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AN IMAGE BASED ATTENDANCE SYSTEM FOR MOBILE PHONES

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Abstract— Automatic attendance system is one of the significant issues of today's research. Among other methods, human face recognition is highly used technique for attendance automation. Many systems have been proposed in literature using face recognition. Most of the systems are using fixed camera and desktop computers. We propose a system using mobile phones where an image is captured of group of peoples and face detection is done automatically. While considering computational and storage power of mobile devices, extracted local binary features for detected faces are then transferred to server machine using firebase database. Matching is done on server side, if face recognized than attendance is marked and feedback is sent back to client side. Experiments show effectiveness of proposed techniques with 95% correct recognition rate.

Keywords— automatic attendance system; face detection; faces recognition; mobile based system; firebase database;

I. INTRODUCTION

Attendance system is a basic need in every educational institute and in every organization. Manual attendance marking wastes much time. With the revolution in technology, attendance systems also need attention. From literature review, it can be noticed that multiple types of modern attendance monitoring systems can be found in market. Like smartcards, RFID tags on ID cards, thumb scanning though smart phones, biometric scanners, attendance cameras where everyone need to go one by one [1][2]. The most common method of taking attendance till date is the roll call method. In this, the teacher maintains a physical/online attendance register and calls out roll numbers or names of the students. This method has several flaws such as, a) high chance of proxies, b) wastage of time on attendance Manual entry of attendance into the computer (d) Prone to human errors. Fixing scanners in class rooms will require students to move from their respective places, which might disturb the flow of the lecture [3]. Use of one camera and marking attendance when a person comes in front of it is also needs place change and more time. Allowing everyone to bring smart phone for attendance purpose is also not good. As everyone could not afford and giving phone to child fewer than 18 also cause problems.

Research has proven that face detection software's are of vital importance to facilitate many functions of human life [4]. They are used to facilitate attendance management, fraud detection, and aid in terrorism. Mobile applications are a convenient form of software as mobiles can be carried around on the go.Face detection mobile applications is also an important avenue of software research [5]. Several applications exist for face recognition like FaceRecPro, EMU, mylio, KeyLemon, and Oasis Face [6][7].

However, significant research has indicated that there is no application that detects face, recognizes it, and marks attendance too. So, we propose a system where teacher will capture image from his/her mobile and attendance will be marked automatically in database by using face detection and recognition techniques. Face recognition in mobile devices has been a challenging task due to limited storage and processing power of mobile devices. Therefore, training of face detection is done on desktop computer. Testing of face detection is done on mobile devices. While testing, after face detection only local binary patterns features are computed and transferred to web server through firebase database. Features of faces extracted from test images are compared to stored features of candidates. Attendance is marked if confidence (similarity measure) is less than certain threshold. A web portal also facilitate to access records using desktop computers. The other purpose of using web portal is that mostly universities and organizations have web portals for managing records of employees. So, instead of making a separate automatic systems and record management for attendee the already built web portals are linked with mobile app. The detailed design of mobile based attendance system is shown in Fig. 1.

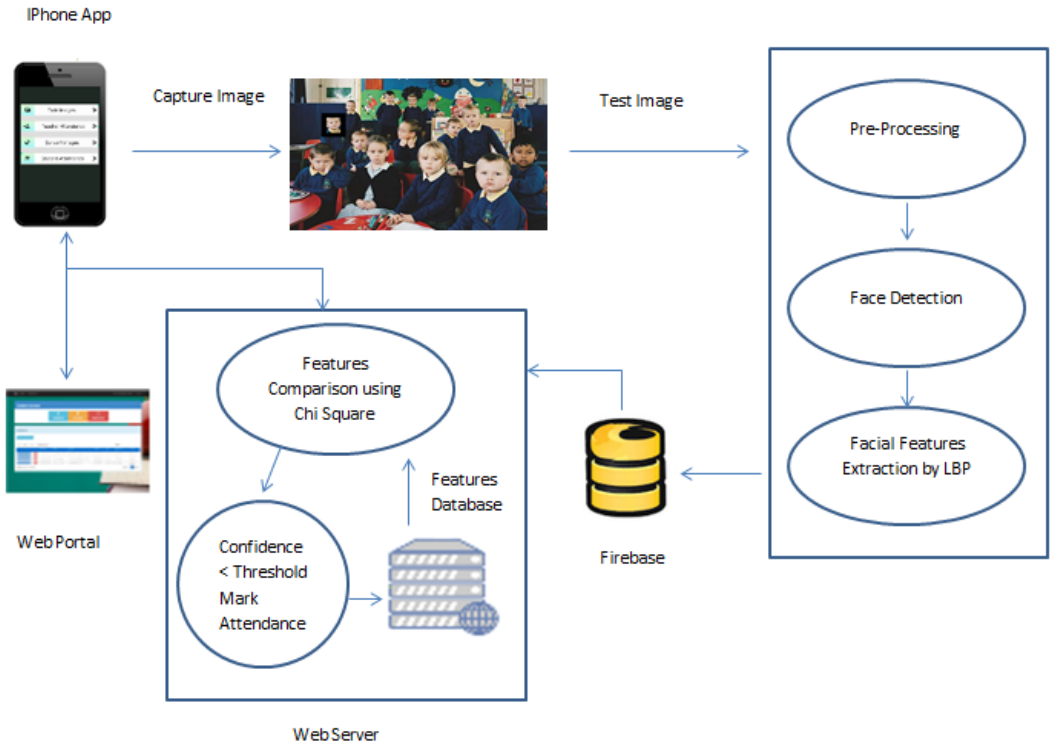

Fig. 1 Detailed design for connectivity of multiple modules in automatic attendance system

II. METHODOLOGY

Design of Application consists of multiple phases like pre-processing, face detection, face recognition, database selection. Detail of each phase is given below.

A. Pre-processing

At pre-processing step, the focus is to smooth the image and removal of unwanted light effects.

1) **Smoothness:** Gaussian filter is applied to remove noise and smooth the image. A 2D Gaussian function is given as:

$$I(x,y) = \frac{1}{2\pi\sigma^2} e^{\frac{-x^2+y^2}{2\sigma^2}} \quad (1)$$

Here σ is the standard deviation of distribution of image I. Zero mean is assumed for distribution.

2) **Illumination Removal:** The goal of illumination removal is to remove unwanted/uneven lighting effects from image. Illumination is removed by converting RGB image to HSV colour space [8] and then applying morphological operations on S channel are applied in 2 steps.
   a. Closing filter is applied on S channel
   b. Resultant closed S channel is subtracted from old S channel. And mean of closed S is added.

B. Face Detection using Haar Cascade

Face detection step extracts the facial part by ignoring anything else. Haar cascaded feature detection mechanism [9] is used to detect faces from image.

Edge, line and centre-surround features are computed for each sliding 24 x 24 image window at multiple scales making 6000 features. Fig. 2 shows some example Haar feature set. To make processing faster, features are grouped and processed one by one. Processing is stopped for a window if it fails at first stage. At each step, new classifiers are learned using Adaboost algorithm and week classifiers are grouped to make strong classifiers. Cascaded mechanism increases detection time while increasing detection accuracy.

C. Face Detection using Skin Colour Approximation

Face detection is also done by using method derived from Bradsky 1998. Multiple templates of different skin types and colours' under varying lightening conditions are derived. Matching is done by estimating numbers of pixels of back projected area (RGB -> HSV). If total count is greater than threshold value than its labelled as face otherwise not.

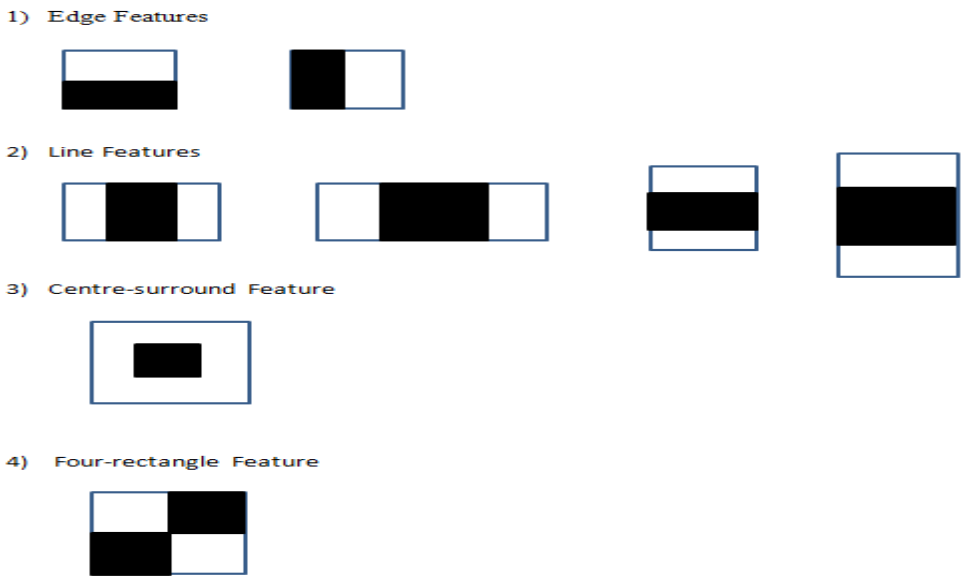

Fig. 2 some example Haar features set

D. Face detection combined approach

As reported in Open CV documentation [10], Haar-cascade gives about 85% accuracy on pre- trained classifiers for face, nose, eyes, smile etc. To increase accuracy further a skin approximation approach is used. Test image is classified by both techniques. Each techniques output face patches along with trust factor. Trust factor parameter is learned while training phase. At start both have trust value 0. Trust factor increases when some detection mechanism gives correct answer and decreases when gives wrong answer.

$$\text{Trust Factor} = \frac{\text{Number of correct outputs}}{\text{Total number of inputs}} x\ 100 \quad (2)$$

At test time, final output is calculated using pre-defined rules as given below.

a. If both detector agreed for an image patch as face than output it as face.
b. If both detector agreed for an image patch as not face than output it as not face.
c. If detector having high trust factor claims as face and detector having lower trust factor claims as not face but the nearest pixels are face than output face.

E. Face Recognition

Several facial recognition methodologies exist to label the identity of face. Local Binary Pattern (LBP) features performed very well in various applications regarding texture classification and segmentation [11].

Features are extracted using original LBP operator by Ojala et al. [12]. 8 neighbouring pixels are used to compare with central pixel. If a pixel is greater than central pixel than a one is marked otherwise zero. These assigned zero/one values are combined and converted to corresponding decimal value.

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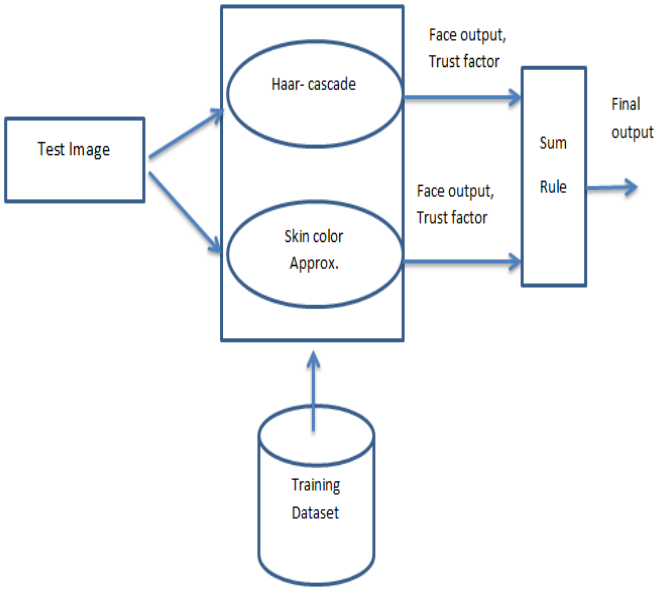
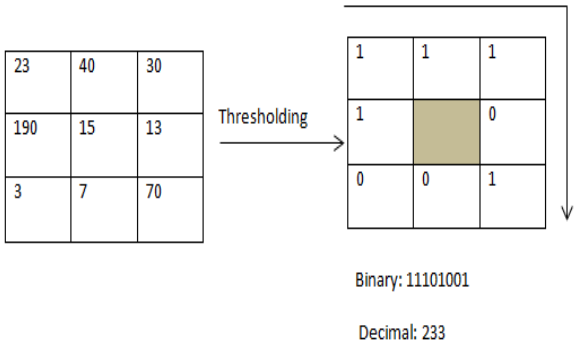


Fig. 3 Proposed combined approach for face detection



Facial image patch is divided into fixed size non-overlapping bins. For each pixel in bin a decimal value is calculated using LBP operator and a histogram is formed using all pixels in a certain bin. Histograms of all bins are than combined into one histogram. For each database image there is one unique histogram for each unique image. Test image is recognized by first calculating LPB histogram and then comparing with each histogram in database. Chi-square formula is used for similarity measure.

$$d(H_X, H_Y) = \sum_{n=1}^{N} \left(\frac{(H_x(i) - H_Y(i))^2}{H_x(i) + H_Y(i)} \right) \quad (3)$$

Here H_x is the feature vector of facial patch of test image. H_y is the feature vector of image features stored in database. Distance d is calculated which shows similarity between both feature vectors. It can also be assumed that d gives confidence of saying H_x as H_y. If similarity/confidence is less than certain learned threshold, then attendance will be marked against image H_y.

F. Communication using Firebase

Communication between mobile and web server is done using firebase database. A firebase real time database is cloud hosted database [13] providing real time data access to their clients. Data is synchronized across all connected clients and web servers. Data remains available even when app goes offline. Storage pattern of data is JSON. Firebase SDK installation is required to connect through firebase.

III. RESULTS AND DISCUSSION

Pre-trained Haar cascade classifiers for frontal and profile faces available publically [14] were used. Further training is done manually by making a simple application that tests an image using pre-trained classifiers, and shows results of face detection. If result is not expected than user can add this image into training data. If detected location (False positive) is not of face than that patch of image is added in negative sample. If there was a face but not detected (false negative) than that patch is added into positive samples. During training of Haar cascade, an optimized decision tree is constructed with known positive and negative image samples. The goal is to determine correct features along with their scales and weights. These learned parameters can be loaded further to initialize cascade classifier. Face detection can be done after initialization of classifier with desired parameters.

During detection phase, trained classifiers are used to detect faces at different scales of test images to detect faces of multiple sizes. At each scale it is moves across all pixels of test image. The scaling parameter (*sp*) determines about how much scaling will be done after each run. The min neighbour (*mn*) parameters determine number of positive neighbours required for positive face rectangle for being a possible match. Face rectangles having fewer faces than min neighbour threshold are rejected. Id value of min neighbour is set equal to zero than all potential face rectangles are returned. The min size (*ms*) parameter determines the size of face rectangle. While training, additional two parameters: combined face detection approach Haar cascade trust factor (*htf*) and skin colour approximation trust factor (*stf*) also learned. Same mechanism of training was done for LBP for face recognition. In order to get good recognition rates at least 15 images for each person will be required. Confidence (*cf*) value is predicted after multiple training and testing iterations. LBPH model can be further updated with more training and testing data improve its performance in future predictions by updating our model with the face image. Table 1 shows values of learned parameters.

TABLE 1- LEARNED PARAMETERS

Learned Parameter	Values
sp	1.1
mn	2
ms	[30 30]
cf	20
htf	65%
stf	45%

Multiple training iterations are done and performance is tested on validation data different from testing data. Graph given in Fig. 4 shows error at each iteration of face detection and recognition module.

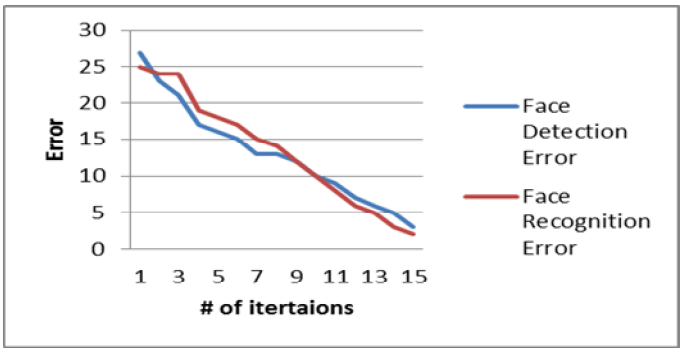


Fig. 4 Error on validation data

Accuracy of face detection module is calculated by using Eq. 4.

$$\text{Accuracy} = \frac{TP + TN}{TP + TN + FP + FN} \quad (4)$$

Accuracy of face recognition module is calculated by using Eq. 5.

$$\text{Accuracy} = \frac{\text{Correctly recognized faces}}{\text{Total detected faces}} \quad (5)$$

Results of attendance system for face detection and recognition modules on test data are shown using Table 2 and Table 3 respectively with 91% correct detection and 95% correct recognition rate.

TABLE 2- FACE DETECTION RESULTS ON TEST DATA

Actual faces in image	Total detected faces	Correctly detected faces	Non-face detected as face	Face detected as non-face
5	5	5	0	0
11	11	10	1	1
9	9	9	0	0
15	13	13	0	2
20	20	19	1	1

TABLE 3- FACE RECOGNITION RESULTS ON TEST DATA

Actual faces in image	Total detected faces	Correctly Recognized faces
5	5	4
11	11	10
9	9	9
15	13	12
20	20	20

IV. CONCLUSION

We propose a system for automatic attendance which can be used with help of mobile devices. Use of firebase database helps in data transformation even if low or no connectivity with internet. Proposed system correctly detects and recognizes faces having low rotation and frontal faces. Percentage of face detection on profile faces is quite low. System also uses pre-trained profile face classifiers but it need to be train on more data to increase correct detection rate.

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