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.
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.

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

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

\[
s(x) = \begin{cases} 
1, & x \geq 0 \\
0, & x < 0 
\end{cases}
\]  
……. (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.

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.

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

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

\[
x_p = x_c + R \cos\left(\frac{2\pi p}{P}\right) \\
y_p = y_c - R \sin\left(\frac{2\pi p}{P}\right)
\]  
……. (3)

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

The LBP operator is robust against monotonic gray scale transformations.

The 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.

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.

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

**Methodology-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.

**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 database.

**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 database, 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

![Flowchart of attendance management system based on facial recognition](image)

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.

![Recognition of face in real time](image)

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