International Journal of Latest Trends in Engineering and Technology
Special Issue April-2018, pp. 037-042
e-ISSN:2278-621X

AN INNOVATIVE EAR BASED RECOGNITION SYSTEM FOR AUTOMATIC ATTENDANCE MONITORING

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Abstract- Biometrics is analysis of physical or behavioral characteristics that can be used for human identification. There are several typical means of recognition which include access cards, personal identification number (PIN), passwords etc. They can be lost, stolen, duplicated, cracked or shared. These drawbacks can cause a great loss to the concerned. In this paper we have used ear as a biometric for validation and verification of a user to determine their identity or to verify a claimed identity. Ear is a stable biometric and does not vary with age. This is a standard technique in forensic investigation and has been used as evidence in hundreds of cases. Ear recognition is unique identification technique rather than face recognition, fingerprint recognition so on. We have used Image processing approach and Watershed Segmentation algorithm, to segment an image into regions for better results. The input ear image is pre-processed and segmented, based on the matching percentage attendance is marked for that concerned user and displayed as output. This paper provides good future prospects for the upcoming researchers in the field of ear recognition. For the purpose of result and analysis, experimental MATLAB tool is very useful for result oriented works.
Keywords- Biometric, Validation, Verification, Image Processing, Segmentation.

1. INTRODUCTION
The basic approach in biometrics is to identify an object or an individual based on their physical structure, behavioral or emotional characteristics. This can be verified using the various techniques & algorithms. Basically biometrics includes three vital tasks:

- Enrollment: In this process ,the user enrolls in the system by establishing baseline measurement for comparison.
- Submission: Here, the user represents the biological behavior of his or her identification to the capture system.
- Verification: Here, the system compares the submitted sample with the stored sample.

Ears are new biometrics; they appear to maintain their structure with increasing age. Ear images have more identification richness than some other parts of the human body. These ear images can be detected using various algorithms and approaches. The images can be segmented using various algorithms; this segmentation process will partition the image into multiple regions which will extract the foreground object from that image. Here, we have used marker based watershed transformation, which helps us to differentiate between the foreground and the background objects in an image.

Image segmentation plays a vital role in the image processing domain; this explains the key procedure from processing to analyzing. Edge detection is performed on the segmented image using the edge operator. Wherever an edge junction is found, the list is terminated and a separate list is generated. All pixels present in an edge may not be equally important and may not be necessary to represent the edge.

So, to get compact representation of the ear, the line segments are fitted to the edges obtained. This eliminates all unnecessary pixels from the edge and breaks every edge into a set of line segments and finds the size and position of the maximum deviation from the line that joins the endpoints. If the maximum deviation exceeds the tolerance value, then the edge is shortened up to the point of maximum deviation and this method is repeated.

2. RELATED WORKS
Dayanand B.Gore, Seema S. Kawthekar, Vipin Y. Borole,[1].”Ear Recognition Techniques for Biometrics Using Digital Image Processing”, proposed the ear recognition system using ANN classifier based on Artificial Neural Network. Iannarelli, (1989), [2].”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 geometric

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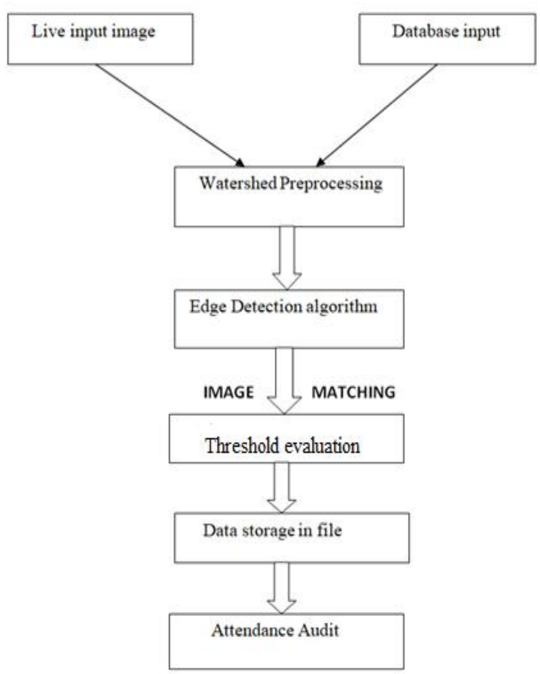
measurements of the ear. Yashomati Dhumal,Madhuri Karkud,Pooja Shinde,Varsha Alhat(2016) ,[3].”The Human Identification System Using Geometrical Feature Extraction Of Ear”,The canny edge detection is carried out on these images. The canny edge detector was applied to identify the main edges on the ear image. We can get outer curve by setting the threshold value. Since the ear has quite a lot of ridges, it seemed like a suitable choice. We have used ANN classifier based on Artificial Neural Network. Asmaa Sabet Anwar, Kareem Kamal A.Ghany, Hesham ElMahdy (2015), [4].”Human Ear Recognition Using SIFTS Features”, this paper is based on SIFT features for ear recognition, SIFT key points are extracted from ear image and extracted SIFT features are used for matching. Edge detection is used for cropping ear part from the image. Then the SIFT features were extracted from ear image. Finally, the extracted features were classified by using minimum distance classifier. K.Kokila,I.Laurence Aroquiaraj(2014), [6].”Ear Biometrics for Automatic Index Segmentation Using Canny Edge Detection”, here the Canny edge detector was applied to identify the main edges of the ear image. 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. Niket Amoda, Ramesh K (2013), [9].” Image Segmentation and Detection using Watershed Transform and Region Based Image Retrieval”, This Region based retrieval uses Discrete Wavelet Transform and watershed to segment image into regions. Each region is represented as set of vectors and similarity between regions is measured using specific metric functions. B.Monica Jenefer, V.Cyrilraj (2014), [10]. “An Efficient Image Processing Methods for Mammogram Breast Cancer Detection”, this paper proposed a method for detection and classification of tumors using SVM classifier, this paper has devised a method to classify accuracy of acquired images Vs obtained images. Surya Prakash et.al (2008), [11]. “Ear Localization from Side Face images using Distance Transform and Template Matching”, 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. Burge & Burger(2000),[12]. “Ear biometrics for Computer vision”, finalized a follow-up study that demonstrated ear biometrics can be used for passive identification.

3. PROPOSED SYSTEM

This Proposed system explains the process related to Ear recognition system and the techniques involved in the detection and processing of ear images. An Input ear image is captured and stored in the database (system folder) using a camera. The resolution of the pixels in the camera and lighting conditions also play a humongous role in ear image processing. The camera must have an adequate and uniform resolution with constant distance from user, throughout the process. Then preprocessing is carried out to segment the image into regions which is further redefined to find out the edges of image using various edge detection algorithms such as canny, sobel and prewitt. Prewitt edge detection method gives best results for the ear images which are appropriately captured with proper lighting.

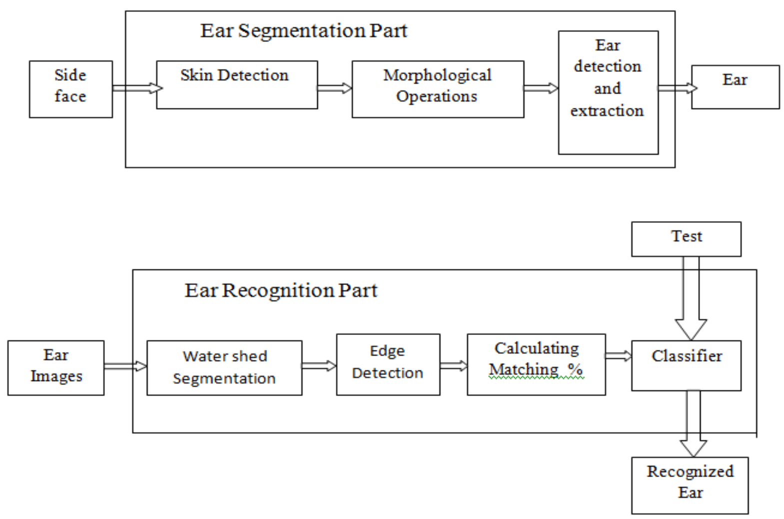
3.1 Workflow



The Image is captured in JPEG format at a distance of 8-10 cm. After the image acquisition process, the original image is converted into a gray scale image and filtered. Then by using watershed segmentation the gray image is segmented into background and foreground objects, where foreground objects are connected blobs of pixels within each of the objects and background objects are pixels that are not part of any object. Then the segmentation function is modified, so that it only has minima at the foreground and background marker locations. The watershed transform of the modified segmentation function is computed.

Then edge detection technique is applied to the segmented image. We have used prewitt edge detection operator for computing approximation of gradient image intensity function as they compute the gradient with smoothing. Therefore, it is a separable filter. At each point in the image, the result is either corresponding gradient vector or norm of this vector. Gradient approximations are applied particularly for high frequency variation in images. Sobel operator is also used to compute edges; each pixel of a gradient image measures the change in intensity of that same point in the original image, in a given direction. To get the full range of direction, gradient intensity of the images in x and y axes are calculated. It can be processed with the areas of high gradient visible as white lines. At last the noise in the image is removed using noise removal; the image in original color i.e. RGB is converted into gray scale. The input image is taken and compared with the saved images. If the matched percentage is greater than the threshold value, then match is found and the person is identified.

3.2 Architecture



3.3 Watershed Transformation algorithm –

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1. Let I be the input ear image present in the database.
2. Capture the live input image of the user.
3. I= remove _noise(I, filter_noise)
4. Convert the rgb image (I_{rgb}) into gray scale image (I_{gr}) before segmenting.
5. Compute a gradient magnitude function (G) and apply watershed transformation to it.
6. Mark the foreground objects (F_m) of the image, by applying morphological operations such as opening and closing by reconstruction.
7. Compute background objects (B_w) in the image (f_m) by performing threshold operations.
8. Compute watershed transformation for image and perform dilation to make the boundaries visible.
9. Apply prewitt edge detection edge(I, 'prewitt') for the segmented image to find the edge of the objects in images.
10. It returns edges at the point where gradient is maximum.
11. Compute black and white pixel points for both live input sample and database sample image.
12. Compare the white points in both the sample images
13. Matching percentage is computed by the formula,

$$match\_percentage = \frac{matched\_data}{total\_data} * 100$$

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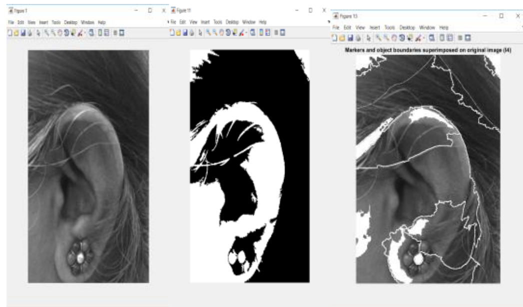

Figure-1: Orginal Image, Threshold approximation,Marker and object boundaries

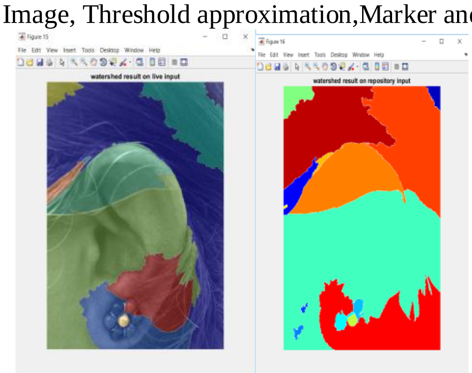

Figure-2: Watershed result on live input, Watershed result on repository input

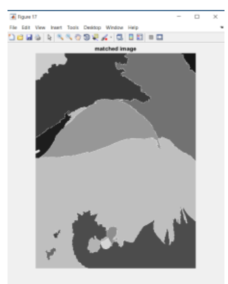

Figure-3: Matched User Image

4. EXPERIMENT AND RESULT

To explore the efficiency of the proposed approach, the algorithm is programmed in MATLAB R2017b software and run on entire datasets. Detected ear images are gathered from the result sets.

4.1 Performance Evaluation

To process an image in MATLAB software it takes minimum of 15seconds using PC with core i5 processor and 4GB RAM. All images are individually trained and tested with database inputs and corresponding output results are obtained for the samples. The Sample data is divided equally and images are tested with the trained data set which specifies whether the live image captured is same as the database image.

The result of the proposed approach is shown in Figure: 1, 2 and 3. Based on the input samples corresponding outputs graph is plotted.

To evaluate the performance of the proposed approach using evaluation metrics such as Sensitivity, Specificity and Accuracy are computed using the formula below:

$$Sensitivity(\%) = \frac{TP}{TP + FN} * 100\%$$

$$Specificity(\%) = \frac{TN}{TN + FP} * 100\%$$

$$Accuracy(\%) = \frac{TP + TN}{N} * 100\%$$

Where, TP$\longrightarrow$True positive, TN$\longrightarrow$ True Negative,

FP ⟶ False Positive, FN ⟶ False Negative,
N ⟶ Total number of images.

The input for watershed transformation is the gray scale image stated above as Figure1, then threshold operations are carried out on that image thereby marking the boundaries of the object using marker controlled watershed segmentation algorithm which is followed by edge detection method where, the object's boundaries are computed based on the matching percentage. Then the exact match of that image is computed.

Table 1: Classification of Sensitivity Results

Total No. of Images	TP	FN	Sensitivity
65	63	2	96.92%

$$\boldsymbol{Sensitivity} = \frac{\boldsymbol{TP}}{\boldsymbol{TN}+\boldsymbol{FN}} = \frac{\mathbf{63}}{\mathbf{65}+\mathbf{2}} = \mathbf{96.92\%}$$

$$\boldsymbol{Specifity} = \frac{\boldsymbol{TN}}{\boldsymbol{FP}+\boldsymbol{TN}} = \frac{\mathbf{20}}{\mathbf{0}+\mathbf{20}} = \mathbf{100\%}$$

Table 2: Classification of Specificity Results

Total No. of Images	TN	FP	Specificity
65	20	0	100.00%

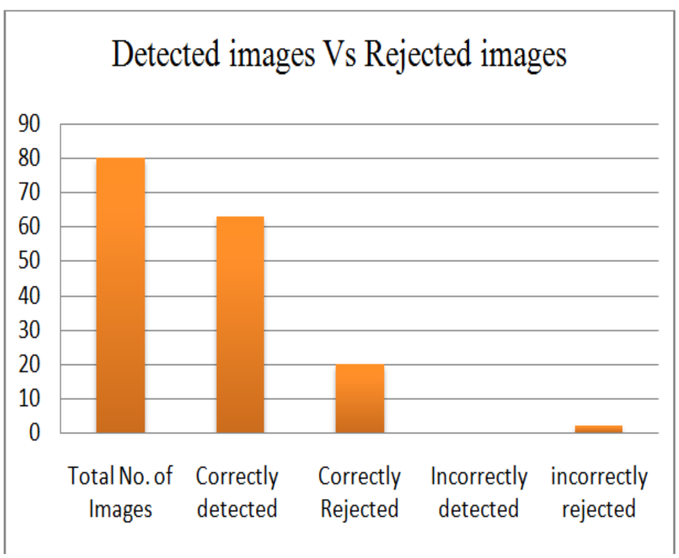

Figure-4: Detected Image vs Rejected Image

4.2 Accuracy Comparison

This Accuracy comparison that the above experiment is conducted for various inputs and outputs under different lighting conditions and corresponding outputs and its matching percentage are plotted as graph below for each input and its corresponding output.

$$\boldsymbol{Accuracy} = \frac{\boldsymbol{TP}+\boldsymbol{TN}}{\boldsymbol{P}+\boldsymbol{N}} = \frac{\mathbf{63}+\mathbf{20}}{\mathbf{67}+\mathbf{20}} = \mathbf{95.4\%}$$

$$\boldsymbol{Where\ P} = \boldsymbol{TP}+\boldsymbol{FN}$$
$$\boldsymbol{N} = \boldsymbol{FP}+\boldsymbol{TN}$$

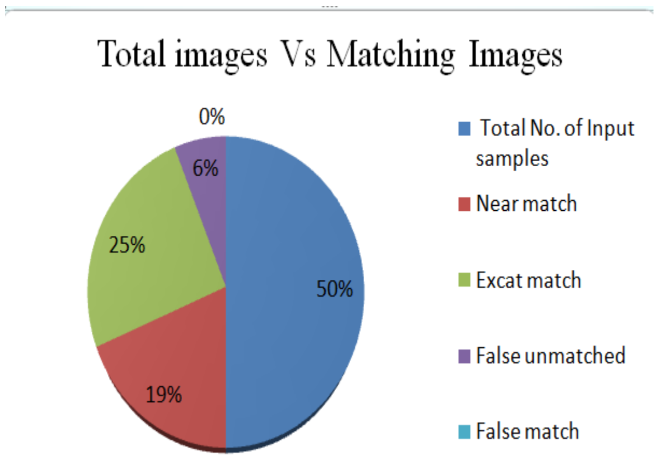

Figure-5: Matching Samples vs Total Samples

Here the input ear image's matching percentage is fetched and graph is plotted for each trials.On an average the trials of all the inputs and corresponding outputs for the threshold values and their matching percentage is plotted as a graph above which is further improved by training with set of ear image samples.

The matching percentage of the input ear image greatly depends on image intensity and lighting of the camera.

After adjusting the illuminating conditions and intensity variations in the image the input sets were tested, there is an improvement in the threshold values of the images obtained after processing.

5. CONCLUSION AND FUTURE WORKS

We have implemented a simple ear recognition model for biometric purposes and based on the result attendance is marked for the corresponding user. We have implemented this using MATLAB image processing tool. The image accuracy can be enhanced by applying segmentation and edge detection approach. For best results, the ear images should be properly captured and must have proper lighting. This method gives poor results for the ear images which are not captured properly or if it has high light intensity. Looking at the results we can conclude that the shape and structure of external ear is unique for each individual.

Further, we have planned to deploy this system in mobile phones as application for authenticated user entry. The accuracy of the system can be further improved by deploying high quality cameras and uniform lighting conditions throughout the detection process to find the variation in various ear images.

6. REFERENCES

[1] Ear Recognition Techniques for Biometrics Using Digital Image Processing: A Review Dayanand B.Gore, Seema S. Kawthekar, Vipin Y. Borole J. Clerk Maxwell, A Treatise on Electricity and Magnetism, 3rd ed., vol. 2. Oxford: Clarendon, 1892, pp.68-73.

[2] "Ear Identification, Forensic Identification Series", Paramount Publishing Company, Fremont, California Iannarelli, (1989).

[3] Yashomati Dhumal,Madhuri Karkud,Pooja Shinde,Varsha Alhat "The Human Identification System Using Geometrical Feature Extraction Of Ear ", IJARCSSE, Vol.6, Issue 3,ISSN:2277 128X,March 2016, pg.298-303.

[4] Asmaa Sabet Anwar, Kareem Kamal A.Ghany, Hesham ElMahdy "Human Ear Recognition Using SIFTS Features", 2015 IEEE

[5] "SEGMENTATION METHODS FOR MULTIPLE BODY PARTS" project in lieu of thesis presented for the master of science degree,University of Tennessee, Knoxville, Sitapa Rujikietgumjorn July 31,2008.

[6] "Ear Biometrics for Automatic Index Segmentation Using Canny Edge Detection" K.Kokila,I.Laurence Aroquiaraj International Journal of Computational Intelligence and Informatics, Vol. 4: No. 3, October - December 2014,ISSN: 2349-6363 190.

[7] "A Method of Ear Feature Extraction for EarBiometrics using MATLAB" Shubhangi Khobragade, Dheeraj Dilip Mo, Aman Chhabra

[8] "A review on biometricsand ear recognition technique," S. Singh and SKSingla,InternationalJournal of Ad-vanced Research in ComputerScience and Software Engineering, vol. 3.

[9] Image Segmentation and Detection usingWatershed Transform and Region Based Image RetrievalNiket Amoda, Ramesh K Kulkarni,Volume 2, Issue 2, March – April 2013International Journal of Emerging Trends & Technology in Computer Science.

[10] An Efficient Image Processing Methods For Mammogram Breast Cancer Detection, B.Monica Jenefer,V.Cyrilraj10th November 2014. Vol. 69 No.1-Journal of Theoretical and Applied Information Technology.

[11] Surya Prakash, Umarani Jayaraman and Phalguni Gupta, "Ear Localization from Side Face images using Distance Transform and Template Matching", IEEE, 2008.

[12] M. Burge, and W. Burger, Ear biometrics for Computer vision, In 23rd Workshop Austrian Association for Pattern Recognition, 2000.