithms that enable the identification of variations mentioned and eliminate irrelevant features from the input. The results can be matched with the images in the database in an effective and efficient manner. However, this is no small task since these would require the combination of various techniques to obtain the optimal robustness, performance, and efficiency. According to Li and Jain, such measure is a key step in the biometric algorithm design (Li & Jain 2009). Hurley et al. (2007), [5] used force

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field features extraction to cut the ear to "an energy field which highlights 'potential wells' and 'potential channels' as features, achieving a recognition rate of 99.2% on a dataset of 252 images".

Hurley, Nixon and Carter (2007), [6] Another significant approach is proposed an based on Force Field Transformations in which an image is treated as an array of Gaussian attractors that act as the source of a force field. Burge & Burger (1998),[7] proposed modeled individual ears with an adjacency graph an early attempt at seriously developing an ear biometric system was launched by calculated from a Voronoi diagram of the ear curves. Nevertheless, they did not offer a detailed analysis of their system's biometric potential. Subsequently, therefore, Burge & Burger finalized a follow-up study that demonstrated ear biometrics can be used for passive identification. Surya Prakash et.al (2008),[8] proposed a color based skin segmentation. But the major obstacle of using color to detect skin region is that the appearance of skin-tone color can be affected by different lighting conditions.

III. EAR BIOMETRICS

Ear is a comparatively new class of biometrics. The ear biometrics for automatic segmentation method used index point calculated in Biometrics. Ear features have been used for many years in the forensic sciences for detection. Ear is a stable biometric and does not vary with age. Ear has all the properties that a biometric trait should have, i.e. individuality, universality, durability and collectability.

A. Anatomy of the Ear

Ear does not have a completely random structure. It has standard parts as other biometric traits like face. Figure .1 shows the standard features of the ear. Unlike human face, ear has no expression changes, make-up effects and moreover the color is constant throughout the ear.

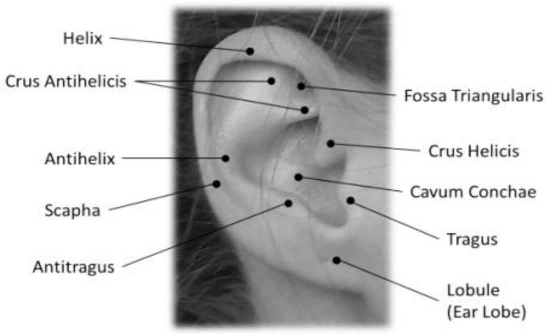

Figure 1. Anatomy of the Ear

In addition to the familiar rim or helix and ear lobe, the ear also has other prominent features such as the anti-helix which runs parallel to the helix, and a distinctive hairpin-bend shape just above the lobe called the inter tragic notch. The central area or concha is named for its shell-like appearance.

IV. THE PROPOSED APPROACH

Several approaches that were proposed for ear recognition.A simple two method based on the concept of Euclidean distance metrics and feature vector. Ear Recognition can be divided into four major steps -image acquisition, pre-processing, feature extraction, segmentation results.

A. Methodology

1. To study, analysis the ear biometrics.
2. To recognize, identity the ear pattern used canny edge detection.
3. To quantify ear angles, distance metrics used Matlab database,

a) Ear Image Database

The proposed work is implemented in Matlab using Ear image Database. We capture ear image our class students and collected them for Image processing method, the database had to be created. Ear images were taken from most of the participants. We decided to limit the database to the left ear in full frontal view.

Figure - 3 contribute the image which conserves the outer shape of the ear is Security and the authentication of individuals is necessary for many different angles of the ear, with most people having to authenticate their identity on a daily basis. Ear recognition is a particular type of biometric system that can be used to reliably identify a person by analyzing the patterns found in the ear. The ear is so reliable as a form of identification because of the uniqueness of its pattern.

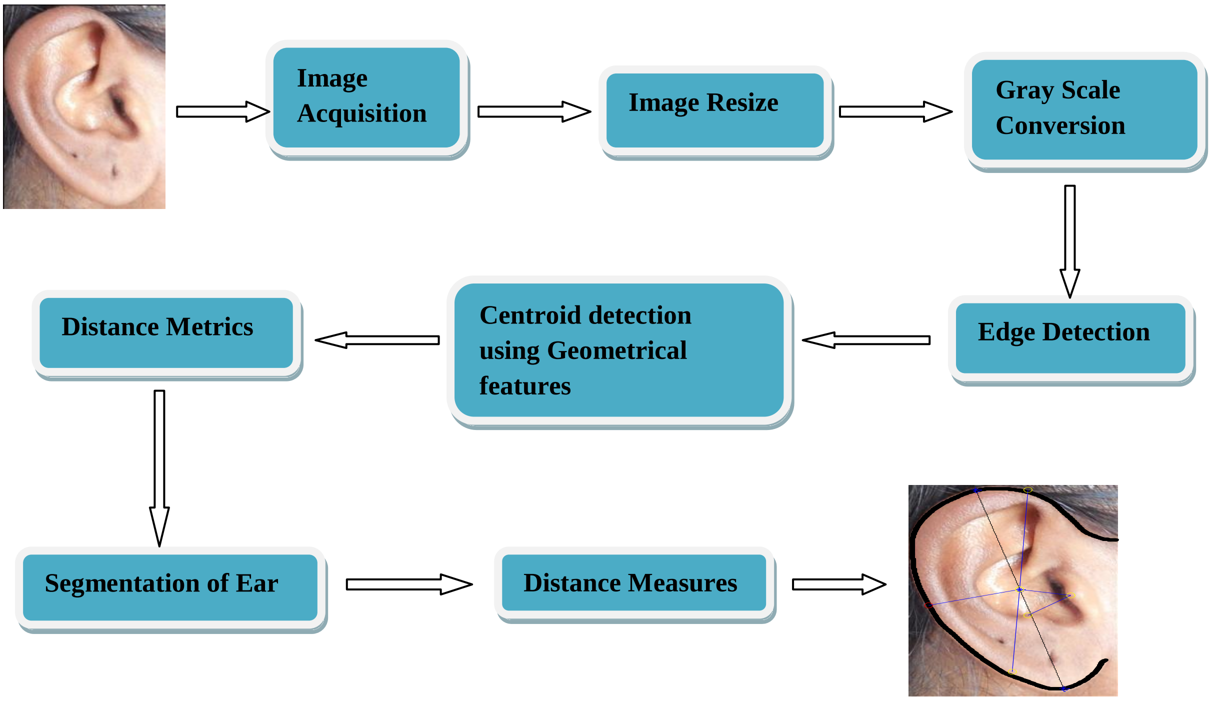

Figure 2. Flow Diagram Of Automated Ear Biometrics Processing

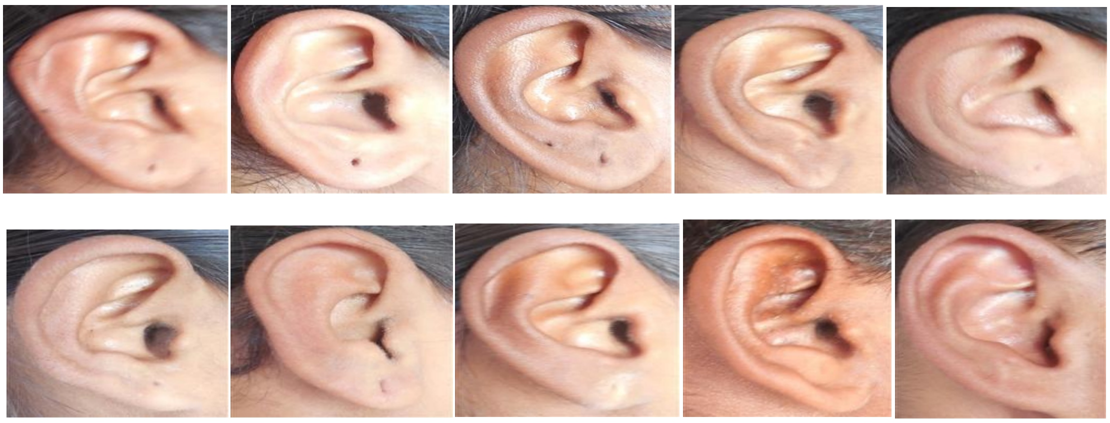

Figure 3. An example image which conserve the outer shape of the ear.

b) Image Acquisition

The side face images have been acquired using Sony DSC-P10 camera in the same lightening conditions with no illumination changes. All the images are taken from the right side of the face with a distance of 15-20cms between face and the camera. The images have been stored in JPEG format. The images should be carefully taken such that the outer ear shape is preserved. The less erroneous the outer shape is the more accurate the results are. Figure- 4 Contribute an image which conserves the outer shape of the Ear.

Figure 4. The side image which conserves the shape of the Ear

The human ear is observed to exhibit variations across individuals as assessed by the curves and geometric measurements pertaining to the pinna or the auricle (the main part of the external ear).

c) Ear Image Resizing

The cropped ear image may be of varying size so the feature set of images may also vary. Hence the images are normalized to a constant size by resizing technique used database. Each file in the database has images of the right ear taken image resize 200*318. Two images per person have been taken and stored. Figure - 5 contribute Resizing an image.

Figure 5. Shows resizing image

MATLAB has been used for completing the method to extract features and match the images to the database. For each of the images a feature vector was planned as follows: First, the color images were converted to a grayscale image.

d) Gray Scale Image Conversions

The ear part is manually cropped from the side face image and portions of the ear, which do not constitute the ear are colored black leaving only the ear. The colored image is then converted to a grayscale image. Figure - 6 contribute the grayscale image which is obtained by cropping the ear part of the image.

Figure 6. Shows TheGrayscale Image

B. Ear Feature Extraction

1. Edge detection &Binarization.
2. Euclidean distances & Angles of triangle detection.

If the shape is getting match than other feature vectors like Euclidian distances, angles of a triangle is compared and the maximum feature vector of a person is matched gets identified.

a) Edge Detection And Binarization

The edge detection and binarization is done using the well known canny edge detector. If w is the width of the image in pixels and h is the height of the image, the canny edge detector used takes as input an array w*h of gray values (float values) and sigma (standard deviation) and outputs a binary image with a value 1 for edge pixels, i.e. the pixels which constitute an edge, and a value 0 for all other pixels. Figure 3.10 contribute a grayscale image and its corresponding edge detected binary image obtained from the canny edge detector.

It can be observed that the edge detected image has many noisy edges. For edge detection the canny edge detection is used with a threshold of 0.3 as canny detection gives the best results under the given illumination conditions. Along with this dilation is used to connect the edges which may be broken by the edge detection process. Thinning has already been incorporated in the canny detection.

b) Canny Edge Detector

Then, the canny edge detector was applied to identify the main edges on the ear image. Since the ear has quite a lot of ridges, it seemed like a suitable choice. We assumed that the longest edge detected would be the outer contour of the ear. Then the longest extend between the contour points was determined.

Before extracting distinguishable features from the ear Images for creating binary ear templates, the images need to go through the preprocessing phase. At first, the ear region needs to be separate using an edge detection method. Canny Edge Detector is used to create an edge-map figure - 7contributes contour edge detection of the captured ear image.

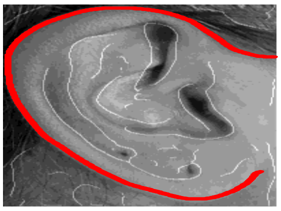

Figure 7. Shows Canny Edge Detection

c) Contour Points Edge Detection

Then, the Canny edge detector was applied to identify the main edges of the ear image. Since the ear has quite a lot of ridges, it seemed like a suitable choice. We assumed that the longest edge detected would be the outer contour of the ear. Then the longest extend between the contour points was determined for this distance matrix for all contour points of all contour points was computed. The two points on the counter, which are farthest apart, are selected. These two points span the main axis of the ear feature vector, as indicated in the following figure - 8.

d) Center Points Detection

The ear image processing has a center point on this line is calculated. Relative to that line three other points are calculated, as can be seen in the next figure. The Distance Metrics are a method for finding shapes in an image. The Centroid detection has been implemented here, which is used to find the center point within image, calculate an edge map figure - 8 shows center point distance find out the image.

e) Centroid Calculation

The centroid of the ear is calculated. The average distance in each direction is taken and expressed as a proportion of the total area of the shape in centroid calculation. The centroid relates to the center of mass. Thus, each and every image will have its different centroid. The centroid comes out to be the Concha region of the ear.

f) Ear Length

By finding the ear length, the distance of some boundary pixels is calculated from some selected boundary pixels. Thus, we come up with two pixels which are at the farthest distance from one another. A line is drawn between these two pixels and referred as the Reference Line. This line denotes the length of the ear. Figure - 8 contribute The Two Points Main Axis Of The Ear Feature Vector

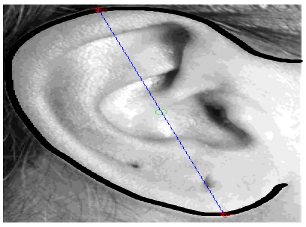

Figure 8. Shows The Two Points Main Axis Of The Ear Feature Vector

g) Extraction Of Feature Vector

There are two feature vectors which are under consideration. Euclidean distances of a side of a triangle d1, d2, d3 and angles of a triangle q1, q2, q3.To reduce the computational complexity and to minimize the errors from the feature extraction process. Figure -9 contribute for a feature vector of distance and ear parts explained.

Here to find a reference point the concept of max line is used. In this a line which is the maximum possible distance from any two pixels of the outer edge is found out.

Now the midpoint is found out which is the reference point.

For the 1st vector division of the line helix Rim and lobe are joined. Normal from these points are taken and their intersection with the boundary is stored. Angles from the reference point and the point obtained are stored as 1st feature vector. An optimal value of “n” for the division of line should be considered for satisfying the accuracy, space and time requirement.

For 2nd feature vector reference point is taken as the midpoint and it is joined to an antihelix and Concha.

For 3rd feature vector reference point is taken as the midpoint and it is joined to ancavum Concha and antitragus.

For 4rd feature vector reference point is taken as the midpoint and it is joined to ancavumConcha and tragus.

For 5nd feature vector reference point is taken as the midpoint and it is joined to a Fossa Triangulars and antitragus.

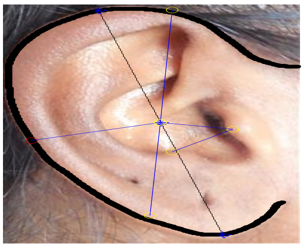

Figure 9. Feature vector of distance

V. SEGMENTATION AND RESULT

Segmentation partitions an image into distinct regions containing each pixel with similar attributes. To be meaningful and useful for image analysis and interpretation, the regions should strongly relate to depict objects or features of interest. Meaningful segmentation is the first step from low-level image processing, transforming a grayscale or color image into one or more other images to high-level image description in terms of features, objects, and scenes. The success of image analysis depends on the reliability of segmentation, but an accurate partitioning of an image is generally a very challenging problem.

The segmentation and measures ear recognition has been Canny edge detector was applied to identify the main edges of the ear image. Since the ear has quite a lot of ridges, it seemed like a suitable choice. The ear image processing has a center point on this line is calculated. The max line, thus obtained needs to be further divided so that we have center points in the feature vector. After getting the similarity result of ear segmentation values find out the Distance metrics Euclidean distance.

A. Boundary of Outer Ear Shape

To find the boundary of the outer ear shape we first have to find out all the boundaries that are available and store them in a vector B. To do this we use a function. It traces the exterior boundaries of objects, as well as boundaries of holes inside these objects, in the binary image BW. “Bwboundaries” also descends into the outermost objects (parents) and traces their children (objects completely enclosed by the parents).To find the outer ear shape we check for the boundaries whose length is greater than 200 pixels and at the same time the starting from the top.

B. Distance Metrics

The distance formula can be obtained by creating a using the Pythagorean Theorem . We can find the distance between the two points $P_1(x_1, y_1)$ and $P_2(x_2, y_2)$ in the rectangular coordinate system. Figure 10 Contribute Graph representation of distance between two points.

The distance that we need to find is represented by d and shown in blue. Notice that the distance between two points on the dashed horizontal line is the absolute value of the difference between the x-coordinates of the two points. This distance, $|x_2-x_1|$, is shown in pink. Similarly, the distance between two points on the dashed vertical line is the absolute value of the difference between the y-coordinates of the two points. This distance, $|y_2-y_1|$, is also shown in pink.

The subscripts refer to the first and second points; it doesn't matter which points you call first or second.

- X_2 and Y_2 are the X,Y coordinates of one point.
- $X_1$and Y_1 are the X,Y coordinates for the second point.
- D is the distance between the two points

Because the dashed lines are horizontal and vertical, a right triangle is formed. Thus, we can use the Pythagorean Theorem to find distance d. By the Pythagorean Theorem, is given by the equation (1).

$$d^2 = |x2 - x1|^2 + |y2 - y1|^2$$

$$d = \sqrt{|x_2 - x_1|^2 + |y_2 - y_1|^2}$$

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad (1)$$

This result is called the distance formula.

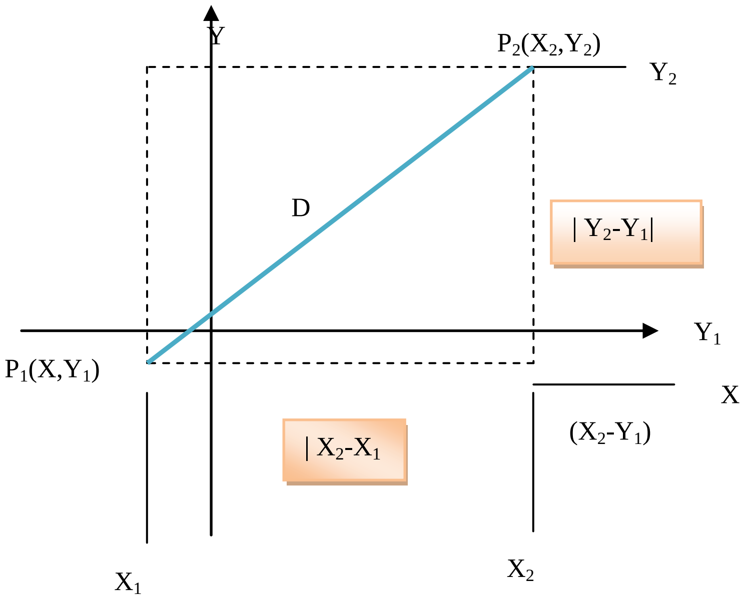

Figure 10. Graph representation of distance between two points

C. The Distance Formula

The distance, d, between the points (x_1,y_1) and (x_2,y_2) in the rectangular coordinate system is given by the equation (2).

$$d = \sqrt{(x_2 - x_1)^2 + (y_2 - y_1)^2} \quad (2)$$

When using the distance formula, it does not matter which point you call (x_1, y_1) and which you call (x_2, y_2).

D. Find The Midpoint Of A Line Segment

The distance formula can be used to derive a formula for finding the midpoint of a line segment between two given points. The formula is given as follows:

E. The Midpoint Formula

Consider a line segment whose endpoints are (x_1, y_1) and (x_2, y_2). The coordinates of the segment's midpoint are is given by the equation (3).

$$\left(\frac{x_1 + x_2}{2}, \frac{y_1 + y_2}{2}\right) \quad (3)$$

To find the midpoint, take the average of the two x-coordinates and the average of the two y-coordinates.

F. Euclidean Distance

The Euclidean distance between points p and q is the length of the line segment connecting them ($\overline{pq}$). In Cartesian coordinates, if $p = (p_1, p_2,..., p_n)$ and $q = (q_1, q_2,..., q_n)$ are two points in Euclidean n-space, then the distance from p to q, or from q to p is given by the equation (4).

$$d(p,q) = d(q,p)\sqrt{(q_1 - p_1)^2 + (q_2 - p_2)^2 + \cdots (q_n - p_n)^2} = \sqrt{\sum_{i=1}^{n}(q_i - p_i)^2} \quad (4)$$

The position of a point in a Euclidean n-space is a Euclidean vector. So, p and q are Euclidean vectors, starting from the origin of the space, and their tips indicate two points. The Euclidean norm, or Euclidean length, or magnitude of a vector measures the length of the vector is given by the equation (5).

$$||p|| = \sqrt{p_1^2 + p_{2+\cdots+}^2 p_n^2} \quad (5)$$

where the last equation involves the dot product.

A vector can be described as a directed line segment from the origin of the Euclidean space (vector tail), to a point in that space (vector tip). If we consider that its length is actually the distance from its tail to its tip, it becomes clear that the Euclidean norm of a vector has been just a special case of Euclidean distance: the Euclidean distance between its tail and its tip. The distance between points p and q may have a direction (e.g. from p to q), so it may be represented by another vector, is given by the equation (6).

$$q - p = (q_1 - p_1, q_2 - p_2, \dots\dots q_n - p_n) \tag{6}$$

In a three-dimensional space (n=3), this is an arrow from p to q, which can be also regarded as the position of q relative to p. It may be also called a displacement vector if p and q represent two positions of the same point at two successive instants of time.

The Euclidean distance between p and q is just the Euclidean length of this distance (or displacement) vector is given by the equation (7).

$$||q - p|| = \sqrt{(q - p).(q - p)} \tag{7}$$

which is equivalent to equation 1, and also to is given by the equation (8).

$$\|q - p\| = \sqrt{||p||^2 + ||q||^2 - 2_{p.q.}} \tag{8}$$

G. N Dimensions

In general, for an n-dimensional space, the distance is given by the equation (9).

$$d(p, q) = \sqrt{(p_1 - q_1)^2 + (p_2 - q_2)^2 + \cdots + (p_i - q_i)^2 + (p_n - q_n)^2} \tag{9}$$

H. Segmentation of Ear

The proposed method for Ear segmentation is tested on an Ear image database. The performance is tested with image quality measurements like Geometry, distance metric and Euclidean distance an angles, triangles.

For the segmentation, measure the all angles, triangles distance point find out. It can be presented feature vector distance index point calculated in following the table is given by 1.

TABLE I. FEATURE VECTOR INDEX POINT CALCULATED

S.No	Feature vector Distance	Calculated Values For Indexing Point
1	CD	0.2415
2	CE	0.1292
3	CF	0.3033
4	ED	0.2084
5	DF	0.5952
6	EF	0.0855
7	DF	0.5138
8	AD	0.6728

Next we have to segment and measures the all angles, triangles distance point find out. It can be presented in the following figure 11.

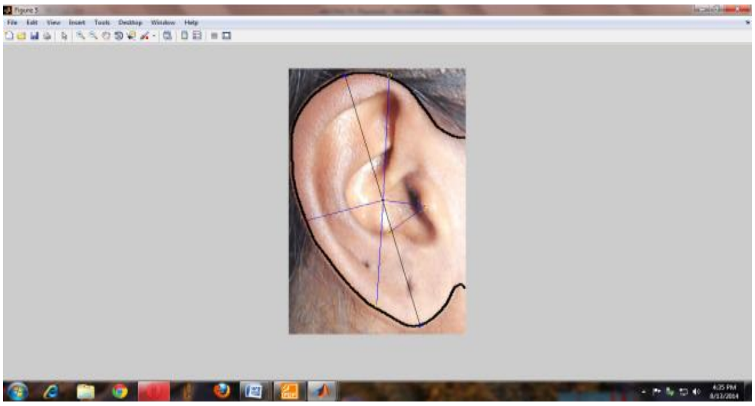

Figure 11. All angles, triangles distance point found.

VI. CONCLUSION AND FUTURE WORK

Ear biometrics for Automatic index segmentation is the recent technique emerging in biometrics for authentication and identification. Ear index point detection is used as a pattern in recognition of ear images. We have identified the boundary of the outer ear from the given image and determined the shape. We have performed Canny Edge Detection using binary extraction. We have found out the midpoints using Distance matrix of the Pythagorean Theorem. We used the Euclidean distance for segmentation and to draw the line segments. Using Canny Edge Detection gives better performance than the method to other algorithm.

In future, we have planned to extend this work to identify and verify a person. We would like to develop an algorithm so that we could use it along with face biometrics system which could serve as a strong authentication system.

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