JETIR.ORG ISSN: 2349-5162 | ESTD Year : 2014 | Monthly Issue
JOURNAL OF EMERGING TECHNOLOGIES AND INNOVATIVE RESEARCH (JETIR)
An International Scholarly Open Access, Peer-reviewed, Refereed Journal

AUTOMATIC ATTENDANCE SYSTEM THROUGH FACIAL RECOGNITION USING RASPBERRY PI AND ML

[1]Navaid Safder, [2]Sachin Kumar Singh, [3]Rahul Kumar, [4]Dr.Chhaya Grover

1,2,3 B.Tech Student,4 Professor

(Department of Electronics & Communication Engineering, JSS Academy of Technical Education, Noida, 201301, Uttar Pradesh, India)

***Abstract*– For organisations such as educational institutions, public or private sectors to prosper Attendance Management system plays a vital role. Conventional methods like calling out roll numbers or taking sign on paper for marking attendance are prone to manual errors. The following paper reside in the idea of using advance technologies in marking attendance efficiently. The most efficient way is designing an attendance system using face recognition. The paper focuses on the utilization of Machine Learning, its various algorithm and Raspberry Pi to identify the facial features of a person and design a system to mark out their attendance.**

1. INTRODUCTION

For every organization managing the attendance of its employees (in case of companies) or students (in educational institutes) is a task that is very vital as it determines the future of that organization . The conventional method such as roll calling or taking sign of every individual is not a very efficient way as the records created would be huge and not easy to maintain if institution is very large.

The disadvantages of the conventional methods are: -

1. If the organisation has large strength it would be very inconvenient to maintain that much huge of a record. Maintaining it over a period of time makes it even more difficult.

2. There is room for manual errors in the process. It is possible that the teacher might miss out a student or some or some person can mark attendance for another person.

3. The process is very time consuming as it requires the teacher to mark the attendance by taking out time from his/her class.

4. For this method to work, a lot of paper is required which leads to exploitation of natural resources.

With the surge in technology in nearly all the fields, a new smart system to mark attendance is required .Hence to tackle all these issues at hand in traditional way are resolved with the help of technology.

Our proposed System aims to mark attendance by means of facial recognition. The system proposed will mark the attendance of students as the class is going on which will certainly help in saving time as the teacher would not have to

take out extra time to mark the attendance manually, moreover it would not disrupt the class and the complete focus of teacher as well as that of student will be on learning.

2. THEORETICAL UNDERSTANDING

2.1. HAAR CASCADES

Haar cascades are a feature-based object detection technique utilized in computer vision and image processing. They have become popular in various applications, including facial recognition systems, due to their high accuracy, fast detection speed, and low computational cost.

The Haar cascades technique is based on Haar-like features, which involves comparing the pixel values of adjacent rectangular regions of an image to determine whether they contain the characteristics of the object being detected. In facial detection, the technique relies on detecting specific features, such as edges, curves, and corners,that are characteristic of human faces.

The process of Haar cascades involves a cascade of classifiers, with each classifier being responsible for detecting a specific feature. These classifiers are trained using a large dataset of positive and negative examples to learn the features of the object being detected. Once the classifiers are trained, they can be used to detect the object in real-time by analyzing each sub-region of the image.

Haar cascades are highly effective at detecting faces even under varying lighting conditions, different facial expressions, and changes in the orientation of the face. This makes them a popular choice for facial recognition systems, as well as other applications such as object detection and tracking.

Several open-source libraries, including OpenCV, provide pre-trained Haar cascades for facial detection, making them easily accessible for developers to use in their applications. While Haar cascades have some limitations, they remain a widely used and effective technique for object detection and recognition.

The Fig.2.1 Depicts how Haar Cascades detects the relevant feature of an image that is face in this case

2.2 Histogram of Oriented Gradients (HOG)

The Histogram of Oriented Gradients (HOG) is a feature descriptor technique used in computer vision for object detection. The HOG method involves calculating the gradient magnitude and orientation of image pixels within local regions called cells. The orientation of the gradient is then quantized into discrete bins, and a histogram is computed for each cell, indicating the frequency of gradient orientations in that cell. These histograms are concatenated to form the HOG feature descriptor for the entire image.

Compared to other feature descriptors, the HOG technique is advantageous due to its ability to capture shape information and robustness to variations in lighting. It is widely used in applications such as pedestrian detection, facial recognition, and object tracking.

There are several variations of the HOG technique that can be customized for specific applications. For instance, Improved HOG (I-HOG) and Dual-Orientation HOG (DO-HOG) have been proposed to improve the detection performance of HOG-based systems.

Overall, the HOG technique remains a widely used and effective feature descriptor for object detection and recognition in computer vision applications. Its ability to capture fine-grained texture information, combined with its robustness to variations in lighting, makes it a popular choice for feature extraction in computer vision tasks.

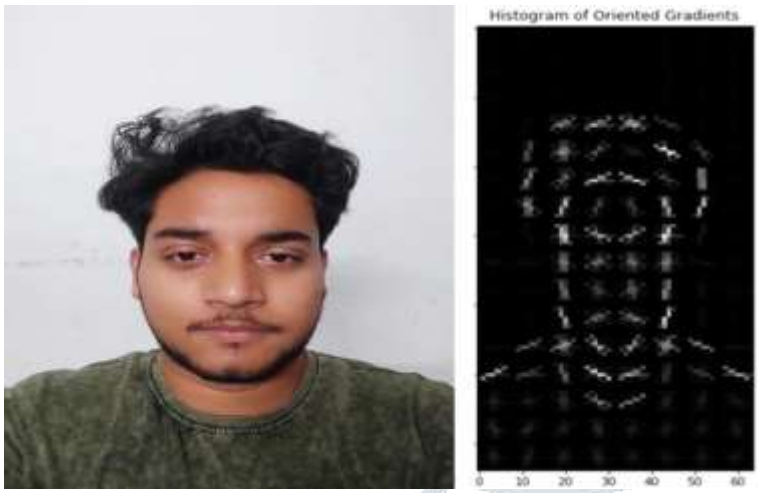


Fig.2.2 Shows feature descriptive image extracted by HOG

The process of generating Histogram of Oriented Gradients can be realized through following steps:-

i) DATA PREPROCESSING: - The most crucial part is to resize the image to a width-height ratio of 1:2. The preferred size of image is 64 x 128.

ii) CALCULATING GRADIENTS: - Gradients in mathematics are used to represent the change in value in x any direction. Let Gx and Gy be the gradients in our image. To calculate these let's consider pixel values of a small patch from our image.

122	88	71	54	46
182	183	48	22	33
245	45	65	72	54
47	35	23	55	18
129	111	94	36	96

Gx = 72-45 =27

Gy =48-23 = 25

The above Gx and Gy are calculated for the change in pixel value in x and y direction around highlighted value. This will generate two matrices one will store gradients in xdirection and other one storing gradients in y –direction.

iii) CALCULATING GRADIENT MAGNITUDE AND ORIENTATION :-

Total Gradient Magnitude = $\sqrt{[(Gx)\ 2+(Gy)\ 2\ ]}$

And orientation is given by $\tan(\Phi) = Gy / Gx$

Now with the help of magnitude and orientation histograms are plotted.

The histograms are initially plotted for a 8x8 patch and then to make prediction more accurate the gradients are normalized in 16x16 cells.

2.3. OpenCv

As an open-source computer vision library, OpenCV provides powerful tools for facial recognition. Among these tools are the pre-trained Haar and Local Binary Patterns (LBP) cascades, which are designed to detect faces in realtime video streams and to automatically extract facial features. OpenCV can be used in combination with machine learning

algorithms, such as Support Vector Machines (SVM) and Convolutional Neural Networks (CNN), to provide advanced facial recognition capabilities. The features extracted from the detected faces, such as the Histogram of Oriented Gradients (HOG) or Local Binary Patterns (LBP), can be used to train machine learning models for facial recognition. During facial recognition, the machine learning models compare the extracted features from the detected face to the features of known individuals in a database. If a match is found, the individual's identity is returned. OpenCV provides a user-friendly interface for implementing facial recognition algorithms in various applications, including security systems, access control systems, and biometric authentication systems. In summary, the combination of OpenCV and machine learning algorithms is a powerful tool for facial recognition, providing advanced capabilities for detecting and recognizing faces in real-world scenarios.

3. RELATED WORK

In order to create an automatic attendance system with most precision and accuracy we went through a lot of research papers to get an understanding of which method would be the most efficient in marking attendance and that cannot be deceived very easily . The following papers talk about a lot of technologies that can be used in automating the process of attendance. We went through all of them and summary of their respective model is mentioned below, we realized that after marking attendance the information of student's attendance an email can also be sent to respective organization head for their reference. So we also integrated this email feature in to our proposed model.

Author in paper [1] proposed a system that contains three different modules namely, Attendance through Face Recognition, Voice Converted Output and Gender classification Module. For first part the images are subjected to viola jones algorithm similar to paper [3] .PCA-principal Component Analysis is the algorithm used here for feature extraction for the set of training images, the system proposed in paper [9] also uses PCA. Further the test and training folder are matched and their intersection is marked as present. The second module converts the names of absentee in to voice using Microsoft speech API. The last module does classification of the gender of students by analyzing the facial traits of the person.

In order to make an efficient attendance system through facial recognition, an algorithm which is very precise to detect the faces is required .Paper [2] describes the algorithm and insight as to how these algorithms work. The algorithms that are described are Haar Cascade algorithm, Eigen faces algorithm, Fisher faces algorithm, Local Binary Pattern Histogram algorithm.

Paper [4] focuses on model which is based on the technology of Open Source Computer Vision Library (Open CV). The system is an application which uses image processing to keep track of the attendance of students in the class. The performance of the system proposed depends upon the computer specification because of the comprehensive resource management needed to acquire accuracy, smoothness and performance. The camera specification affects the facial recognition as it depends on its frame rate and resolution. In paper [3] and [4] GUI is designed to access all the functionalities of the system.

The use of raspberry pi is proposed in paper [5], it works on Raspbian Operating System installed on micro SD card. The Raspberry pi is programmed to handle the face recognition by implementing the Local Binary Patterns algorithm (LBPs). .An improved Two-Dimensional approach for face recognition is used. The attendance is taken just outside the class room and if the student is not recognized the door to class will not open and if recognized the door will open and the student's information will be saved in a MySQL file. The LBP algorithm is used to form a final feature vector and once we create a feature vector face recognition can be performed by implementing K-nearest-neighbors (KNN) algorithm. The LBPs algorithm is sensitive to light which is a major drawback as it deals with each pixel of an image and these pixels change their values with different lighting.

To increase the efficiency and accuracy of system the camera should take images continuously after a certain interval of time as mentioned in paper [6] and [5] and then crosscheck for attendance for precise marking of attendance. To increase the efficiency even more the skin Classification technique can be used [6]. In this method first the pixels of the image is realized then except the skin color pixels all other pixels are blurred. The algorithm uses Histogram Normalization [2] to convert colored images to gray scale images.

Paper [7] focuses on implementing a Facial recognition system using Python with the help of OpenFace and dlib (digital library), a similar approach is also adopted in system proposed in paper [8]. In [7] the image when the faces of student are in different direction it would cause error in the model. To counter this FACE LANDMARK ESTIMATION

algorithm is used to wrap each picture in such a way that eyes and lips will always be in same place in the image. After training the model to map the name with a person's name Linear SVM Classifiers are used. However in [8] the concept of CNN-Convolutional Neural Network is used for facial feature extraction as deep learning can be a top explanation for object diagnosis, pattern identification and face acknowledgement.

Paper [9] proposes a system which indulges microcontrollers. The microcontroller used here is AVR-ATMEGA 32 ,it is used for controlling operations , the system also has a feature of sending messages to HOD/Parents/Teacher on their mobile number in case a student is absent in classroom. This was achieved here by using GSM-900(operating frequency 900MHz for text sending). The software used in this model for image processing is MATLAB version R2013a. This paper also detects the faces from images with the help of Viola James algorithm.

Paper [10] proposes a system which is based on NFC (Near – Field Communication) technology .NFC is a system technology that transfers data in a short distance wirelessly and the standards communication protocol are based on existing RFID standards. There are two major components in this type of system namely "reader/writer" and a "tag" every student is given a unique tag with the help of which he/she is identified by putting the tag in front of reader.

Paper [11] proposes two systems or a multimodal approach to mark attendance of student. It discusses a system which uses RFID technology as in [10] and other is face recognition. RFID encourages the usage of unique tags for marking attendance whereas the latter recognizes the facial features and mark the attendance accordingly. The paper suggests improving the facial recognition system performance through a blend of recognition using HAAR CASCADE [2] + PCA and verification using MS-SSIM (Multi scale Structural similarity index for image quality assessment). Paper [12] mentions a system using Convolutional Neural Network which implies the system is based on deep learning. The process of face recognition is divided in to two major tasks: Face detection and face identification.

Sr. no.	Published Name	Published by	Observation	Research gaps
1	Attendance MonitoringSystem Using Face Recognition	Amrutha H. B, Anitha C, Channanjamurthy K. N, Raghu R B.E. Dept. of Electronics and Communication, VVIET Mysuru, Karnataka,India	Only works for a Single Student at a time The system has problems working in low light	Fails to detect multiple faces at a time.
2	Attendance Monitoring System using Facial Recognition with AudioOutput and Gender Classification	Poornima S1 , Sripriya N2 , Vijayalakshmi B3 ,Vishnupriya P4 1,2,3,4SSN College of Engineering, Chennai, India	System takes images at beginning of every hour	The system can be evaded with ease as it marks attendance on basis of one image.
3	Face Detection and Recognition Using OpenCV	Maliha Khan Deptt. of Comp. Sc. and Engg, School of Engg. AndTechSharda University, Gr.Noida, Uttar Pradesh –201306 malihakhan0009@gma il.com	Works only for a Single person at a time	Fails to detect multiple faces at a time.
4	Automated Attendanc e Management System Based On Face Recognition Algorithms	Shireesha Chintalapati, M.V. Raghunadh Department of E and CE NIT Warangal,INDIA 506004 Email: cshireesha102@gmail.co m, raghunadhmv@gmail.co m	Works when student enters classroom.	Can be interfered and controlled by students. Our proposed system will only starts when it

				detects the teacher.
5	Class Attendance Management System Using Face Recognition	Omar Abdul Rhman Salim Department of Electrical and Computer Engineering, Faculty of Engineering International Islamic University Malaysia, Kuala Lumpur, Malaysia o.salem92@gmail.com	Single person with controlling the door access.	Fails to detect multiple faces at a time.
6	Attendance Management System	Ravi Kishore Kodali Department of ECE National Institute of Technology, Warangal WARANGAL, INDIA ravikkodali@gmail.com	System takes images at beginning of every hour	The system can be evaded with ease as it marks attendance on basis of one image.
7	Multimodal student attendance management system (MSAMS)	Khaled Mohammed , A.S. Tolba , Mohammed Elmogy	Using both RFID and face recognition	Using two technologies adds to the cost of our overall system.

4. MOTIVATION

Developing an automatic attendance system with face recognition technology offers an efficient and accurate alternative to the traditional attendance process. The system eliminates errors and saves valuable time for teachers and students, allowing for a more productive and engaging learning experience. Moreover, it can enhance the security of schools and institutions by detecting and alerting administrators of unregistered individuals. Adopting this technology demonstrates a commitment to advancing education and creating a better learning environment. Implementing an automatic attendance system with face recognition technology is an exciting opportunity to revolutionize education and make a positive impact on the lives of students and teachers.

5. METHODOLOGY

5.1 Data collection: - Firstly, we created a dataset containing images of 10 teachers and 15 students. We then manually performed data cleaning on the dataset to ensure its accuracy and consistency. The images were then organized and stored in a folder named after the respective subject, making it easy to locate specific images.

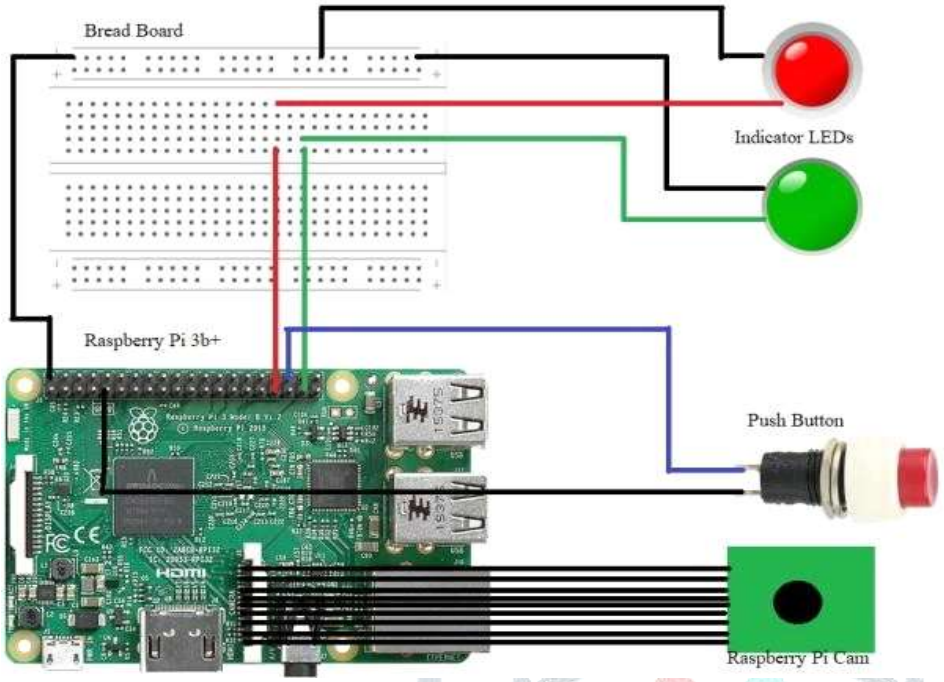
5.2 Data Preprocessing: - To prepare the collected data for face recognition, it is necessary to preprocess the data and extract only the relevant information. The first step in this process is to use Haar cascades to detect the faces in the images. Once the faces are detected, we use a hog model for feature extraction, which helps to capture the unique features of each face. In addition, we perform image resizing and normalization to ensure that all images have the same size and brightness, which is important for accurate recognition. Overall, this preprocessing step helps to ensure that the face recognition model is trained on high-quality data and can perform accurately in real-world scenarios.

5.3 Real time face detection using OpenCV: - After preprocessing the images and extracting the relevant features, the captured image can be compared to the encodings previously created and stored in the database with the assistance of OpenCV. This comparison involves identifying the face in the captured image and searching for a match in the pre-existing encodings. If a match is found, the name of the individual associated with the encoding is returned, allowing for accurate face recognition. This step is crucial in ensuring that the face recognition model can accurately identify individuals based on their unique facial features. With the help of OpenCV, these tasks can be performed quickly and efficiently, making face recognition a valuable tool for various applications.

5.4 Deployment: - To use our face recognition system in real-time, we will install the code we have developed on a Raspberry Pi, a compact and efficient computer suitable for this application. Additionally, we will integrate the necessary

hardware components, such as a Raspberry Camera and LEDs, to enable image capture and feedback in real-time. With the system set up, it will be capable of capturing images and identifying individuals based on the encodings stored in the database.

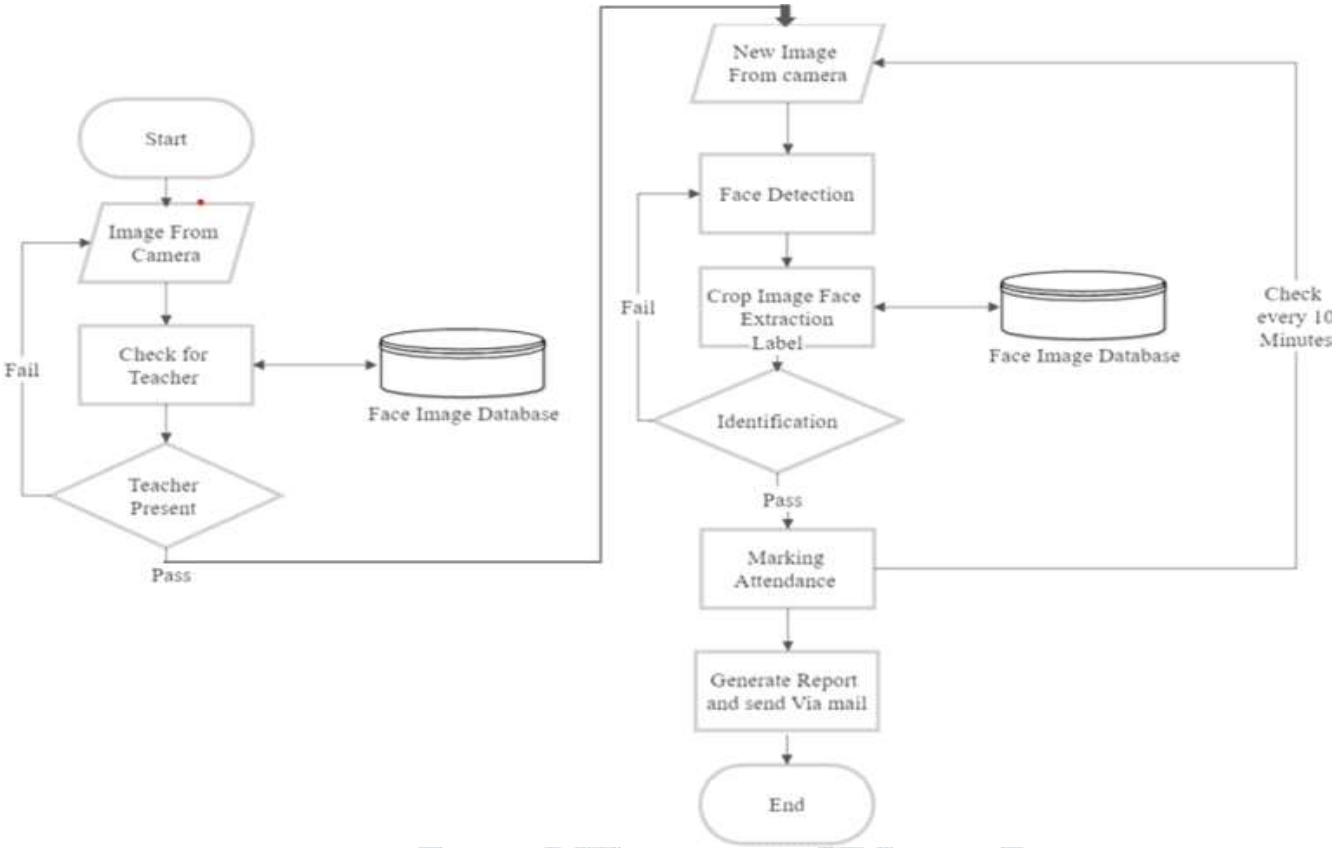
6. IMPLEMENTATION



The Fig.6.1 Represents how the hardware of our proposed system is interconnected to each other.

Our proposed system will be installed in classrooms by configuring the software in raspberry pi which has an arm based central processing unit.

The teacher will start the system by clicking the button and once the teacher is detected then as the class continues, marking of attendance of students will start and the system will take images 3 times in a period of one hour and mark the attendance accordingly. The system will also compile a csv file which will have the names of students present in the class. The compiled sheet of marked attendance would be send to the responsible authority.



The Fig.6.2 Represents the flow of the proposed system.

7. RESULT

The Fig.7.1 Face detection and recognition

The attendance system works as intended. Various trials were conducted to measure the accuracy of the project was tested with various parameters and it was observed: -

No. of Subjects Present	Accuracy (%)
1	98
3	90
4	85
5	80

Distance(meters)	Accuracy
1	96
2	87
3	82
4	75

For optimal performance there should be ample light present in the room. The accuracy is high when subjects are within 4 meters and is able to accommodate 7-8 subjects good accuracy.

8. CONCLUSION

Use of Facial recognition as an efficient way of marking attendance has been proposed in all the different papers mentioned in this study. Facial features of every person are unique, thus a system can be formed to where we can use it as a biometric. Most important aspect to face detection is a precise algorithm and an efficiently trained machine learning model. We hope that the system provides some additional insights in to the field of face detection and contributes in the development of field.

9. FUTURE SCOPE

The face recognition system project has tremendous potential for improvement in various aspects. For instance, the utilization of advanced ARM processors of the new generation can lead to faster and more efficient face detection. Moreover, upgrading the camera's quality can expand the range of detection, making it feasible to capture images from a greater distance or under low-light conditions. In addition, a cloud service can be employed to remotely and swiftly update the data of teachers. This will ensure that the database is always up-to-date with the most current information, and real-time updates can be performed efficiently. These improvements can make the face recognition system even more dependable and beneficial for a broader range of applications.

10. REFERENCES

[1] S. Poornima, N. Sripriya, B. Vijayalakshmi and P. Vishnupriya, "Attendance monitoring system using facial recognition with audio output and gender classification," 2017 International Conference on Computer, Communication and Signal Processing (ICCCSP), 2017, pp. 1-5, doi: 10.1109/ICCCSP.2017.7944103.

[2] M. Khan, S. Chakraborty, R. Astya and S. Khepra, "Face Detection and Recognition Using OpenCV," 2019 International Conference on Computing, Communication, and Intelligent Systems (ICCCIS), 2019, pp. 116-119, doi: 10.1109/ICCCIS48478.2019.8974493.

[3] S. Chintalapati and M. V. Raghunadh, "Automated attendance management system based on face recognition algorithms," 2013 IEEE International Conference on Computational Intelligence and Computing Research, 2013, pp. 1-5, doi: 10.1109/ICCIC.2013.6724266.

[4] M. I. P. Delos Trinos, J. H. Rios, K. G. O. Portades, P. Rae O. Portades, R. M. P. Langreo and M. B. Abisado, "Real-time Class Attendance Monitoring using Smart Face Recognition," 2019 IEEE 11th International Conference on Humanoid, Nanotechnology, Information Technology, Communication and Control, Environment, and Management (HNICEM), 2019, pp. 1-6, doi: 10.1109/HNICEM48295.2019.9072846.

[5] O. A. R. Salim, R. F. Olanrewaju and W. A. Balogun, "Class Attendance Management System Using Face Recognition," 2018 7th International Conference on Computer and Communication Engineering (ICCCE), 2018, pp. 93-98, doi: 10.1109/ICCCE.2018.8539274.

[6] Amrutha H. B, Anitha C, Channanjamurthy K. N, Raghu R, 2018, Attendance Monitoring System Using Face Recognition, INTERNATIONAL JOURNAL OF ENGINEERING RESEARCH & TECHNOLOGY (IJERT) NCESC – 2018.

[7] Nalini, N. & Tuladhar, Emerald & Shah, Avinash & Hegde, Anusha & Sai, Alekya. (2021). ATTENDANCE MONITORING SYSTEM BASED ON FACE RECOGNITION. 10.13140/RG.2.2.26342.75845.

[8] Jain A, Gupta R, Shariq M, Ikram T. Attendance Monitoring System Using Face Recognition.

[9] Owandkar M, Kolte A, Peshave D, Jadhav MS. Attendance monitoring system using face recognition. International Research Journal of Engineering and Technology. 2017 May;4(5).

[10] Mohd Nasir MA, Asmuni MH, Salleh N, Misra S. A review of student attendance system using near-field communication (NFC) technology. InInternational Conference on Computational Science and Its Applications 2015 Jun 22 (pp. 738-749). Springer, Cham.

[11] Mohammed K, Tolba AS, Elmogy M. Multimodal student attendance management system (MSAMS). Ain Shams Engineering Journal. 2018 Dec 1;9(4):2917-29.

[12] R. K. Kodali and R. V. Hemadri, "Attendance Management System," 2021 International Conference on Computer Communication and Informatics (ICCCI), 2021, pp. 1-5, doi: 10.1109/ICCCI50826.2021.9402659.