Tuijin Jishu/Journal of Propulsion Technology
ISSN: 1001-4055
Vol. 45 No.2 (2024)

Machine Learning-Driven Attendance System Using KNN and Image Processing

A.Kondababu[1], B.Satya Sridevi[2], T.Srinivasa Rao[3]
[1,2,3]*Department of ECE, Aditya University, Surampalem, A.P, India*

Abstract:- Numerous time-consuming techniques are available to monitor an individual's presence, including biometric attendance tracking. Thus, image processing provides a more effective solution than biometrics or manual techniques. Particularly important for identification among physical characteristics is the face, with its plethora of distinctive features. This research presents a technique where a group image is initially captured, followed by individual face identification utilizing a face recognition module and the KNN (k-nearest neighbors) algorithm. Image capturing continues throughout the session, and attendance is recorded at the end once all individuals have been identified. Regular updates to the database have the potential to enhance accuracy over time. Individuals' attendance is recorded via Automatic Attendance Tracing (AAT) when the taken image matches the one stored in the database, indicating a match. This proposed approach reduces manual effort and streamlines the process of tracking student attendance, making it easier to register their presence.

Keywords*: KNN (k-nearest neighbours), Automatic Attendance Tracing (AAT), Image Processing, Face Detection, Face Recognition.*

1. Introduction

Employee attendance monitoring can be done manually by recording in and out times, maintaining timesheets and mechanized systems. Manual recording involves handwritten registers or books to log employee entry and exit times, while timesheets provide detailed breakdowns of tasks accomplished and time spent. Mechanized systems automatically generate records of employee in and out timings, reducing manual effort and increasing reliability. The advantages include faster data processing, accurate records, minimal supervision needs, easy report generation, and simple integration with payroll software.

Biometrics is another attendance tracking method, providing employee verification and identification through physiological (fingerprints, iris recognition) or behavioral (voice, signature) characteristics. Fingerprint and retinal scanning are commonly used biometric options in offices. Access cards like magnetic stripe or proximity cards are also employed, allowing entry after swiping or via contactless access. Proximity cards enable user access from short ranges without removing the card. These card-based systems generate records of employee entry/exit times for payroll calculation. The current manual attendance system at our organization faces several limitations - it is time-consuming, error-prone, lacks transparency, hinders attendance analysis, and poses security risks with physical records. The objectives of implementing a new system include reducing errors, saving time, providing real-time attendance data, improving payroll processing, and enhancing employee satisfaction through an efficient, user-friendly system.

The new digital attendance tracking system will cover all employees, allowing sign-in/out via personal or workplace devices, and provide real-time attendance patterns. This will enable managers to make informed decisions regarding scheduling and resource allocation based on accurate attendance trends. While costs for hardware/software and employee training may be constraints, the benefits of accurate attendance data, streamlined processes, and informed decision-making outweigh the challenges. Transitioning from an ineffective manual system to an automated attendance solution is crucial for our growing modern workplace.

This paper introduces existing ways of tracking employee attendance, including manual recording, timesheets, mechanized systems, biometrics, and access cards. It highlights the problems associated with the current manual attendance system in our organization, including time-consuming processes, error-prone records, lack of

transparency, and difficulty in analyzing attendance patterns and also outlines the objectives of implementing a new attendance tracking system, including reducing errors, saving time, providing real-time data, improving payroll processing, and enhancing employee satisfaction. The proposed methodology for the attendance tracking system, focusing on the main working algorithm, K-Nearest Neighbors (KNN). It explains the training and prediction processes involved in the system, providing a detailed understanding of how the system operates. The outcomes of the attendance monitoring system utilizing several photos and an Excel spreadsheet. It displays the system's capacity to reliably identify and recognize faces for attendance tracking, emphasizing its efficacy and dependability. Utilizing Convolutional Neural Networks (CNN), their system aims to mark attendance, overcoming proxy and fake attendance issues. However, the accuracy is hindered by false detections, and occasional missed attendance markings due to image capture limitations [1]. The authors presented a facial detection model that utilizes algorithms such as AdaBoost and Haar Cascades [2]. This model focuses on facial feature extraction using pattern recognition techniques. Proposed a systematic approach for image processing, including facial feature extraction such as the framework of face, nose, and eyes, utilizing Eigen Values for accurate attendance marking [3]. Face recognition-based mobile attendance systems have been explored, requiring users to download mobile applications for attendance tracking. While tested satisfactorily, drawbacks include the need for multiple applications, limiting its efficiency [4]. The system incorporates a proxy removal technique, enhancing efficiency compared to fingerprint scanners [5]. However, challenges arise when multiple faces are detected simultaneously, leading to false detections. Similarly, Author proposed a Face Recognition and RFID Verified Attendance System, successfully integrating face recognition and RFID verification [6]. The system provides accurate and organized attendance data, offering potential improvements over manual attendance systems. Compared various face recognition techniques and system architectures, providing a mathematical model for attendance tracking [7]. Proposed a smartphone-based attendance monitoring system utilizing Wi-Fi fingerprinting and facial recognition, offering a cost-effective solution with foolproof measures against fake attendance [8]. Moreover, [9] presented an IoT-based attendance tracker, leveraging motion sensors and cloud-based logging for quasi real-time attendance tracking.

Despite the lower accuracy compared to other recognition methods, facial recognition remains popular due to its non-contact nature. Their system offers automatic and continuous attendance monitoring, enhancing student participation tracking in real-time. To improve image quality for face recognition, researchers have proposed enhanced image acquisition methods, dataset creation from video frames, and tailoring the face recognition models and algorithms for optimal accuracy on the target dataset [13]. Advantages of these automated face recognition attendance systems include high usability, portability, cost-effectiveness by eliminating paper and manual labor, real-time attendance tracking visible to [14] teachers and parents, and prevention of proxies. Some systems are designed as mobile apps for instructors, students and parents, while others use embedded devices with integrated [15] AI and IoT capabilities for classroom deployment. Cloud connectivity allows global access to attendance logs. Researchers have [16],[17],[18] compared the performance of different face recognition algorithms like Eigenfaces, SVMs, neural networks etc. on created datasets, evaluating aspects like accuracy and execution time to identify the most suitable approaches. Certain systems are [19] event-driven, staying in low-power standby mode until motion is detected to trigger the face recognition pipeline. This design approach enables quasi real-time attendance tracking while optimizing power consumption. While facial recognition is generally less accurate than biometrics like fingerprints or iris scans. The current attendance system used in many organizations relies on manual methods such as sign-in sheets, which are prone to errors, time-consuming, and difficult to maintain. This has led to a number of problems, including inaccurate attendance records, delayed payroll processing, and a lack of real-time information about attendance trends. As a result, there is a need to improve the attendance system by implementing a more efficient and reliable method. With continuous improvements to algorithms and hardware, automated face recognition systems show promise for efficient and secure attendance management.

2. Objectives

- To reduce errors in attendance tracking by implementing a more accurate system.
- To cut down on the time and work involved in maintaining attendance records.

- To offer up-to-date data on trends and attendance patterns.
- To improve payroll processing by ensuring accurate and timely attendance data.
- To improve employee satisfaction by providing a more efficient and user-friendly attendance system.

3. Design Methods

The proposed design improves facial recognition accuracy and streamline the conventional approach to attendance tracking. This objective can be met by employing the K-Nearest Neighbours (KNN) technique, which is renowned for its effectiveness in this context. Manual management of attendance is laborious for educators, prompting the adoption of advanced, automated solutions. Yet, ensuring authenticity remains a significant challenge in numerous systems. These automated attendance systems commonly utilize biometric technologies for user authentication and identification. Facial recognition emerges as a valuable biometric method for enhancing attendance management systems. The technology holds promise for refining attendance monitoring processes.

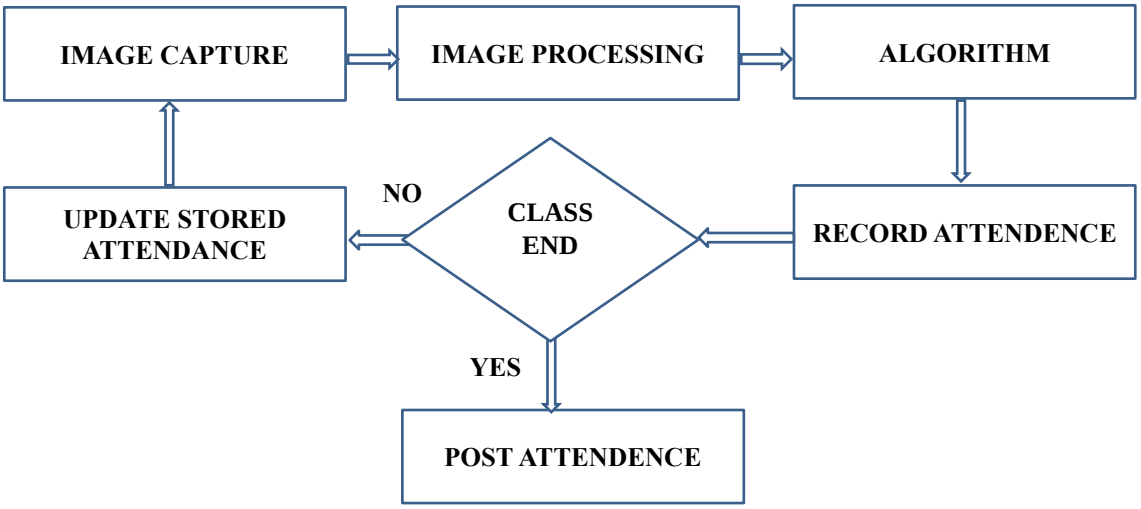


Figure 1: Work flow of algorithm

A. The Specifications

The KNN has three basic steps.

- Calculate the distance.
- Find the k nearest neighbours.
- Vote for classes

The entire algorithm is predicated on the k value. Even minor modifications to k can result in significant effects. KNN, like most machine learning algorithms, uses hyperparameters. K can be thought of as a controlling variable in the prediction model. The in-built face-recognition module in python detects the crucial face points. These locations and the distance between them is noted and these are different for each individual's face. These values are given to a KNN (k-nearest neighbors) algorithm for training. The face of an individual is identified by using the trained model it selects the nearest neighbor for the facial points and shows the result. The attendance will be recorded from that image, and images will continue to be taken until the end of the class.The students who are identified in those images will be recorded as attendees for the respective class.

B. KNN Algorithm Training

- Data Gathering: The student images will be captured and organized in a file hierarchy according to the specifications needed for algorithm training.

- Algorithm Training: The algorithm needs to be trained with the captured images such that it yields maximum accuracy. The trained model is saved to the given path so that we can use it for prediction purpose.

C. Prediction

- Face Detection: Faces are detected from the image captured during class.
- Face identification: Faces detected are identified by using the pre-trained KNN model.
- Naming Faces/Marking attendance: Detected faces will be named by the person's name and used for marking attendance.

D. Trained Algorithm Working:

- Image capturing: Image will be captured by the available camera devices.
- Image processing: The captured image will be processed and the human faces in the image will be detected by using haar-features.
- Algorithm: The faces detected will be given to the algorithm part and the faces will be identified by using pre-trained KNN model.

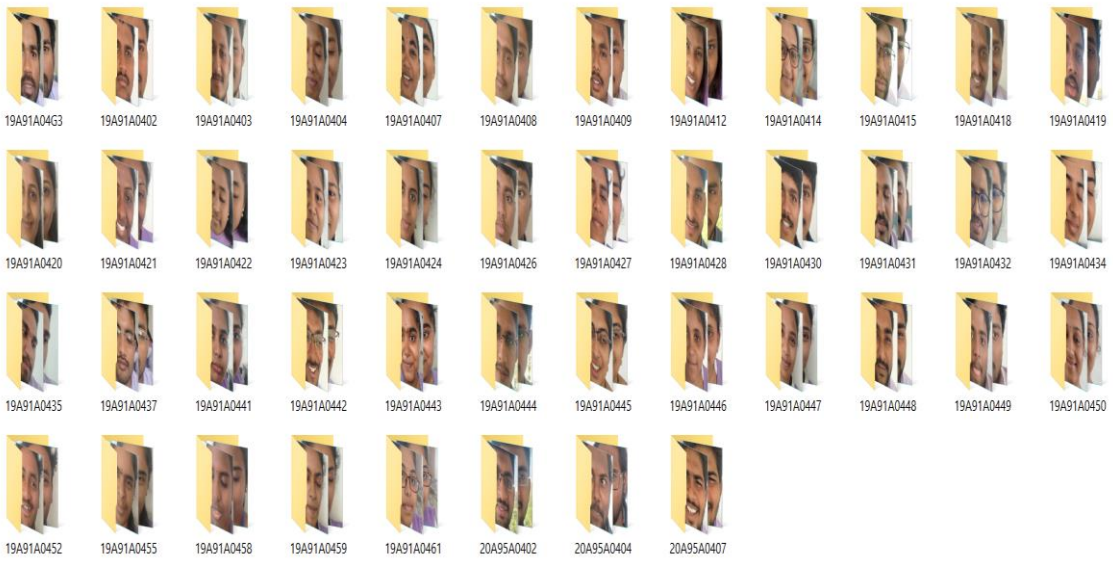


Figure 2: Dataset folders

To implement a K-Nearest Neighbors (KNN) algorithm for capturing attendance from images, need to extend the process of training the model and integrate it with an attendance management system. Establish a database to manage both student details and attendance records. Certain face recognition algorithms function by pinpointing distinctive landmarks or features within a subject's facial image. The image database serves as the reference point for the face recognition algorithm. When a new image (such as a captured image during attendance tracking) is compared against the images in the database, it helps determine if there is a match, enabling the system to accurately identify individuals.

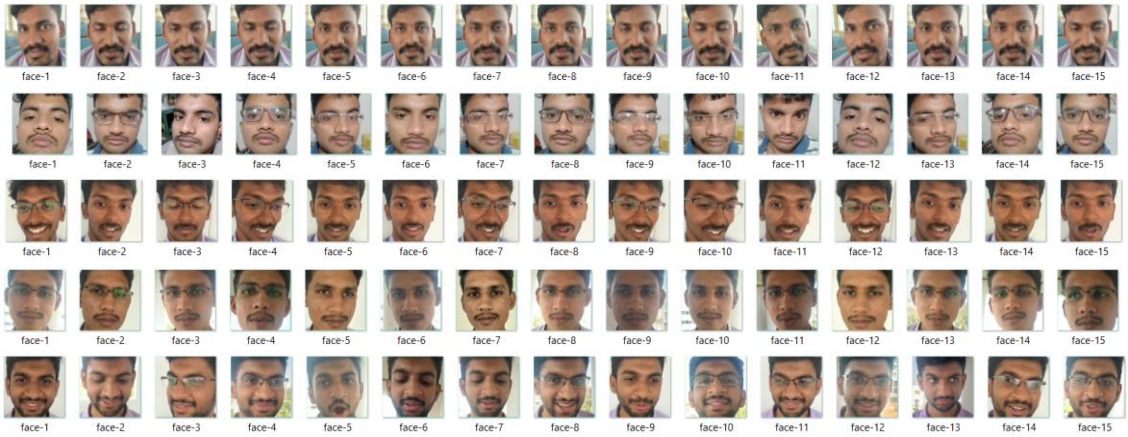


Figure 3: Dataset images

4. Results

The in-built face-recognition module in python detects the crucial face points. These locations and the distance between them are noted and these are different for each individual's face. These values are given to a KNN (k-nearest neighbors) algorithm for training. The face of an individual is identified by using the trained model it selects the nearest neighbor for the facial points and shows the result. Detected faces will be named by the person's name and used for marking attendance. If a person is not detected in a particular image, the person may be captured at any time of the class. Recapturing the images is the main advantage in the proposed system.

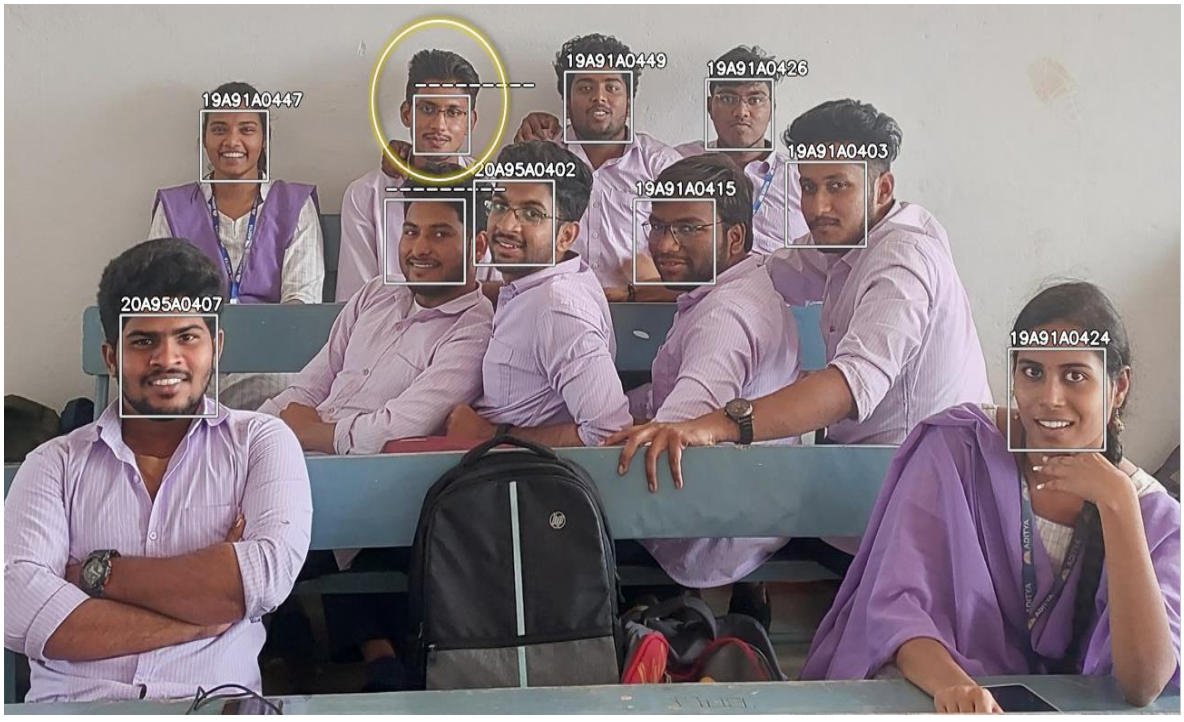


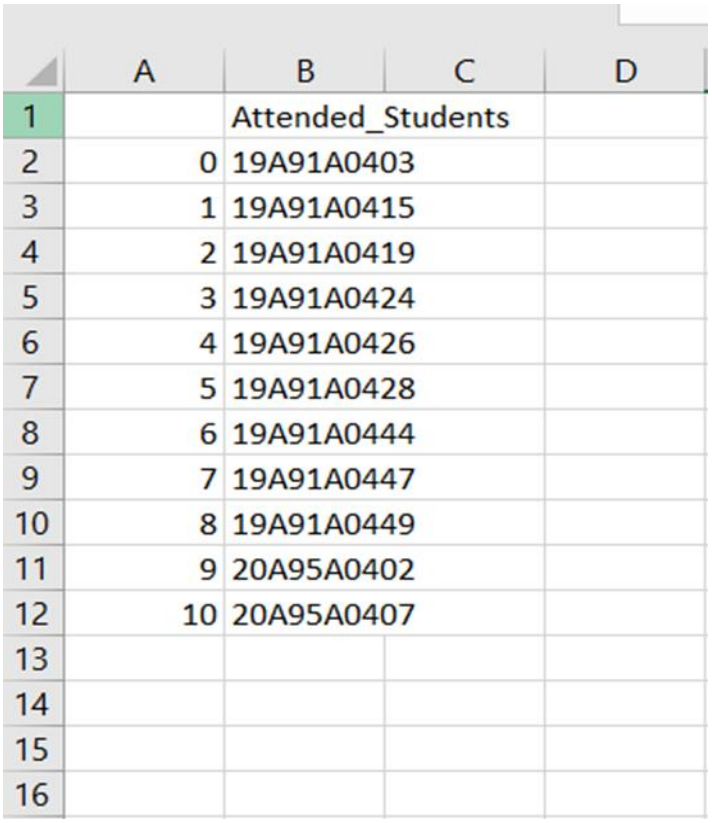
Figure 4: Identifying faces with distance threshold=0.4

Figure 5: Identifying faces with distance threshold=0.6

Figure 6: Detecting faces from crowd

Images that are taken in campus are given as input images for prediction algorithm and the output will be shown in two different ways.

- Roll numbers on the detected face in the output images.
- Roll numbers of the students detected from all images in single excel file.



	A	B	C	D
1		Attended_Students		
2	0	19A91A0403		
3	1	19A91A0415		
4	2	19A91A0419		
5	3	19A91A0424		
6	4	19A91A0426		
7	5	19A91A0428		
8	6	19A91A0444		
9	7	19A91A0447		
10	8	19A91A0449		
11	9	20A95A0402		
12	10	20A95A0407		
13				
14				
15				
16				

Figure 7: Recording attendance in microsoft excel sheet

5. Discussion

First, a group photograph is taken from which individual faces are then extracted using a face-recognition module and identified using the KNN (k-nearest neighbours) algorithm. Up until the end of class, images are still being taken. After each student has been identified, the attendance will be posted at the end of the lesson. To produce more reliable findings, the database can be updated annually. If the picture that was taken and the image in the dataset match, the Automated Attendance Tracking (AAT) system records the attendance of the individual. The suggested method reduces effort, records daily management activities for each student, and streamlines the presence marking process. This work can be further extended by posting the attendance directly into attendance portal after the class and also can be implemented by using a CCTV monitoring.

Refrences

[1] S. Sawhney, K. Kacker, S. Jain, S. N. Singh, and R. Garg, “Real-time smart attendance system using face recognition techniques,” in Proceedings of the 9th International Conference on Cloud Computing, Data Science and Engineering, Confluence 2019, 2019. doi: 10.1109/CONFLUENCE.2019.8776934.

[2] K. Goyal, K. Agarwal, and R. Kumar, “Face detection and tracking: Using OpenCV,” in Proceedings of the International Conference on Electronics, Communication and Aerospace Technology, ICECA 2017, 2017. doi: 10.1109/ICECA.2017.8203730.

[3] A. Jha, “Class Room Attendance System Using Facial Recognition System,” The International Journal of Mathematics, vol. 2, no. 3, 2020.

[4] R. Samet and M. Tanriverdi, “Face recognition-based mobile automatic classroom attendance management system,” in Proceedings - 2017 International Conference on Cyberworlds, CW 2017 - in

cooperation with: Eurographics Association International Federation for Information Processing ACM SIGGRAPH, 2017. doi: 10.1109/CW.2017.34.

[5] Prof. G. Manasali, A. S. Deshmukh, B. S. N, C. V K, and J. V Das, "Smart Attendace System Using ML," Int J Res Appl Sci Eng Technol, vol. 11, no. 5, 2023, doi: 10.22214/ijraset.2023.53407.

[6] M. S. Akbar, P. Sarker, A. T. Mansoor, A. M. Al Ashray, and J. Uddin, "Face Recognition and RFID Verified Attendance System," in Proceedings - 2018 International Conference on Computing, Electronics and Communications Engineering, iCCECE 2018, 2018. doi: 10.1109/iCCECOME.2018.8658705.

[7] P. Wagh, R. Thakare, J. Chaudhari, and S. Patil, "Attendance system based on face recognition using eigen face and PCA algorithms," in Proceedings of the 2015 International Conference on Green Computing and Internet of Things, ICGCIoT 2015, 2016. doi: 10.1109/ICGCIoT.2015.7380478.

[8] S. Anand, K. Bijlani, S. Suresh, and P. Praphul, "Attendance Monitoring in Classroom Using Smartphone & Wi-Fi Fingerprinting," in Proceedings - IEEE 8th International Conference on Technology for Education, T4E 2016, 2017. doi: 10.1109/T4E.2016.021.

[9] R. Johar, S. M. Qaisar, A. Subasi, and R. F. Kurdi, "An Event Driven Attendance Tracker," in 21st Saudi Computer Society National Computer Conference, NCC 2018, 2018. doi: 10.1109/NCG.2018.8592968.

[10] L. Fung-Lung, M. Nycander-Barua, and P. Shiguihara-Juarez, "An image acquisition method for face recognition and implementation of an automatic attendance system for events," in Proceedings of the 2019 IEEE 26th International Conference on Electronics, Electrical Engineering and Computing, INTERCON 2019, 2019. doi: 10.1109/INTERCON.2019.8853603.

[11] A. Yadav, A. Sharma, and S. S. Yadav, "Attendance Management System Based on Face Recognition Using Haar-Cascade," in 2022 2nd International Conference on Advance Computing and Innovative Technologies in Engineering, ICACITE 2022, 2022. doi: 10.1109/ICACITE53722.2022.9823613.

[12] D. D. Nguyen, X. H. Nguyen, T. T. Than, and M. S. Nguyen, "Automated Attendance System in the Classroom Using Artificial Intelligence and Internet of Things Technology," in Proceedings - 2021 8th NAFOSTED Conference on Information and Computer Science, NICS 2021, 2021. doi: 10.1109/NICS54270.2021.9700991.

[13] Y. Kortli, M. Jridi, A. Al Falou, and M. Atri, "Face recognition systems: A survey," Sensors (Switzerland), vol. 20, no. 2. 2020. doi: 10.3390/s20020342.

[14] R. Muthunagai, D. Muruganandhan, and P. Rajasekaran, "Classroom Attendance Monitoring Using CCTV," in 2020 International Conference on System, Computation, Automation and Networking, ICSCAN 2020, 2020. doi: 10.1109/ICSCAN49426.2020.9262436.

[15] K. Bhatti, L. Mughal, F. Khuhawar, and S. Memon, "Smart Attendance Management System Using Face Recognition," EAI Endorsed Transactions on Creative Technologies, vol. 5, no. 17, 2018, doi: 10.4108/eai.13-7-2018.159713.

[16] T. Van Nguyen and T. D. Chu, "Comparative Study on The Performance of Face Recognition Algorithms," Eureka, Physics and Engineering, vol. 2023, no. 4, 2023, doi: 10.21303/2461-4262.2023.002831.

[17] A. M. Reddy, K. Naresh, S. S. Kumar, and M. Bandu, "Comparison of various face detection and face recognition algorithms," International Journal of Engineering Research in Computer Science and Engineering (IJERCSE), vol. 5, no. 4, 2018.

[18] N. Annamareddy, L. G. Donepudi, L. Parvathaneni, K. B. V. Brahma Rao, J. Putta, and P. Yellamma, "Comparison of Various Face Recognition Algorithms in ML/DS," in 2nd International Conference on Sustainable Computing and Data Communication Systems, ICSCDS 2023 - Proceedings, 2023. doi: 10.1109/ICSCDS56580.2023.10104690.

[19] Prof. S. Ahire, R. Jadhao, V. Gawai, and P. Giri, "Automated Student Attendance Management System Using Face Recognition," International Journal of Advanced Research in Science, Communication and Technology, 2021, doi: 10.48175/ijarsct-2019.

[20] A. Jain, R. Gupta, Mohd. S. Ansari, and T. Ikram, "Attendance Monitoring System Using Face Recognition," Int J Res Appl Sci Eng Technol, vol. 10, no. 5, 2022, doi: 10.22214/ijraset.2022.42389.