International Journal of Research in Engineering, Science and Management
Volume-3, Issue-5, May-2020
www.ijresm.com | ISSN (Online): 2581-5792

Facial Recognition Based Attendance Management System Using Raspberry Pi

Prakash Jadhav[1], Chilukuri Madhu Vamsi Krishna[2*], V. Chandana[3], L. Krithika[4], Anusha Shetty[5]
[1]*Associate Professor, Department of Electronics and Communication Engineering, Sapthagiri College of Engineering, Bangalore, India*
[2,3,4,5]*Student, Department of Electronics and Communication Engineering, Sapthagiri College of Engineering, Bangalore, India*
*Corresponding author: krishna135219@gmail.com

***Abstract*: Automatic attendance management is one of the major advancements that is helpful in effective utilization of time and reduces human efforts in maintaining the data. Modernized class rooms are equipped with smart learning devices that have supporting software to improve the effectiveness of teaching in the class rooms. It is often seen that the precious time of class room is wasted during attendance or the class may face various interruption due to late entries of students. Face recognition technology is the rapidly evolving technology which has enormous advantages over other biometric authentication systems. The objective of the project is to completely automate the attendance management system which is simple and easy to use. Compared to traditional methods of attendance management system, this automated system eases up the workload of record maintenance by the institutions and saves time. Classifiers such as Haar cascade and LBPH (Local Binary Pattern Histogram) along with OpenCV library functions are used in this work.**

***Keywords*: Raspberry Pi 3B+ model, Automated attendance management System, Facial Recognition, Haar cascade classifier, LBPH (Local Binary Pattern Histogram).**

1. Introduction

Facial recognition is one of the booming technologies which has major applications in the educational institutions to automate and manage the attendance management system efficiently. As the number of student intake is swiftly increasing every academic year, managing of attendance system of that many students is the major concern in universities. Basically face recognition is a bio-metric technique which involves determination of the face of any person and compare it with the face images stored in database. This issue is hard to solve instinctively due to various factors such as facial expression and room lighting can cause on the image capturing process. Facial recognition has several advantages over other bio metric systems. It is widely used in various fields such as security, automated surveillance, and multimedia applications and in attendance management system. Therefore, in this paper we discuss a constructive way of detecting the face and recognition system which is capable of recognition at low intensities of light. Here we are using OpenCV, which is a library function in python used prominently for real time computer vision applications that has a modular structure. We are using image processing module to transform geometrically the image in aspects like size, shape and color conversion and it is also used to perform specific operation on an image, in order to get an enhanced image or to extract the required information from the image. The image processing is divided into 5 different groups namely visualization, image restoration, image retrieval, measurement of various objects in an image, distinguishing objects in an image. Our project also includes libraries Haar classifier, LBPH (Local Binary Pattern Histogram) face recognizer. Effective object detection method using Haar cascade classifiers was proposed by Paul Viola and Michael Jones. This machine learning based approach uses a lot of positive and negative images to train the cascade function. It is then used to detect objects in other images. Human faces have some amount of similar properties and these similarities maybe matched or compared using Haar features. We are using NumPy a fundamental package for scientific computations in python. This provides fast precompiled functions for mathematical and numerical routines with the help on an open source extension module. The NumPy converts image into a number of matrices and arrays which allows NumPy to rapidly integrate with the wide variety of data bases.

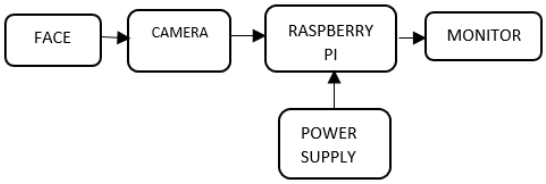

Fig. 1. Block diagram of facial recognition system


Fig. 2. Image cropped into MxM dimensions for every region

Local Binary Patterns Histogram algorithm is based on local binary operator. It is recognition process with its simple computation and discriminative power. Consider an image having N x M dimensions.

The region is divided into m x m dimensions for every region.

The local binary pattern operator is defined in window of 3x3. The LBP is used for every region.

$$LBP(x_c, y_c) = \sum_{p=0}^{P-1} 2^p s(i_p - i_c) \quad \text{…….. (1)}$$

Here '(Xc, Yc)' is central pixel with intensity 'Ic'. The middle pixel compares it with respect to 8 neighbouring pixels

$$s(x) = \begin{cases} 1, & x \geq 0 \\ 0, & x < 0 \end{cases} \quad \text{…….. (2)}$$

The values are assigned in such a way that if the neighboring pixel value is greater than or equal to central value then it is set as 1 or else the value is set as 0. We obtain 8 binary values from 8 neighbouring pixels. For our convenience we combine these values and obtain a 8 bit binary number and later convert it into decimal form. This decimal number value ranges between 0-255.

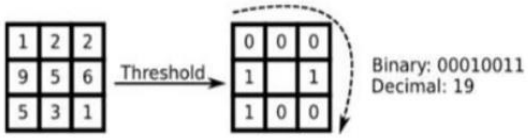

Fig. 3. Representation of 8 binary values from the neighbouring pixels

The LBP with 8 fixed neighbour values failed to encode complete details. Then circular LBP was introduced to improve to use different number of radius and neighbours.

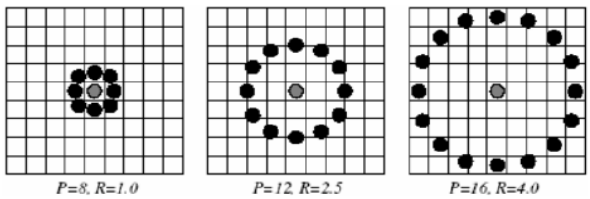

Fig. 4. Representation for different number of radius and neighbours in circular LBP

Aligning an arbitrary number of neighbors on a circle with a variable radius to compute the features are used.

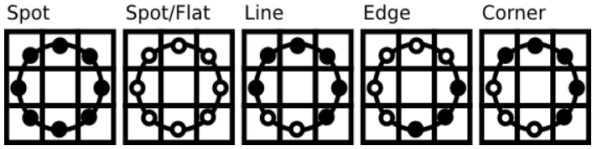

Fig. 5. Representation of different features

For a given point (Xc,Yc) the position of the neighbor (Xp,Yp), p belonging to P can be calculated by:

Here R is radius of the circle and P is the number of sample points. If coordinate on the circle doesn't correspond to image coordinates then it is interpolated by bilinear interpolation:

$$x_p = x_c + R\cos(\frac{2\pi p}{P})$$
$$y_p = y_c - R\sin(\frac{2\pi p}{P}) \quad \text{…….. (3)}$$

$$f(x,y) \approx \begin{bmatrix} 1-x & x \end{bmatrix} \begin{bmatrix} f(0,0) & f(0,1) \\ f(1,0) & f(1,1) \end{bmatrix} \begin{bmatrix} 1-y \\ y \end{bmatrix} \quad \text{….(4)}$$

The LBP operator is robust against monotonic gray scale transformations.

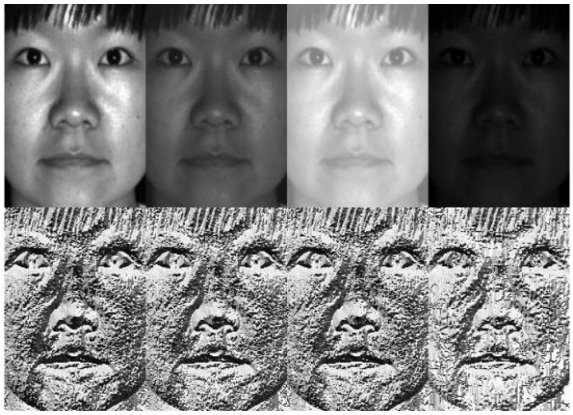

Fig. 6. Image of variable intensity and their equivalent gray scale image using LBP operator

LBP value histogram of the region is created by counting similar LBP values in the region.

All the histograms are merged to form single histogram.

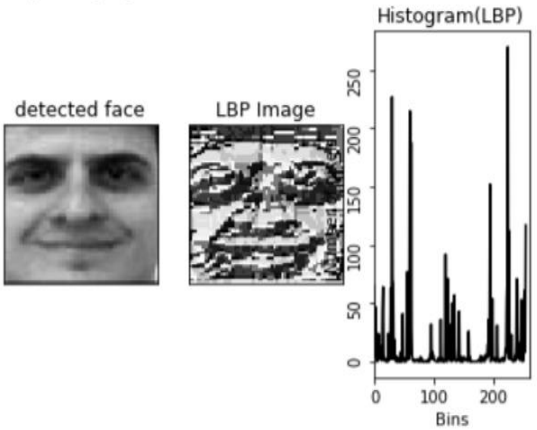

Fig. 7. Histogram of merged images

The histograms of test image and dataset images are compared and then the closest histogram is returned.

The minimum distance between test image and original image is calculated using Euclidean distance.

2. Literature Survey

The paper [1] proposed focused on making the attendance management fully automatic, simple and easy. The image processing techniques used includes image capturing, segmentation, face detection, face comparison and recognition. It requires more data to train the classifier and two different faces has to be distinguished accurately.

The paper [2] proposed a system to check the tasks in office surveillance monitoring system using RFID (Radio Frequency Identification). It is comparatively efficient than the traditional attendance management system. The speed of processing of the system is low. Training the model for higher accuracy can be obtained.

The paper [3] mainly focused on exploring the feasibility of implementing raspberry pi based face recognition system. The techniques used are conventional face detection, Haar detection and principle component analysis. It is highly accurate but cannot multitask.

The paper [4] proposed a system to automate attendance management using histogram oriented gradient, AMS. PCA algorithm is used for very accurate operation but the system cannot handle more number of inputs.

The paper [5] proposed a system that focused on acquiring the ideal speed for recognition. Reduction of camera resolution for increasing the number of frames per second. Level of security is high but the raspberry pi memory is overloaded. Optimum speed of the system should be

The paper [6] focused on minimizing the time it takes to detect the object. Bayesian classifier, Haar cascade classifier and Machine learning were used to be a speed process with high accuracy. The disadvantage was multitasking consumed time.

The paper [7] mainly aimed to avoid human error, in order to do so a system was modelled with quick design development and feedback. Human involvement was completely avoided and hence reducing human error. Disadvantage was system development cost more and recognition of faces from a far distance was not possible.

3. Objectives and Methodology

Objective-1: To capture the images and to create a database.
Methodology-1:

1. Import OpenCV2 for image processing and capture video.
2. Detect the faces in the video stream using Haar cascade frontal face
3. Assign a unique face ID for each of the detected image.
4. Convert color video frame to grayscale image and crop the image frame to rectangular frames.
5. Increment the count and save the captured image into the dataset folder, when count reaches 100, stop taking the video and turn off the camera.

Objective-2: To detect the images in real time
Metodology-2:

1. Import OpenCV2 for image processing, OS for file path, and NUMPY for matrix calculation and PIL.
2. Create local binary patterns histograms for face recognition, convert image to grayscale, convert PIL image into NUMPY array.
3. Obtain the image ID and stored faces from the training images and then append each face and append to its respective ID, add the image to face samples.
4. The images are captured at varying angles and varying intensities of light and stored in the database.
5. The model is trained using faces and IDs.

Fig. 8. Representation of the student images stored in the dataset

Objective-3: To capture image in real time and recognize the detected face.
Methodology-3:

1. Face recognition is the next step after detection.
2. The recognition process is done by LBPH (Local Binary Patterns Histogram) classifiers.
3. LBPH classifier compares the pixel to each of its 8 neighboring pixels.
4. The image is cropped to the region of interest then they are converted into gray scale image.
5. The gray scale image is matched with the images stored in the dataset.

Objective-4: Store the attendance status in the excel sheet and intimate the parents via SMS if the student is found absent.
Methodology-4:

1. After the recognition of the student the next step is to verify the face.
2. If the face captured in real time matches with the face samples stored in the data base, the student will be marked present.
3. The default status of student will be absent, until the match occurs.
4. This information is stored in the excel sheet corresponding to the students name.
5. Parent/guardian will be intimated periodically via SMS if the student fails to attend the class.

4. Algorithm

1. Import OpenCV library function and start capturing

the video, where Haar cascade frontal face is used to detect faces in the video stream.

2. For each person a unique ID is assigned and the RGB image is converted to grayscale image and the images of different sizes are cropped into rectangular frame.
3. Increment the count, obtain various images and save in the dataset folder, when the count reaches 100 stops capturing of video.
4. Import NumPy for matrix calculations and import images from PIL (Python Image Library), create LBPH (Local Binary Pattern Histogram) for face recognition.
5. Convert PIL image into NumPy array and obtain the image ID from trained images.
6. Append each face to its respective ID and add image to face sample.
7. Load the trained model and the pre-built model and then create a classifier from the pre-built model.
8. Set a font style, initialize and start capturing the video.
9. Read the video frame, convert the captured RGB image into grey scale and obtain the faces from the video frame by creating a rectangular frame around the faces. Recognize the identity of the detected face.
10. In the loop check if the ID exists and assign the ID with a name. If ID does not exist then display unknown. Once the face is recognized then display the name assigned.

5. Flow Chart

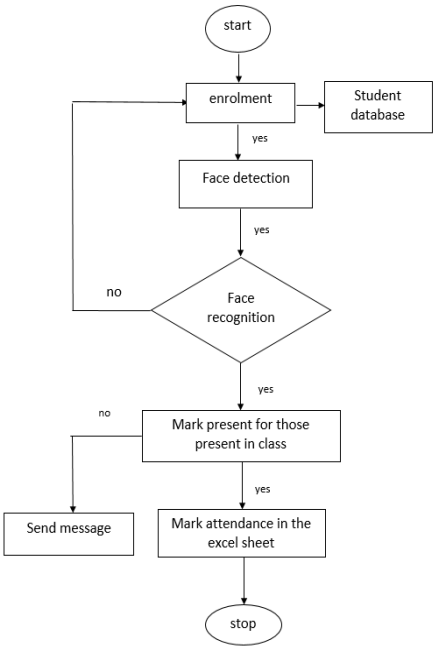

Fig. 9. Flowchart of attendance management system based on facial recognition

6. Result

In this system we are storing student images in the database prior to commencement of the academic year during the enrolment in their respective college or university. The system captures 100 images of the students in varying angles under their respective face IDs Corresponding to their names or university seat number. During the lecture hours the camera captures and recognizes the detected faces in real time and records the attendance status. An intimation to the parent/guardian is sent periodically if the student remains unattended.

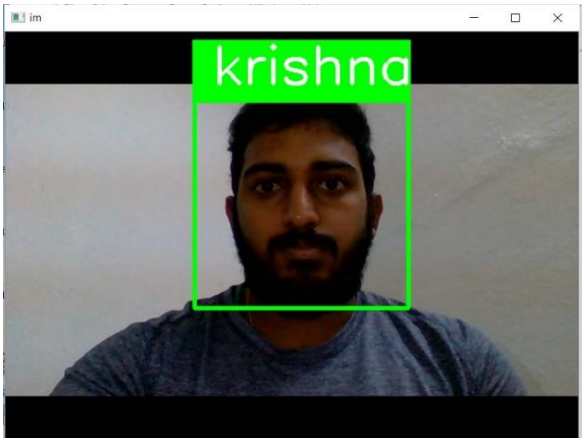

Fig. 10. Recognition of face in real time

7. Advantages

The system is completely automated it eliminates the risk of manual errors. Complete automation made the system efficient which led to more accurate results. As the system does not require any physical involvement of the students, the system is time saving and decreases the loss of output. The system assigns unique ID to each individual and compare in real time, this makes the system fool proof. The system is easily installable in every classroom or workplace.

8. Conclusion

The existing traditional methods of attendance management system such as maintaining manual attendance record books, bio metric fingerprint, RFID based and so on are tedious tasks and less efficient. The proposed system focuses on overcoming the issues faced with the traditional methods. Hence we have accomplished to build up a robust system to effectively capture, recognise and to acquire student's attendance status periodically. Facial recognition process with the Haar cascade algorithm is able to recognize the detected faces with varying intensities of light. The proposed system is able to detect the face up to a certain angle, it can be further improved to recognise faces at much more varying angles to make it more efficient. Facial detection at low intensities of light can be worked upon.

9. Future Scope

Further we can use infrared cameras for detection of face during the night time as well. To improve the performance of the system we can make use of ADROID-XU4. It has more advanced features than raspberry pi 3 module. A high resolution camera can be used in order to capture the image at a distance of several meters. A remote controlled capture technique can be implemented so that the device need not run for the complete duration of the classes.

References

[1] R. Dharani et al. “Automatic Attendance Management System Using Face Detection” Online International Conference on Green Engineering and Technologies
[2] Savitha K S et al. “How’s the Turnout to The Class? A Face Detection System for Universities” IEEE Conference on e-learning, e-management and e-services, pp. 179-184, 2018.
[3] Erica K Shimomoto et al. “A Faster Face Detection Method Combining Bayesian and Haar Cascade Classifiers” IEEE paper, pp 7-12, 2015.
[4] Omar Abdul Salim et al. “Class Attendance Management Systems Using Face Recognition” 7th International Conference on Computer and Communication Engineering, pp. 93-99, 2015.
[5] Andrew Fiade et al. “NFC Based Mobile Attendance System with Facial Authorization on Raspberry Pi and cloud server”, 6th International Conference on Cyber and IT Service Management, 2018.
[6] Ayman A. Wazwaz et al. “Raspberry Pi Computer Based Face Detection and Recognition System”, 4th International Conference on Computer and Technology Applications, pp. 171-174, 2018.
[7] Khem Buthea et al. “A Review Paper on Attendance Marking System Based on Face Recognition”, 2nd International Conference on Information Technology, Information Systems and Electrical Engineering, pp. 304-309, 2017.
[8] Umm-e-Laila et al. “Comparative Analysis for A Real Time Face Recognition System Using Raspberry Pi” 4th International Conference on Smart Instrumentation, Measurement and Applications, 2017.
[9] Vivek Kishor Bhanse et al. “Face Detection and Tracking Using Image Processing on Raspberry Pi” Proceedings of the International Conference on Inventive Research in Computing Applications, pp. 1099-1103, 2018.
[10] Shubhobrata Battacharya et al. “Smart Attendance Monitoring System (SAMS) Face Recognition Based Attendance System for Classroom Environment” 18th International Conference on Advanced Learning Technologies pp. 357-360, 2016.
[11] Jenif D’Souza et al. “Automated Attendance Marking and Management System by Facial Recognition Using Histogram” 5th International Conference on Advanced Computing and Communication System, pp. 66-69, 2019.
[12] Ramprasad et al. “An Efficient Automated Attendance Management System Based on Eigen Face Recognition” 7th International Conference on Cloud Computing, Data Science Engineering, pp. 66-69, 2019.
[13] Suad Maji et al. “Real Time Face Recognition System” 4th International Symposium on Digital Forensics and Security, pp. 107-111, 2016.
[14] Anisha Mohammed. Et al. “A Method for Real Time Face Spoof Recognition for Single and Single Authentication” International Conference on Intelligent Computing, Instrumentation and Control Technologies, pp. 376-380, 2017.
[15] Xinxiong Liu al. “User Centered Design of Attendance Record System Based on Mobile Terminals” 2017 International Symposium on Computer Science and Intelligent Control, pp. 141-146, 2017.
[16] Itisha Gupta et al. “Face Detection and Recognition Using Raspberry Pi” IEEE International WIE Conference on Electrical and Computer Engineering, Pune, India, pp. 83-86, 2016.
[17] Prakash Jadhav, G.K. Siddesh, “Bandwidth oriented Image Compression using Neural Network with ASAF”, International Journal of Neural Networks and Advanced Applications, ISSN: 2313-0563, Vol 5, pp 25-32, 2018.
[18] Prakash Jadhav, Sai Eshwar K R, “Bandwidth Reduction of Video Compression Using ANN for Virtual Multimedia”, International Journal of Management, Technology and Engineering, ISSN NO: 2249-7455, Volume IX, Issue VI, pp 1830-1840, JUNE/2019.
[19] Prakash Jadhav, G.K. Siddesh,"Codec with Neuro-Fuzzy Motion Compensation & Multi- Scale Wavelets for Quality Video Frames", International Journal of Image, Graphics and Signal Processing, Vol.9, No.9, pp.11-17, 2017. DOI: 10.5815/ijigsp. 2017.09.02
[20] Prakash Jadhav, G.K. Siddesh, “Near Lossless Compression of Video Frames using Soft Computing Technologies in Immersive Multimedia” International Journal of Soft Computing and Engineering, ISSN: 2231-2307, Volume-4 Issue-6, pp 16-24, January 2015.
[21] Seyyed Mohammed Reza Hashemi et al. “Evaluation of The Algorithms of Face Identification” 2nd International Conference on Knowledge based Engineering and Innovation, pp.1049-1052, 2015.
[22] Dr. M M Sardeshmukh et al. “Facial Based Attendance Monitoring System Using Discrimination Robust Facial Binary Pattern” 3rd International Conference on Computing, Communication, Control and Authentication, 2017.
[23] Dr. Bhawani Shankar Chowdhry et al. “Real Time Face Detection or Monitoring Using Raspberry Pi and Matlab” International Journal of Computer Visdion, 2016.
[24] H. Daryanavard et al. “Implementing Face Detection System on UAV Using Raspberry Platform” Iranian Conference on Electrical Engineering, pp.1720-1723, 2018.
[25] Suchitra et al. “Real Time Emotion Recognition from Facial Images Using Raspberry Pi 2” 3rd International Conference on Signal Processing and Integrated Networks, pp-666-670, 2016.
[26] Prakash Jadhav, Yeshwanth, “Design and Fabrication of a Multitasking Agricultural Robot with Stairs Climbing Capacity”, International Journal of Current Engineering And Scientific Research, Vol. 5, Issue 5, pp 70-73, 2018.
[27] Prakash Jadhav, G.K.Siddesh, “Neuro-Fuzzy Nod Restitution and Multi-Scale Wavelets for Superiority Video”, International conference on Advance computing, Networking and Informatics 2017, Recent findings in intelligent computing techniques, Vol 3, pp599-606, 04 November 2018.
[28] Sajid Akbar et al. “Face Recognition and RFID Verified Attendance System” IEEE Paper, pp. 168-172, 2018.
[29] Shweta Patil et al. “Attendance System Based on Face Recognition Using Eigen Face and PCA Algorithm” International Conference on Green Computing an Internet of things, pp. 303-308, 2015.
[30] Sarah Lina Saad et al. “Monitoring and Complaining Web-Based Face Recognition Using Haar Matlab” 8th International Conference on Control system, Computing and Engineering, Penang, Malaysia, pp. 206-211, 2018.
[31] Van-Dung Hong et al. “A Solution Based on Combination of RFID Tags and Facial Recognition for Monitoring Systems” 5th NAFOSTED Conference on Information and Computer Science, pp. 384-387, 2018.
[32] Gagandeep Singh Nagpal et al. “Facial Detection and Recognition Using OpenCV On Raspberry Pi 0” International Conference on Advanced Computing, Communication Control and Networking, pp. 945-950, 2018.