HYBRID CORDIC TRIGONOMETRIC VECTOR ROTATION MODE for AUTHENTICATING EAR and FINGER IMAGES

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Abstract - Security is a major issue as far as the use of computers is concerned. As computer technology is becoming more complex the problem of security is also becoming complex. The ingenuity of the human brain is such that for every innovation which has positive use there is also a parallel innovation in circumventing the positiveness of that use and it comes up with an antidote to that positivity. The problem of hackers and with the evolution of the idea of cloud computing security has become an important issue. In this paper we are primarily concerned with the problem of access control and authentication. As everyone knows biometrics is used for authentication in computer science. Biometrics identifies physical characteristics of the human beings that are distinctive to each individual and are easily measured. Among other things the popular physiological feature that has stood the test of time is finger print matching which is mostly used in forensic science. In recent years ear matching is also considered a possible physiological feature for authentication and identification of individuals. Now the question is how fool proof are these? In this paper we attempt to review recent literatures on these and applying Hybrid CORDIC Trigonometric Vector Rotation Mode algorithm and taking a pair of index fingers and a pair of ears as test cases we found better results in accuracy.

Keywords – Authenticating, Ear and Finger images, Hybrid CORDIC, Trigonometry, Vector Mode.

I. INTRODUTION

A. Biometric Authentication:

Authentication in computer science refers to the act of confirming the identity of a person. Here we are not concerned with other kinds of authentication. Even here we are concerned with something the person *is.* In other words, in this paper, we are concerned with what is known as inherence factor. It can be fingerprints, iris, voice, Finger vein, DNA or other biometric identifiers. To be more specific in computer science one talks of biometric authentication which is also called realistic authentication. In this physiological characteristics which are distinctive and measurable are taken for consideration of the physiological characteristics as we have already referred finger print has been considered an authentic characteristic for authentication since 1891. And lately the ear has also become an important physiological area for proper identification. [1]. There are two phases in biometric authentication, this diagrammatically represented in Fig.1.

B. Finger print authentication:

Finger print is nothing but taking impressions of a finger of a human being for authentic identification. This is the key method in forensic science. It is easy to take impressions of finger prints as they are easily made on metal ore glass. The advantage of finger prints is that it is durable, unique and cannot be changed.[6] This is shown in Fig.2.

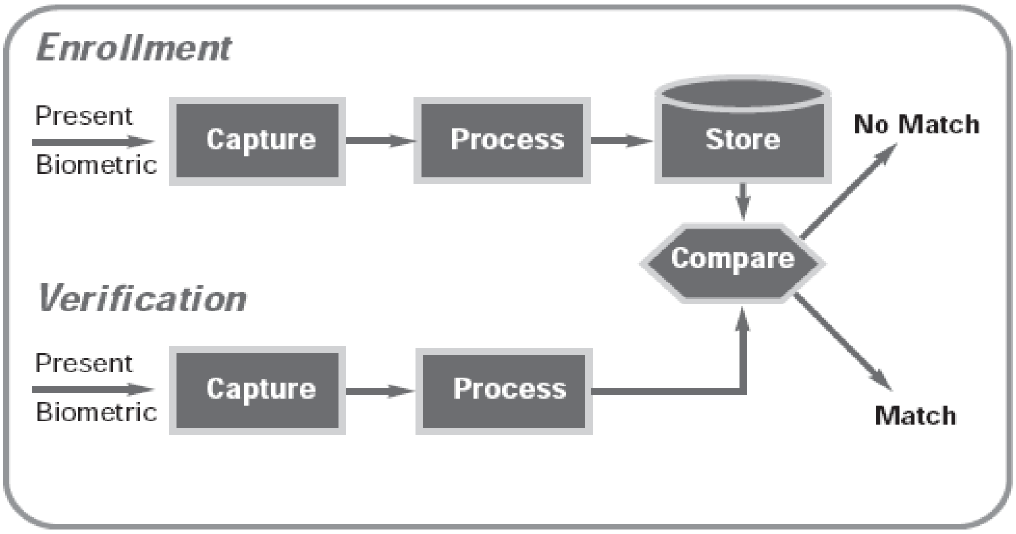


Fig.1 Biometric Authentication Phases

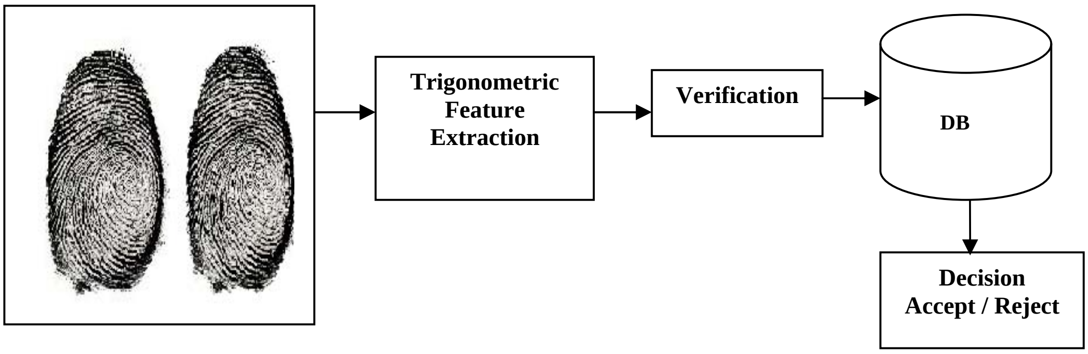


Fig.2 Finger Print Authentication

C. Ear Pattern Recognition :

The shape of the outer ear, lobes, bone structure and the size are unique to each person. Ear pattern recognition is employed as a physical contactless biometric (Carreira-Perpinan & Sanchez-Calle, 1995) and uses an Optophone toverify the shape of the ear. A French company, ART Techniques, developed the Optophone and the process. It is a telephone type handset, which is comprised of two components (lighting source and cameras). Much like the minutiae points of a palm print or fingerprint the outer ear has many detailed features that can be measured and compared to a biometric template. [2][3].

II. REVIEW OF LITERATURE

In our review of literature we have taken up for review only those reputed International Journal articles that we found important for our research. We have not reviews all journal articles that we have read.

1.“An Enhancement Algorithm Using Gabor Filter For Fingerprint Recognition”:

The authors of the under review begin their paper with a good introduction to finger print recognition. However there is ambiguity even in the interlocutory part as in some other parts. Not with starveling grammatical truth and lack of and false lexical markers one can comprehend the main drift of their argument. [7][8] The authors attempted to improve upon the Gabor filter by separating two 2D Gabor filter to two one dimensional Gabor filter to two one dimensional Gabor filter. This the authors say reduces the time of the image process. They also say that the filtering was based on the Eucledian distance principle to be maintained between template finger print & import finger print. The presented enhanced algorithm for finger print recognition has given them better results, the authors claim and this is statistically explained in table 5 of the paper. However there is a certain doubt lingering in our minds about the validity of the results as one feels not enough databases have been obtained. The sentences about their future course of certain reads this:"in future we are working to handle the filtering of finger print in age in a good quality" this beats our understanding.

2. "Minutiae-based Triangular Acreage Fingerprint Match Method":

The paper entitled bears testimony to the fact the authors are very clear in presenting their findings. Their introduction to the subject fingerprint in general and to minutiae based finger printing in particular is clear and exhaustive. They also explain clearly the minutiae based algorithm and its four steps. This paper in a way is an advance on their previous attempts. In this paper they propose a minutiae based triangular acreage fingerprint match method. Their attempt was to overcome the drawbacks of the existing system. This method, the authors aver, handles complicated fingerprint images such as skew, displacement, unevenness, different background brightness and size partial overlap, missing and spurious minutiae points. And their new approach satisfactory addresses all the aforementioned complications in finger print matching.[12]. This paper is interesting as the detailed process of experimentation proves. As they clarify they divided whole fingerprint into three points and then connect the three points with straight lines and then calculate the acreage of it. This method, the authors argue, is fast and it overcomes the relative nonlinear deformation present in the finger print image pairs.

3. "An Efficient and Reliable Fingerprint Matching Authentication by FFT":

One of the problems of getting fool proof results is the problem of clarity and continuity of ridge structures. The paper under review addresses this curse. The authors propose a novel (as claimed by them) finger print enhancement algorithm to overcome the problem of continuity of ridge structures. Using FFT analysis and by adopting the other two properties such as Histogram equalization and image Binarization. There model algorithm going by their results seems better than such previous attempts. In their paper beautifully illustrates the difference between enhanced FFT and ordinary FFT. In an enhanced FFT one council see false broken points on ridges getting connected and spurious connections between ridges getting removed. Then Figure 8 illustrates the difference between Binarized images after FFT and before and with naked eyes one could realize the values of FFT. This paper under review is well written in a clear style. A step by step description of the processes has been well presented by the writers. ROI extraction by morphological extraction, taking care of Ridge Thinning by which they were able to eliminate redundant pixels,[11] after enhancing the picture image and segmenting the required area the minutiae extraction gave them the final to their steps.

4. " Ear Authentication using Log-Gabor wavelets":

The authors of the paper under review claim a new approach to the study of ear as an authentic biometric option for authentication. There are several approaches to ear identification and these have chosen Log-Gabor filter method. They studied only side face images and as they have rightly said their own further research will be directed in trying to integrate matching scores generated from the side face image with these from localized ear images employed in this work.

III. EXISTING METHODS

Many approaches and several researches have been proposed to extract unique features from human ear to identify people depend on this features**.** Zhichun Mu et. al [4] discussed the edge-based ear recognition method including ear edge detection, ear description, feature extraction, recognition method and ear database construction. The feature vector is composed of two vectors: inner and outer vectors. They constructed ear database which composed of 77 subjects. The images of each subject are taken under two conditions: illumination variation and orientation variation. Individuals were invited to be seated 2m from t he camera and change his/her face orientation. The images size is 300x400 pixels. Using the Back Propagation network as classifier, they got a recognition accuracy of85%. Accuracy is still low. JitendraB et. Al [5] produced multiple geometrical feature extraction (such as shape, Euclidean distances of side of a triangle, and angles of a triangle as a feature vector) of ear based method to identify a person using ear biometrics. They used their own database. The side face images are acquired using digital camera under lighting conditions with no illumination change. Data of 30 people tests have been conducted, successful results were found for 28 subjects with overall efficiency of 90%, but they used very small database. AnupamSana et. Al [6] presented ear biometrics system for human recognition based on Haar wavelet transform. Haar wavelet transform was used to decompose the ear image and compute coefficient matrices of the wavelet which were clustered in its feature template. Decision was made by matching one test image with n trained images using Hamming distance approach. They used two data bases IITK and database created from Saugor University, India. Accuracy of the system is 96%. Coefficient matrices were very large. Choraset. al [7] also used an approach for feature extraction based on contour detection, but disadvantage of this method is erroneous curve detection. They performed their experiments on their database of collected ear images. 240 images). They divided the database into several sets of images concerning their quality and degree of complexity. They limited their experiment with images of very high quality. For such easy images from their database they obtained error-free recognition. Chang et. al [8] used Principal Components Analysis which is the most popular approaches to ear recognition. Their database used consisted of 197-images as a training set. But this approach gives very low accuracy 71.5%. Wang et. al [9] used moment invariants and Back Propagation neural network. Their database consisted of 60 images and accuracy=91.8%. Database is small.

IV. PROPOSED SYSTEM

Out of the several papers we read, we narrowed down on six specific papers that bear actual relevance to our study. We are presenting in a tabular column a brief summary of these papers. This is shown in the following table.

Table 1. Existing Methods and Authors Proposed

Physical Feature	**Algorithm**
Fingerprint	Enhancement algorithm using Gabor Filter
Fingerprint	Minutiae Based Triangular Acreage
Fingerprint	FFT
Ear Pattern	Log Gabor Wavelets
Ear Pattern	Locally Linear Embedding
Ear Pattern	Geometrical Feature Extraction
Authors: Pair of Index Finger and Ear images	***Trigonometric and Hybrid CORDIC Vector Mode***

All the research of the above papers have studied only single ears and not two ear of the same person. Some of these have studied only finger prints, some only ears, some both. They have also used old CORDIC rotation mode method. But we have studied patterns of two ears of the same person and applied trigonometric and Hybrid CORDIC Vector Mode method. The proposed algorithm and system are described in Table2 .

A. Ear Recognition:

The usage of ears in biometrics seems peculiar at first; however, it is a good anatomical feature for identifying a person as it is unique to every person and rarely changes its shape and characteristics over time. The structure of outer ear is not complex when compared to other physiological biometrics. Moreover, it is highly stable and does not vary according to facial expressions of a person. Fig.4 is represented the anatomy of ear.

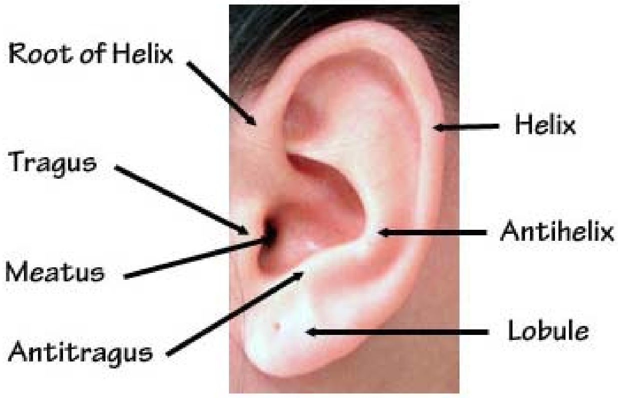


Fig.4. Anatomy of Ear

B. Ear and Edge Detection:

Ear detection is defined as the localization of the regions that contain human ear regardless of its size, orientation and hair occlusion. Ear recognition is either ear identification or ear verification. Both of them assume that the ears have been already extracted from an image or at least have already been localized. So ear detection is the preliminary step in automatic ear recognition systems. In the process of ear detection first we took the photographs of the side faces of both the ears. After that by proper cropping the pictures we narrowed to the exact ear then we took the length and breadth measurements of the bigger picture of the side face. [9] This we followed with the length and breadth measurements of the smaller picture which is that of the ear alone subtracting the latter measurement from the former we get the actual measurement of the ear This was done by applying trigonometric method of measurement the process of ear detection first we took the

***** Measuring lengthwise (1-2) from the ear lobe(lobule) in a straight line.

***** Measuring breath wise (3-4) in a straight line from a few centimeters(depending on the ear image) away from the centre of the center towards 1.

***** Again measuring breath wise (7-8)in a straight line from a few centimeters moving away from the centre towards 2.

***** Measuring from the anti helix towards point marked(5-6).

***** Covering the entire angle of the inner ear(9-10).

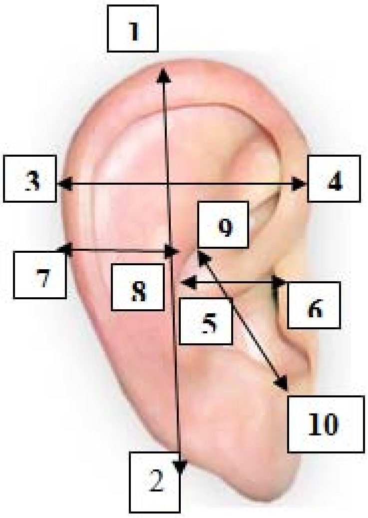
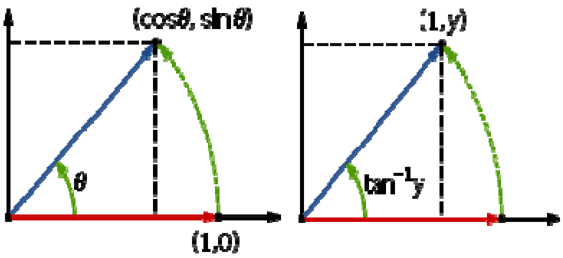


Fig.. 5. Measurement of an ear image

V. CORDIC ARCHITECTURE

The CORDIC computing technique was developed by J.E. Volder in the late 1959's for the computation of trigonometric functions, multiplication and division operations. Walther, in 1971, has generalized this algorithm to implement hyperbolic, logarithm and exponential functions. This algorithm is iterative with an ability to decimate elementary operations with simple shift and addition operations. The number of iteration is determined by the word length of the inputs. The CORDIC algorithm performs the rotation of a vector in both modes as a sequence



of micro rotations of elementary angles recalled from ROM. In this Section, we discuss the basic principle underlying the Hybrid CORDIC Vector based computation, and present its iterative algorithm. The general concept of the CORDIC algorithm is consider the following vector rotations.

VI. VALIDATION AND EXPERIMENTAL RESULTS

Using CORDIC in vectoring mode,

$$y_{i+1} = y_i + d_i x_i 2^{-i}$$
$$z_n = z_0 + \tan^{-1}(y_0/x_0) \quad y_n = 0$$
$$z_{i+1} = z_i - d_i \alpha_i$$

For convergence of y_n to 0,

choose $d_i = -\mathrm{sgn}\,(x_i y_i)$.

If we start with $x_0 = 1$ and $z_0 = 0$, we find $z_n = \tan^{-1} y_0$

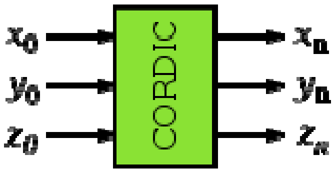
We can implementing the CORDIC using bit parallel iterative , to get the edge detection of the ear image. This process is explained in the following algorithm and the iterative method represented diagrammatically in fig.6.

- Start at (1, 0)
- Rotate by θ
- We get ($\cos\theta$, $\sin\theta$)

- Start at (1, y)
- Rotate until $y = 0$
- The rotation is $\tan^{-1}y$

If we were to have a computationally efficient method of rotating a vector, we can directly evaluate sine, cosine and arctan functions. However, rotation by an arbitrary angle is non-trivial .(sine and cosines).

CORDICs can be used to compute many functions. A CORDIC has three inputs, x_0, y_0, and z_0. Depending on the inputs to the CORDIC, various results can be produced at the outputs x_n, y_n, and z_n.



$$x_{i+1} = x_i - d_i y_i 2^{-i}$$

$$x_n = K\sqrt{x^2 + y^2}$$

```
for j = 0:n-1;
    if beta < 0
        sigma = -1;
    else
        sigma = 1;
    end
    factor = sigma * poweroftwo;
    R = [1, -factor; factor, 1];
    v = R * v; % 2-by-2    beta = beta - sigma * angle; % update the
remaining angle
    poweroftwo = poweroftwo / 2;
    % update the angle from table, or eventually by just dividing by two
    if j+2 > length(angles)
        angle = angle / 2;
    else
        angle = angles(j+2);
    end
end
```

In the vectoring mode, the vector x0 is rotated towards the x-axis so that the y-component approaches zero.[10] The sum of all angles of micro rotations (output angle ω n)is equal to the angle of rotation of vector x0, while output x" n corresponds to its magnitude. In this operating mode, the decision about the direction of the micro rotation depends on the sign of yi: if it is positive then σi = −1otherwise σi = 1.CORDIC iterations are easily implemented in both software and hardware. After each iteration the number of shifts is incremented by a pair of barrel-shifters. To have an n-bit output precision, (n+ 1) CORDIC iterations are needed. Note that it could be implemented by a simple selection operation in serial architectures like the one proposed in the original work, or in fully parallel CORDIC architectures the shift barrel-shifters. To have an n-bit output precision, (n+ 1) CORDIC iterations are needed. Note that it could be implemented by a simple selection operation in serial architectures like the one proposed in the original work, or in fully parallel CORDIC architectures the shift operations could be hardwired, where no barrel-shifters.

Table. 2 The Proposed Algorithm

1. Read pair of Ear and Index Finger images.
2. Resize images to specific pixel size.
3. Apply Feature extraction for finger print images using trigonometric method
4. Detect ear images using trigonometric method
5. Compute the distance of the ear images mentioned in Section IV-B.
6. Apply edge detector using Hybrid Cordic
7. Dovetail of the pair of ear and finger images.
8. Classification for authenticate

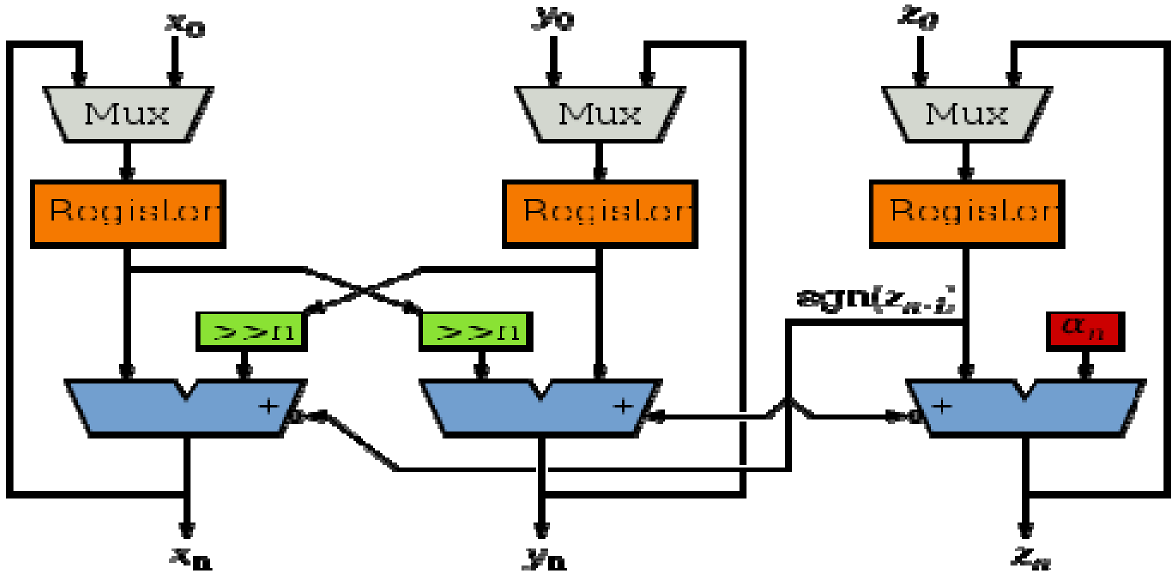


Fig.6. Bit parallel Iterative implementation

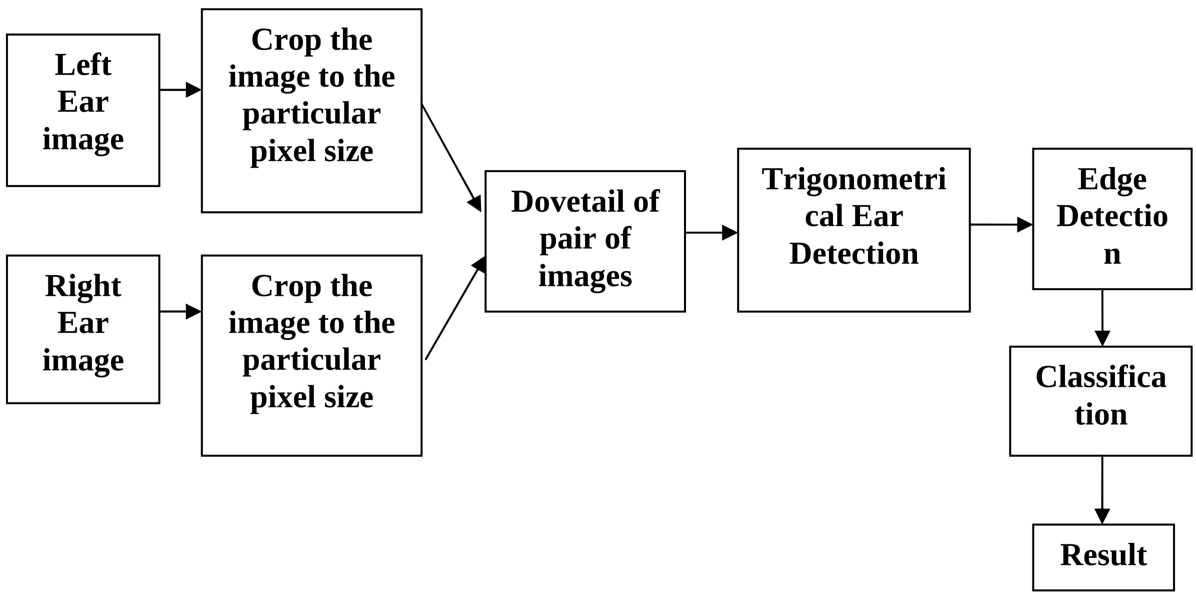
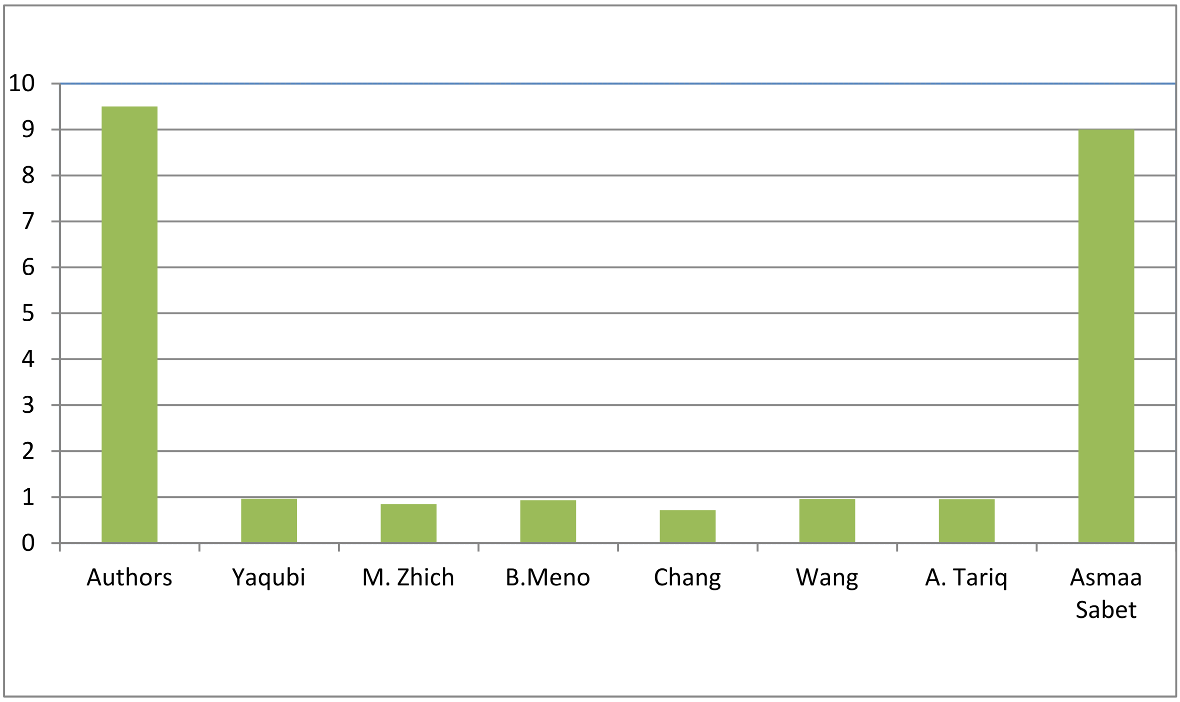


Fig.. 3 . Ear Authentication – Proposed System

In this experiment we used sample database, 2pairs of ear and finger images(4) for 50 people. After classification step the sum of absolute difference distance which give the highest accuracy. We made a comparison between researchers worked in this topic according to accuracy and number of images used in database. This is shown in the following Table 3. And also presented by chart.

Table 3. Comparing the accuracy of our work

Publication	Approach	Name of Database	Ear database	Accuracy
Yaqubi	HMAX and support Vector Machine	USTB	180	96.5%
Mu Zhichun	Geometrical Features	Own database	144	85%
Bele Moreno	Neural Networks	Own database	168	93%
Chang	Principal Component Analysis	ND Human ID	285	71.6%
Wang	Moment Invariants	USTB	180	96%
Anam Tariq	Haar Transformation	IIT	375	95.2%
Asmaa Sabet	Geometrical features	IIT	150	98%
Authors	Trigonometric Hybrid CORDIC	UOM	200	98.5%



VII. CONCLUSION

This paper proposes Hybrid CORDIC architecture as an approach to implement some operators in a pair of index finger and ear pattern recognition application. It is well known that in the process of biometric authentication time elements of total authentication are important. We proposed a new algorithm for pair of finger and ear images recognition is the latter better results are found in FAR, FRR and ERR. This algorithm gives higher accuracy. Even recognition rate is better than the old methods. and the results showed that the proposed approach gives better results and obtained overall accuracy almost 98.5%.

Future possibilities of Ear Authenticate Study

All the studies done so far including hours confined to a 180 degree focus of the ear picture. Now the question is could angular derivations of the face give any different result. May be it could be a progressively ascending 45, 90, 135 degrees. Will these give any better result in terms of accuracy recognition rate etc. This should be an interesting study.

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