FACE RECOGNITION FOR ATTENDANCE PURPOSES USING DEEP LEARNING

With Real Time Database

AVNI JAIN
SCHOOL OF COMPUTER SCIENCE
VELLORE INSTITUTE OF TECHNOLOGY CHENNAI
CHENNAI, INDIA
avni.jain2022@vitstudent.ac.in

CHHAVI TRIPATHI
SCHOOL OF COMPUTER SCIENCE
VELLORE INSTITUTE OF TECHNOLOGY CHENNAI
CHENNAI, INDIA
chhavi.tripathi2022@vitstudent.ac.in

SHAUNAK WHAVAL
SCHOOL OF COMPUTER SCIENCE
VELLORE INSTITUTE OF TECHNOLOGY CHENNAI
CHENNAI, INDIA
shaunak.whaval022@vitstudent.ac.in

***Abstract*—Attendance tracking in a classroom environment is often a cumbersome task, exacerbated by the potential for proxy attendance when large numbers of students are present. Traditional methods of recording attendance have proven to be challenging, prompting the need for more efficient and automated approaches. This project addresses this challenge by proposing the development of an automated classroom attendance marking and management system utilizing face detection and recognition algorithms. The primary objective is to design a system that is efficient, time-saving, and user-friendly. Facial recognition algorithms will be employed to identify individuals, and processed images will be compared with existing records to update attendance information in the database. Furthermore, the versatility of this facial recognition technology opens up the possibility of broader applications, including enhancing the security and integrity of voting processes. Electoral fraud is a pressing issue in many regions, and the utilization of facial recognition for voter authentication could provide a robust solution to ensure the accuracy and fairness of elections**

***Index Terms*—component, formatting, style, styling, insert**

I. INTRODUCTION

In the dynamic realm of education, the precise and efficient tracking of student attendance has long been a persistent challenge. Conventional methods of attendance recording, reliant on manual processes, are not only cumbersome but also vulnerable to inaccuracies and proxy attendance, especially in large classrooms or lecture halls. In light of these challenges, there is an increasing need for a more streamlined, automated approach. This project seeks to tackle this issue by proposing the creation of an automated classroom attendance marking and management system, driven by the capabilities of face detection and recognition algorithms, implemented in the versatile Python programming language, and supported by a suite of powerful libraries including OpenCV, NumPy, Cmake, Face-recognition, Dlib, Haar cascade, and further complemented by real-time Firebase integration. By harnessing cutting-edge technology and these libraries, this system aspires to redefine the way attendance is monitored in educational institutions.

The primary aim of this project is to design and implement an attendance tracking system characterized by efficiency, time-saving capabilities, and user-friendliness.At its core, the system employs facial recognition algorithms, where libraries such as OpenCV, Dlib, and Face-recognition play a pivotal role, to identify individuals and facilitate the seamless recording of attendance data. The concept behind this system hinges on the idea that facial recognition, made attainable through these libraries, can offer a precise, reliable, and unobtrusive method for verifying a student's presence in the classroom.

Facial recognition algorithms, driven by deep learning techniques and Cmake for efficient building, have made significant strides, with libraries like Dlib and Face-recognition forming the backbone of these advancements. Leveraging a predefined dataset comprising a diverse range of facial images, these libraries serve as a crucial component in training and fine-tuning the face recognition model. This dataset forms the basis for ensuring that the system can adapt to the wide spectrum of facial characteristics typically encountered in educational settings.

The system's operation is elegant in its simplicity. It involves capturing images of students as they enter the classroom, employing OpenCV for real-time image processing, and utilizing deep neural networks facilitated by Dlib, alongside libraries like NumPy for data handling and Haar cascade for feature detection. The detected faces are then cross-referenced with the predefined dataset, allowing the system to verify a student's attendance status, update it in the database, and provide real-time attendance statistics to educators. This approach not only eliminates the need for manual attendance-taking but also significantly reduces the likelihood of inaccuracies or proxy attendance.

One of the project's key innovations is the integration of Firebase, Google's real-time database, which enables the immediate synchronization and management of attendance data. Firebase plays a pivotal role in ensuring that educators have access to up-to-the-minute attendance records, enhancing the overall user experience and the convenience of attendance monitoring.

Beyond its immediate application in the education sector, the versatility of Python, these libraries, and Firebase in handling data, machine learning, image processing, and real-time data management lends itself to a myriad of potential applications, extending its impact beyond the classroom. One particularly noteworthy application is in enhancing the security and integrity of voting processes. Electoral fraud remains a pressing concern in many regions, underscoring the need for solutions to ensure the accuracy and fairness of elections. The deployment of facial recognition, driven by Python, these libraries, and Firebase, for voter authentication, could offer a robust response to these challenges. In this context, the predefined dataset, supported by libraries like NumPy for efficient data management, takes on a more extensive role, not only as a resource for tracking attendance but as a foundation for strengthening the security and fairness of democratic processes. By expanding the capabilities of facial recognition to voter authentication, the system, with Python at its core and these libraries, alongside Firebase for real-time data updates, has the potential to redefine the electoral landscape, ensuring that only eligible voters participate in the democratic process. In conclusion, this project embarks on a journey to reimagine the way attendance is recorded in educational settings, employing Python's computational prowess and supported by a suite of powerful libraries and real-time Firebase integration. The use of a predefined dataset and cutting-edge algorithms, executed with these resources, promises to bring efficiency, accuracy, and convenience to the traditionally cumbersome task of attendance tracking. Beyond the classroom, the technology holds the potential to make significant strides in the realm of electoral integrity. This project is dedicated to exploring these possibilities, while meticulously addressing the ethical, legal, and technical challenges, to create a system that not only simplifies the lives of educators but also reinforces the foundations of democracy.

II. Literature Survey

Face recognition technology has emerged as a potent tool across various sectors in this digital era. It is a widely utilized biometric method that offers multifaceted applications, including security, authentication, and identification. In the context of educational institutions, particularly schools, colleges, and offices, where attendance monitoring is of paramount importance, face recognition technology has found its niche. Here, we delve into a literature survey covering four seminal research papers, each offering insights into the world of face recognition-based attendance management systems.

1) Smitha, Pavithra S Hegde, Afshin - "Face Recognition based Attendance Management System": This research, conducted at the Yenepoya Institute of Technology, India, explores the potential of face recognition technology in automating the attendance management process. The authors highlight the system's four key phases: database creation, face detection, face recognition, and attendance updating. By employing Haar-Cascade classifiers and the Local Binary Pattern Histogram algorithm, the system successfully detects and recognizes faces in real-time classroom video streams. The result is an automated attendance system that mitigates the time-consuming nature of manual attendance management, with attendance records conveniently mailed to faculty at the end of each session.

2) Dr. A Manjula, D. Kalpana, Sanjay Guguloth - "Facial Recognition Attendance Monitoring System using Deep Learning Techniques": This research, conducted at Jyothishmathi Institute of Technology and Science in Karimnagar, India, focuses on the implementation of a facial recognition attendance monitoring system. The authors stress the importance of accurate attendance records and the limitations of manual tracking. They propose the adoption of face recognition technology to address these issues, leveraging OpenCV and a database of student profiles. The system utilizes algorithms such as Haarcascade, Eigen values, support vector machines, and Fisher face algorithm to detect, verify, and record attendance efficiently.

3) Serign Modou Bah, Fang Ming - "An Improved Face Recognition Algorithm and Its Application in Attendance Management System": This research, conducted at Changchun University of Science and Technology, China, seeks to enhance face recognition accuracy by addressing challenges like variations in lighting conditions, noise in face images, scale, and pose. The authors introduce a novel approach that combines the Local Binary Pattern (LBP) algorithm with advanced image processing techniques such as contrast adjustment, bilateral filtering, histogram equalization, and image blending. The results of their experiments indicate that this method significantly improves the accuracy and robustness of face recognition systems, making them suitable for practical implementation in automatic attendance management systems.

4) Anirudha B Shetty, Bhoomika, Deeksha, Jeevan Rebeiro, Ramyashree - "Facial Recognition Using Haar Cascade and LBP Classifiers": This research, carried out at Shri Madhwa Vadiraja Institute of Technology and Management in Udupi, India, explores facial recognition techniques, specifically comparing Haar Cascade and Local Binary Pattern (LBP) classifiers. The study underscores the importance of face identification, particularly in the context of security and vital circumstances. While Haar Cascade demonstrated higher accuracy in facial recognition, LBP was more efficient in terms of execution time. This comparison sheds light on the trade-offs and considerations for selecting the appropriate classifier

for a specific application.

In summary, these research papers collectively demonstrate the growing significance of face recognition technology in automating attendance management processes in educational institutions. These systems offer the potential to enhance efficiency, reduce errors, and provide real-time data to educators. As the field of face recognition continues to evolve, these papers illuminate the diverse approaches and techniques that researchers are exploring to make attendance management more effective and user-friendly in this digital age.

III. Proposed System

A. Face Detection

In the field of technology face detection is treated as the demanding and practically applied approach. It involves the crucial task of identifying every face present within an image. In this implementation, we rely on the powerful combination of OpenCV and Haar cascade classifiers.

The process begins by partitioning the image into smaller 16x16 pixel squares. Within each square, we meticulously tally the number of gradients pointing in various major directions. These gradients signify how many points upwards, up-right, rightward, and so forth. Subsequently, we'll replace that square in the image with the arrow directions that were the strongest.

The following steps outline the methodology we intend to follow in our image processing and face detection procedure:

Step I: Image Loading
Import the necessary libraries.
Capture images from the camera.

Step II: Image Transformation to Grayscale
To process the images through classifiers, convert them into grayscale

Step III: Application of the Haar Cascade
Use OpenCV to apply the Haar cascade classifier.

Step IV: Comparative Analysis of Classifiers
a. Import the required libraries.
b. Capture images from the camera.
c. Convert the images into grayscale for processing.
d. Load the images using OpenCV.
e. By default, the image will be loaded in the BGR color space.

B. Haar Cascade Classifier:

Step I: Loading the Input Image Utilize the built-in function cv2.imread(img_path) to load the input image, with the image path as the input parameter. Step II: Image Transformation and Display Convert the loaded image to grayscale mode. Display the grayscale image. Step III: Loading the Haar Cascade Classifier

C. Face Recognition:

Face recognition process can be divided into three steps prepare training data, train face recognizer, and prediction. Here training data will be the images present in the dataset. They will be assigned with a integer label of the student it belongs to. These images are then used for face recognition.

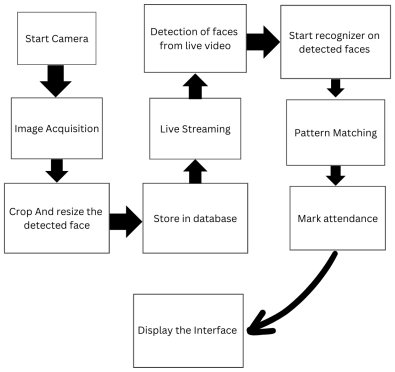

Fig. 1. Proposed System Architecture

Haar Cascade classifier.

No.of faces in an image	Execution Time (sec)	No.of faces detected	Accuracy (%)
5	0.141	5	100
10	0.055	9	90
15	0.11	12	80
20	0.369	19	95

Fig. 2. Haar cascade Classifier

Face recognizer used in this system is Local Binary Pattern Histogram. Initially, the list of local binary patterns (LBP) of entire face is obtained. These LBPs are converted into decimal number and then histograms of all those decimal values are made. At the end, one histogram will be formed for each images in the training data. Later, during recognition process histogram of the face to be recognized is calculated and then compared with the already computed histograms and returns the best matched label associated with the student it belongs to.

D. Accuracy calculation:

1. Performance Metrics: True Positives (TP): These are instances where actual objects of interest are correctly identified by the system. False Positives (FP): These are situations where non-objects of interest are mistakenly identified as true objects. False Negatives (FN): These are cases where actual objects of interest are falsely identified as negatives.

2. Metrics Calculation: True Positives Rate (TPR): It quantifies the proportion of actual objects of interest that are correctly classified. TPR = TP / (TP + FP) False Negatives Rate (FNR): It measures the proportion of actual objects of interest that are falsely identified as negatives. FNR = FN / (FN + TP) 3. Accuracy: This metric assesses the overall system's performance, considering both true positives and true negatives, and it's calculated as: Accuracy = (TP + TN) / (TP + TN + FP + FN) Accuracy for Haar Cascade: By applying the aforementioned equations and evaluation, the accuracy obtained for the Haar cascade is calculated as 96.24This accuracy value reflects the system's ability to correctly identify objects of interest and non-objects, serving as a key performance indicator.

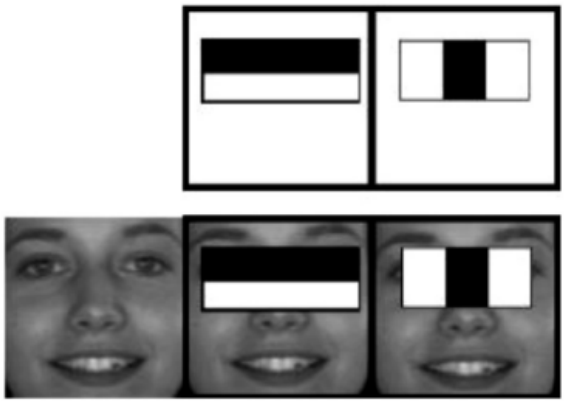

Fig. 3. Haar Like Features

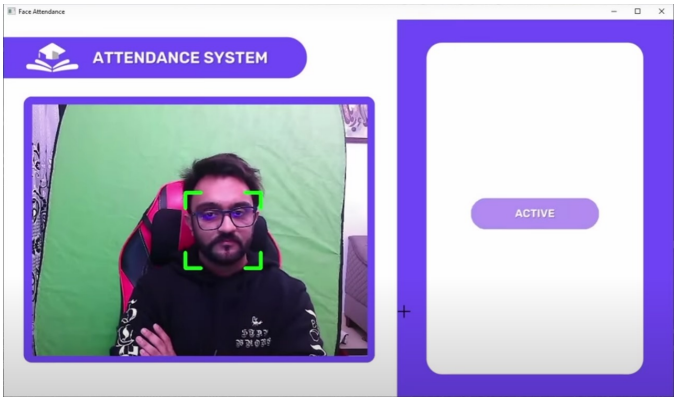

Fig. 4. Figure shows which screen is shown when the system is working and is ready to capture images.

E. Attendance system:

Once the system has effectively recognized human faces, the next step is to seamlessly integrate the recognized face images into our sophisticated attendance system. This system is meticulously designed to automate the attendance marking process for individuals, thus alleviating the manual burden.

F. Attendance system:

In our attendance database (Firebase console), we will extract each recognized face image to mark the attendance of individuals, using date and time deduced from when the face is recognised. This meticulous timestamping ensures accurate and real-time tracking of attendance records. The Firebase console provides a secure, accessible, and convenient platform for educators and administrators to monitor attendance data with ease. In our final output, we have successfully implemented an advanced attendance system that harnesses the power of face recognition technology. Once the system accurately identifies human faces, these recognized face images seamlessly flow into our meticulously designed attendance system. Backing this system is our robust attendance database, hosted on the reliable Firebase console. Within this database, each recognized face image is meticulously logged, complete with precise date and time information. The timestamping ensures that our attendance records are not only accurate but also constantly updated in real-time as faces are recognized. Here is a small working of our system:

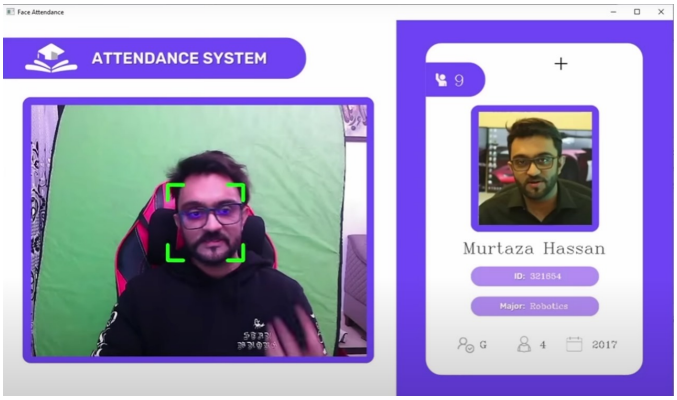

Fig. 5. Figure shows the screen display which consists of the details of the student/employee when the face captured matches with any one of the faces in the predefined database.

IV. PROCESS FLOW

A. Camera Access and Face Recognition:

Access the camera using the OpenCV library. Continuously capture images, recognizing faces as they appear in the camera's field of view.

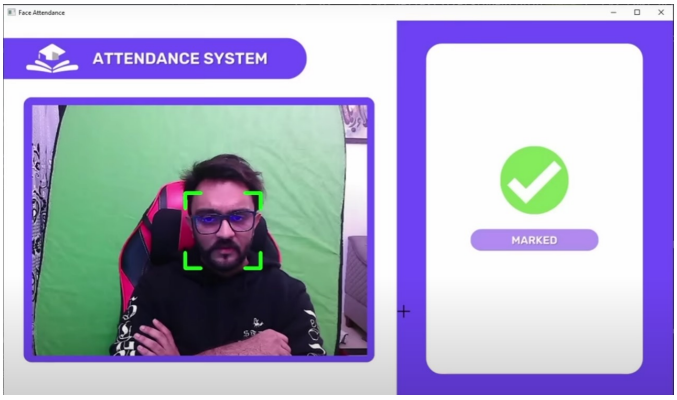

Fig. 6. Figure shows that the face is marked present.

B. Face Detection:

Implement face detection using the Haar cascade classifier and the Dlib library, which offers pre-trained facial landmark detectors.

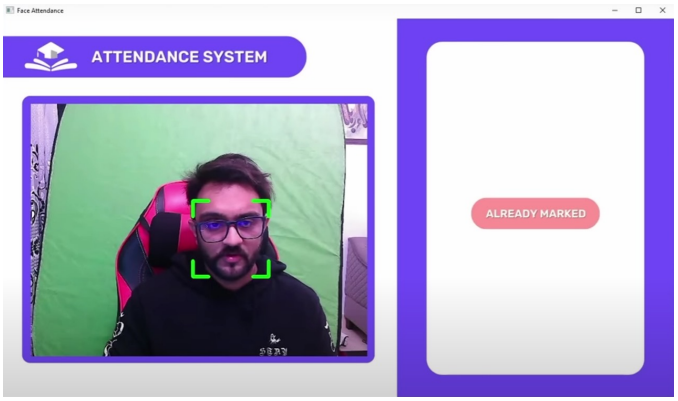

Fig. 7. Figure shows that whenever an image of an already marked face is captured then the interface shows the attendance is already marked.

	A	B	C	D	E
1	S. No.	Reg No.	Name	Date	Time
2	1	22BPS1034	Shaunak Whaval	23-10-2023	17:34:27
3	2	22BRS1043	Avni Jain	23-10-2023	17:33:16
4	3	22BRS1096	Chhavi Tripathi	23-10-2023	17:33:45
5					
6					
7					
8					
9					
10					
11					

Fig. 8. Figure shows the real-time database, sourced directly from the online repository in the format of an Excel spreadsheet.

C. Face Recognition:

Recognize detected faces by checking if they match faces already present in the predefined database of students or employees. Utilize the face_ encodings function from the face_recognition library, which divides the image into blocks and calculates measurements for facial features such as eyes, nose, and more.

D. Attendance Marking:

If the encodings of the captured image match entries in the database, mark the attendance for the recognized person. Display the relevant data, such as the person's identity.

E. Real-time Database Storage:

Store the time, person's details, and other relevant information in the real-time database, hosted on Firebase's console. This data can be conveniently accessed and utilized later, such as for generating Excel sheets.

F. Handling Unrecognized Faces:

In cases where the captured image doesn't match any database entries, display appropriate details on the user interface.

G. Preventing Duplicate Entries:

Ensure that an individual can't be marked present multiple times while the system is operational.

H. Attendance Retrieval:

Teachers or administrators can later retrieve attendance data from the system for their record-keeping and assessment.

V. EXPERIMENTAL SETUP

A. LIBRARIES

OpenCV-

1. Accessing camera.
2. Detection of face.
3. Displaying the camera output.
4. Displaying the Interface for the attendance system.

Numpy- Used to perform a wide variety of mathematical operations on arrays

Cmake- Used as a requisite for Dlib.

Face-Recognition- It has machine learning-backed methods for advanced face detection. The algorithms detect faces in an image by breaking it down into thousands of patterns and features that it matches.

1. To find the encodings of the face captured
2. To check if the captured face's encodings and a face in the data base is similar
3. It calculates the approximate similarity 3 times if it is low the face is recognised

Dlib- It provides a pre-trained facial landmark detector that can detect 68 points on a face.

Haar-cascade classifiers(file) - It detects if there is a face in front of the camera by taking measurements of the facial features like - Eyes, noes, lips, Eyebrows, etc.

B. DATABASE

To train the model we use a predefined database.

To store the attendance details we use Firebase console realtime database.

VI. RESULT

The journey to develop an automated classroom attendance marking and management system, powered by facial recognition technology and an array of supporting libraries, including OpenCV, Dlib, and Face-recognition, has culminated in a successful and transformative project. Detecting and recognizing student faces is the core functionality of the system. The collaborative efforts of OpenCV, Dlib, and Face Recognition proved pivotal in achieving this goal. Through the careful orchestration of deep learning techniques, these libraries successfully identified individuals with remarkable precision. The result is an attendance system that effectively verifies a student's presence in the classroom. One of the project's primary objectives was to enhance efficiency and accuracy in attendance tracking. By capturing images of students as they enter the classroom and processing them

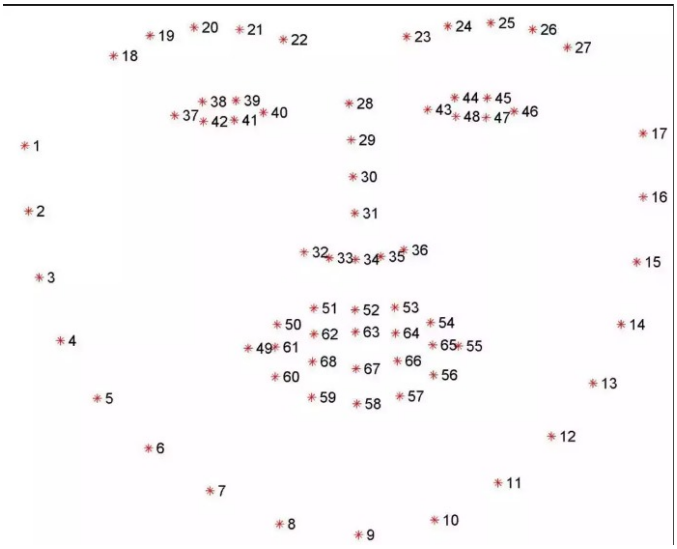

Fig. 9.

in real-time using OpenCV, the system significantly reduced the burden of manual attendance recording. Furthermore, the use of predefined datasets and facial recognition algorithms contributed to a substantial reduction in inaccuracies and proxy attendance, ensuring that attendance records are more reliable than ever. The integration of a user-friendly interface for educators further amplified the project's success. This interface, made possible through OpenCV and other libraries, provides a convenient means for educators to interact with attendance data. It empowers them to access, update, and monitor attendance records with ease, enhancing the overall user experience.

REFERENCES

[1] A. Kumari Sirivarshitha, K. Sravani, K. S. Priya and V. Bhavani, "An approach for Face Detection and Face Recognition using OpenCV and Face Recognition Libraries in Python," 2023 9th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2023, pp. 1274-1278

[2] G. G. Dordinejad and H. Çevikalp, "Face Frontalization for Image Set Based Face Recognition," 2022 30th Signal Processing and Communications Applications Conference (SIU), Safranbolu, Turkey, 2022, pp. 1-4,

[3] R. He, J. Cao, L. Song, Z. Sun and T. Tan, "Adversarial Cross-Spectral Face Completion for NIR-VIS Face Recognition," in IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 42, no. 5, pp. 1025-1037, 1 May 2020,

[4] A. Kumar, S. Samal, M. S. Saluja and A. Tiwari, "Automated Attendance System Based on Face Recognition Using Opencv," 2023 9th International Conference on Advanced Computing and Communication Systems (ICACCS), Coimbatore, India, 2023, pp. 2256-2259.

[5] A. Rao, "AttenFace: A Real Time Attendance System Using Face Recognition," 2022 IEEE 6th Conference on Information and Communication Technology (CICT), Gwalior, India, 2022, pp. 1-5

[6] J. P. Jeong, M. Kim, Y. Lee and P. Lingga, "IAAS: IoT-Based Automatic Attendance System with Photo Face Recognition in Smart Campus," 2020 International Conference on Information and Communication Technology Convergence (ICTC), Jeju, Korea (South), 2020, pp. 363-366

[7] V. Bittal, V. Jagdale, A. Brahme, D. Deore and B. Shinde, "Multifarious Face Attendance System using Machine Learning and Deep Learning," 2023 7th International Conference on Intelligent Computing and Control Systems (ICICCS), Madurai, India, 2023, pp. 387-392

[8] S. Bhattacharya, G. S. Nainala, P. Das and A. Routray, "Smart Attendance Monitoring System (SAMS): A Face Recognition Based Attendance System for Classroom Environment," 2018 IEEE 18th International Conference on Advanced Learning Technologies (ICALT), Mumbai, India, 2018, pp. 358-360

[9] M. Singhal and G. Ahmad, "Deep Learning Based Real Time Face Recognition For University Attendance System," 2023 International Symposium on Devices, Circuits and Systems (ISDCS), Higashihiroshima, Japan, 2023, pp. 01-04

[10] N. Narkhede, A. Menon, I. Mathane, S. Nikam and S. Dange, "Facial Recognition and Machine Learning-based Student Attendance Monitoring System," 2023 3rd International Conference on Intelligent Technologies (CONIT), Hubli, India, 2023, pp. 1-7