EarBox

An ear biometric based application

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Abstract—***Ear biometrics is a subset of Biometric Authentication System which is gaining popularity and research view point. Ear biometric finds its applications in the crime investigation, attendance monitoring, security purpose etc. Ear biometrics using CNN for images is proposed in this paper and has been implemented by using edge detection and matching techniques.***

Keywords—Convolution Neural Nets(CNN), Ear recognition, Biometrics.

I. INTRODUCTION

Like other biometric using face, iris and finger, ear as a biometric contains a large amount of specific and unique features that allow for human identification. The ear morphology changes slightly after the age of 10 years and the medical studies have shown that significant changes in the shape of the ear happen only before the age of **8** years and after the age of **70** years. It does grow symmetrically in size and begins to bulge downwards as the person ages, but that is a measurable effect. Studies suggest that ear changes only **1.22 mm** per year. Also, the color distribution of ear, unlike face, is almost uniform. The position of the ear is almost in the middle of the profile face. Ear data can be captured even without the awareness of the subject from a distance. Ear biometrics can stand as an excellent example for passive biometrics and does not need much cooperation from the subject, which meets the demand of the secrecy of authentication system present in the environment.

A digital camera takes the profile face images of the subjects in the environment from different angles, from which the section of the ear is segmented, preprocessed. The feature vectors are then analysed in different test cases which consists of the rotation of the face in the same plane, different plane, different light conditions, etc. will be given to machine learning model as input which would be trained to recognize a person in the environment. The process, though complicated, would develop a system which would provide an authenticated ear-based biometric identification system.

II. CONTROLLED ENVIRONMENT

The purpose of CAMERA A is to get a clear shot of profile face without expecting much tilt or rotation of the ear. Meanwhile, CAMERA B and CAMERA C are used for capturing more profile photos for multiple images of the same person to form the feature matrices.

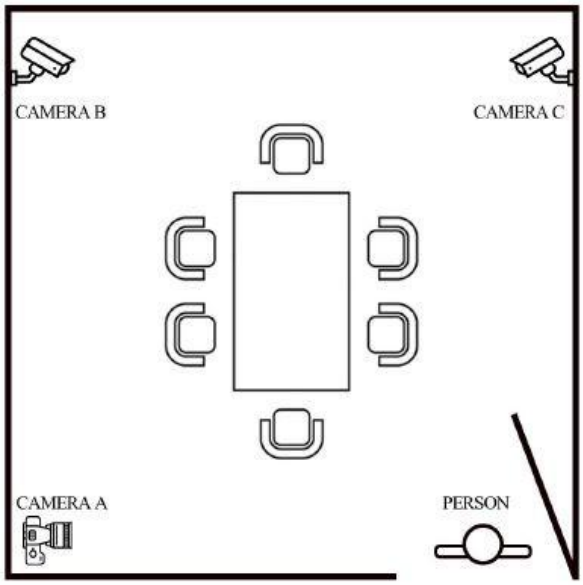


FIGURE 1 IMAGE CAPTURING

III. SEGMENTATION OF EAR FROM PROFILE FACE

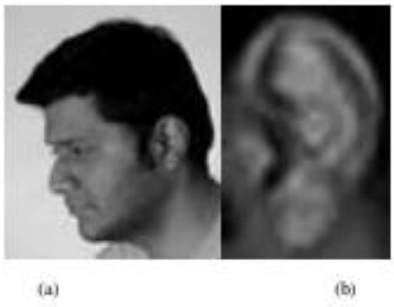
Image (a) is the profile face captured from camera. In image (b) topographical labeling is done. Topographical labeling is used to find curved surfaces and edges. Image (c)is the difference of erosion & dilation i.e. applying morphological operations on the profile face to sharpen the features. Image (d) is the simple dot product of (b) & (c). Image (e) is obtained by blurring (d) 10 times so that connected component analysis can be applied.The complexity of each connected component is found and shaded with different colors in image (f). As the highest complexity region is found out to be ear, it is segmented and converted into gray scale in image (g) for faster computation.

(a) (b)

(c) (d)

(e) (f)

(g)



(a) (b)

(c) (d)

FIGURE 2 FEATURE EXTRACTION

IV. Dataset and Preprocessing

Dataset preparation is the first step towards any machine learning model. In this system a deep neural network is used to obtain the features and characteristics of the subjects in the environment. Large dataset is required to feed as an input to the Neural Network. At least 500 images per subject to train the network properly because all the classes are the images of ears machine can be easily confused with the features and characteristics, the more samples per subject, the easier it is to find the distinct features. Dataset should cover a wide range of variety of images e.g images with different light conditions, different angles, gaussian filter, blur etc.

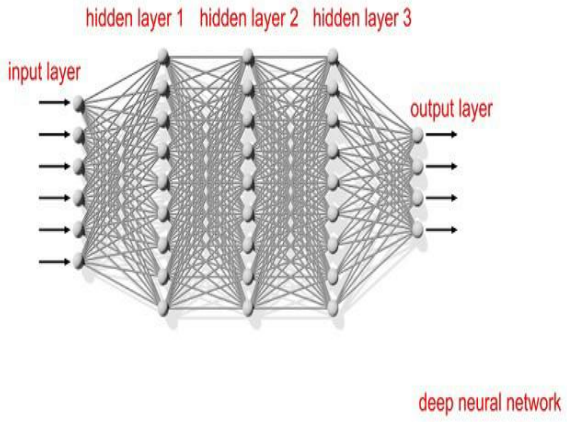


FIGURE 3 DEEP NEURAL NETS

There are small occlusions to be covered also while training the CNN network like ear covered with hair or earphones or jewels. Image augmentation is useful to generate multiple copies of images with slight variations to increase the dataset. For example data generator of keras can be used.

FIGURE 4 DIFFERENT VARIATIONS OF SAME IMAGE

V.CONVOLUTIONAL NEURAL NETWORK

As we are working with image dataset (instead of .csv files or numeric data), CNN is used after the data preprocessing is done. The preprocessed data is passed to the architecture of neural network. As ear has less surface area than face the computation time required for ear is less. The gray scale images are taken by the input layer of the network.

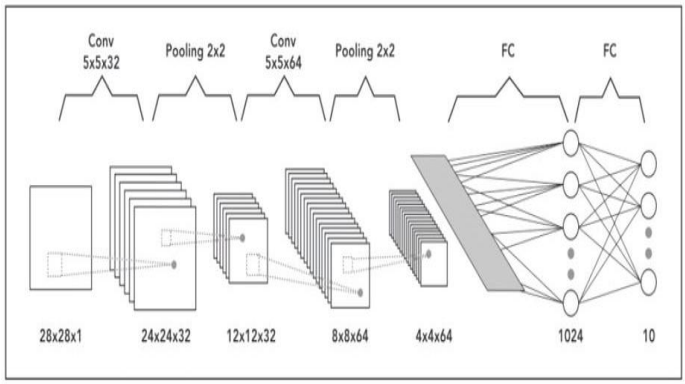


FIGURE 5 CNN

Stride convolution and max pooling is used to increase the depth (features) in each hidden layer.
Convolution filter reduces 9 image pixels to generate a single pixel without affecting the features.

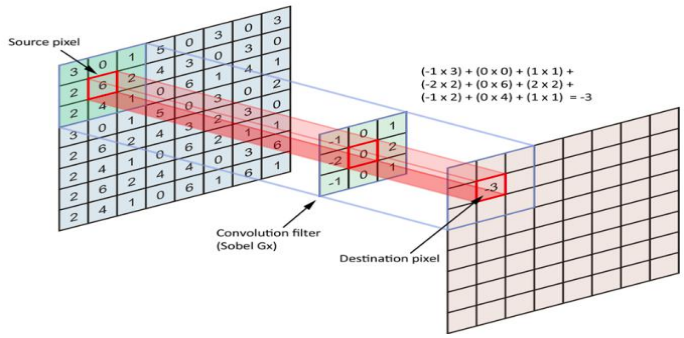


FIGURE 7 CONVOLUTION MASK

In the final dense layer, Feature classification (FC) is done based on which the subjects are classified to a corresponding class of the network.

VI. LIMITATIONS

There would be cases of occlusions of different types like hair, earphones or ear is injured or covered with cloth. The chances of individual to get authenticated would become less. As the percent of pure ear taken for feature extraction is less so the accuracy would be affected. The system aims to concern for small environment rooms like security rooms, board meeting, medical labs etc.

VII. FUTURE SCOPE

The ear houses the smallest bones in the human body. That would be quite difficult for cyber criminals to duplicate. In addition, it can be used to measure temperature, blood flow, heart rate and glucose levels. Ear biometric system will have diverse uses in the fields — authentication, access and attendance control, travel control, financial and other transactions requiring authorizations, remote voting, use of automated working devices, action control. e.g., nowadays airports uses combination of face & iris biometrics to authenticate a person, instead a single ear biometric system can be used to achieve the authenticity of a person with same accuracy. Every single feature of the body has an impact on how a person's general personality is going to be like — face, eyes, palms & even handwriting. Personality analysis through handwriting is used to detect if the person is lying, etc. Similarly, ear can be used for personality analysis of a Person. Ear lobe has many features that can be used for Personality analysis — attached lobe, broad lobe, narrow ear, pointed ear, round lobe, square ear, ear sticking out, etc.

VII. SUMMARY

The most significant advantage of the Ear Biometric System is to identify the person without their knowledge/awareness. This feature will change the dynamics of passive biometrics and can bring complete automatism in the biometric field.
Points to focus —

- Large dataset (500 samples per subject) with variety of images to train the learning model properly.
- Preprocessing of images to reduce the computation time.
- Good network architecture (without much loss or dropout).
- Run enough epochs to train the network efficiently (with GPU, suggested).
- Use the trained model to predict the person precisely.

Table 1: Comparison between existing method and proposed method.

Data Set	Data Set	Existing Method(%)	Proposed Method(%)
Data Set 1	801	95.88	99.20
Data Set 2	802	94.73	98.51
Data Set 3	1070	91.11	95.65

VII. REFRENCES

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