ISSN 2319-5991 www.ijerst.com

Peer Reviewed, Referred & Indexed Journal

Research Paper

FACE RECOGNITION BASED ATTENDANCE SYSTEM USING MACHINE LEARNING

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Abstract:

The Face Recognition Based Attendance System Using Machine Learning is developed to automate student attendance while overcoming the limitations of manual registers and fingerprint-based methods. The proposed system captures real-time facial images through a webcam and performs image preprocessing, face detection, feature extraction, and recognition. Haar Cascade Classifier is employed for face detection, while Convolutional Neural Network (CNN) is used to extract facial features. Support Vector Machine (SVM) and K-Nearest Neighbors (KNN) classifiers are applied to identify registered students. The system maintains student facial data under different expressions, poses, and lighting conditions to improve recognition robustness. Once a student is identified, attendance is automatically recorded with name, date, and time in Excel/database records. Testing and validation evaluate accuracy, reliability, speed, and performance under varied classroom conditions, providing an efficient, contactless, and secure attendance solution.

Keywords: Face Recognition, Machine Learning, Attendance Management, Face Detection, CNN, SVM.

I. INTRODUCTION

Student attendance is an essential activity in educational institutions for monitoring student participation, discipline, and academic progress. Traditional attendance methods, such as manual registers and roll calls, are time-consuming, labor-intensive, and prone to human errors. They may also allow proxy attendance and require additional effort for maintaining and monitoring records. Although fingerprint-based biometric systems provide automation, they require physical contact with specific devices and may create hygiene and maintenance concerns. The advancement of Artificial Intelligence, Machine Learning, and computer vision provides an effective alternative through automated face recognition. The proposed Face Recognition Based Attendance System Using Machine Learning captures students' facial images through a webcam and processes them for automatic identification. Image preprocessing techniques such as resizing, normalization, and noise removal improve image quality. Haar Cascade Classifier detects faces, while a Convolutional Neural Network extracts important facial features. SVM and KNN algorithms recognize registered students. After successful identification, the system automatically records the student's name, date, and time, thereby providing a faster, contactless, reliable, and efficient attendance management solution.

II. LITERATURE SURVEY

Recent research has demonstrated significant progress in applying machine learning and deep learning techniques to face recognition and automated attendance management. Modern face recognition approaches emphasize robust feature extraction, accurate face localization, quality assessment, and improved recognition performance under varying environmental conditions. Several studies have developed automated attendance systems using OpenCV, Haar Cascade, CNN, SVM, KNN, and other deep-learning techniques for real-time student identification. Research has also explored multiple-face recognition, webcam-based attendance, IoT-enabled attendance frameworks,

and deep-learning-based recognition for educational environments. Advanced approaches have attempted to address challenges associated with facial masks, illumination variations, different facial poses, image quality, and recognition reliability. These developments demonstrate that facial recognition can reduce manual attendance effort, minimize recording errors, support contactless identification, and improve attendance record management. However, existing systems continue to face limitations related to low-light environments, scalability, computational requirements, processing time, duplicate attendance, and potential spoofing attacks. Therefore, there is a continuing need for an efficient, reliable, and practical face recognition attendance framework capable of providing accurate real-time identification while maintaining organized attendance records and satisfactory performance under different classroom conditions.

III. PROPOSED WORK

The proposed work focuses on developing an automated Face Recognition Based Attendance System Using Machine Learning to provide accurate, efficient, and contactless attendance management. The system begins with student registration, where personal details and multiple facial images are collected and stored in the student database. During attendance, a webcam captures real-time classroom images, which undergo preprocessing operations such as resizing, normalization, and noise removal to improve image quality. The Haar Cascade Classifier is then used to detect and isolate faces from the captured images. A Convolutional Neural Network (CNN) extracts significant facial features and converts them into feature representations. These features are supplied to Support Vector Machine (SVM) and K-Nearest Neighbors (KNN) classifiers for identifying registered students. When a student is successfully recognized, the system automatically records the student ID, name, date, and time. A duplicate-entry mechanism prevents repeated attendance within a configurable interval. Unknown faces are identified separately, while multiple students can be processed simultaneously. Attendance records are maintained in CSV or Excel format, and administrators or faculty can view and generate attendance reports. The proposed system is designed to reduce manual effort, prevent proxy attendance, improve record management, and support reliable real-time classroom attendance.

IV. METHODOLOGY

The proposed methodology follows a systematic workflow for automated student attendance using facial recognition and machine learning. It includes student registration, image acquisition, preprocessing, face detection, feature extraction, face recognition, attendance marking, database management, and report generation. Each stage contributes to accurate and efficient real-time attendance processing.

a. Student Registration and Face Image Enrollment

The first stage involves registering students in the attendance system. The administrator collects student details such as student ID, name, and department and stores them in the database. Multiple facial images of each student are captured and enrolled to represent variations in facial expressions, head poses, and lighting conditions. These images form the reference dataset for subsequent recognition. The enrolled facial information is securely associated with the corresponding student identity. This stage ensures that the system has sufficient facial samples to recognize registered students during real-time classroom attendance.

b.Image Acquisition and Preprocessing

During attendance, the system uses a webcam to capture real-time images or video frames of students in the classroom. The acquired images may contain variations in lighting, image quality, facial orientation, and background conditions. Therefore, preprocessing is performed before recognition. The proposed system applies operations such as image resizing, normalization, and noise removal to improve image quality and provide suitable input for subsequent processing stages. Proper preprocessing helps produce clearer facial regions and supports reliable face detection and feature extraction during real-time attendance processing.

c. Face Detection Using Haar Cascade

After preprocessing, the system detects facial regions from the captured classroom images using the Haar Cascade Classifier. The classifier

identifies faces within the input image and isolates the detected facial regions for further processing. This step is important because recognition should be performed only on relevant facial areas rather than the complete image. The detected regions are subsequently passed to the feature extraction stage. The system can process multiple faces appearing simultaneously in a classroom frame, making the detection stage suitable for automated classroom attendance scenarios.

d. Feature Extraction Using CNN

The detected facial images are processed using a Convolutional Neural Network (CNN) for feature extraction. CNN-based processing identifies important and discriminative facial characteristics from the detected face. These characteristics are represented as feature vectors that can be used for identifying individual students. The extracted features are associated with the corresponding student labels during enrollment and are later compared with features obtained from live classroom images. This approach enables the system to represent facial information in a form suitable for machine-learning-based classification and recognition.

e. Face Recognition Using SVM and KNN

The extracted facial features are supplied to machine learning classifiers for student identification. The proposed system uses Support Vector Machine (SVM) and K-Nearest Neighbors (KNN) algorithms. KNN identifies a student by comparing the extracted feature vector with stored reference vectors and selecting the nearest matching examples. SVM performs classification in the feature space to distinguish between different student identities. Confidence thresholds can also be applied so that uncertain or low-confidence predictions are not automatically accepted, thereby helping reduce incorrect attendance marking.

f. Automatic Attendance Marking

Once a student's face is successfully recognized, the system automatically generates an attendance record. The recognized student's ID and name are retrieved from the registered database, and the current date and time are recorded using a timestamp. A duplicate-detection mechanism prevents the same student from being repeatedly marked during a configurable attendance interval. Multiple recognized students can be processed from a single classroom frame. Attendance information can be stored in CSV or Excel format, while manual correction facilities can be provided for instructors when required.

V. ALGORITHMS

The proposed system uses multiple algorithms at different stages to achieve reliable face-based attendance. Haar Cascade is used for face detection, CNN for extracting meaningful facial features, while SVM and KNN are employed for recognizing registered students. Together, these algorithms enable real-time face detection, feature representation, classification, and automated attendance marking.

a. Haar Cascade Classifier

The Haar Cascade Classifier is used to detect human faces from images captured through the webcam. It identifies facial regions from the preprocessed classroom images and separates them from the background. The detected face regions are then forwarded to the feature extraction stage for further analysis. This algorithm provides the initial detection capability required by the proposed attendance system. Its integration allows the system to locate faces before applying CNN-based feature extraction and machine-learning-based recognition. It also supports processing facial regions from classroom images containing multiple students.

b. Convolutional Neural Network (CNN)

The Convolutional Neural Network (CNN) is used for extracting important facial features from detected face images. It processes the facial region and generates a feature representation containing discriminative information useful for identifying individual students. During enrollment, extracted features are associated with the corresponding student identity and stored for later comparison. During attendance, features from newly detected faces are generated using the same process and supplied to the recognition classifiers. CNN-based feature extraction therefore provides the facial representations required for accurate machine-learning-based student identification.

c. Support Vector Machine (SVM)

Support Vector Machine (SVM) is one of the classification algorithms used for recognizing

registered students. The extracted facial features are provided to the SVM classifier, which separates different student identities within the feature space. The document specifies the use of an RBF kernel and a one-versus-rest strategy for multi-class recognition. SVM is suitable when the available training examples for individual student classes are relatively limited. The classifier can produce a prediction and confidence-based decision, while low-confidence results can be directed for manual verification to reduce incorrect attendance.

d. K-Nearest Neighbors (KNN)

K-Nearest Neighbors (KNN) is another classification approach employed for face recognition in the proposed system. During student enrollment, facial feature vectors are stored together with their corresponding student identities. During attendance, the feature vector extracted from a detected face is compared with the stored reference vectors. KNN identifies the closest feature vectors and uses the nearest neighbors to determine the student's identity. The method provides a straightforward approach for matching new facial representations against enrolled students and is used alongside SVM as a recognition method within the proposed attendance framework.

VI. RESULTS AND DISCUSSION

The proposed system was evaluated using key performance measures reported in the document, including recognition accuracy, processing time, environmental performance, and resource utilization. The results indicate that the system can perform automated attendance effectively, with satisfactory recognition accuracy and real-time processing capability.

Table 1: Recognition Performance

Parameter	Result
Overall Accuracy	92–95%
Low-Light Accuracy	78–82%
Recognition Time	0.8–1.2 s
Attendance Time	2.1 s

Table 1 summarizes the major recognition results of the proposed system. Overall recognition accuracy reached 92–95%, demonstrating effective identification of registered students. Under low-light conditions, accuracy decreased to 78–82%, indicating the influence of illumination on recognition. Recognition was completed within 0.8–1.2 seconds, while complete attendance marking required an average of 2.1 seconds.

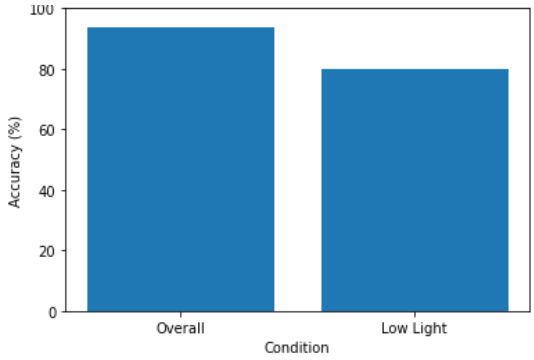

Fig 1: Recognition Accuracy

Fig 1 illustrates the recognition accuracy of the system under normal and low-light conditions. The overall value is represented by the midpoint of the reported 92–95% range, while low-light performance uses the midpoint of 78–82%. The graph clearly shows that illumination affects recognition performance, although the system continues to function under reduced lighting conditions.

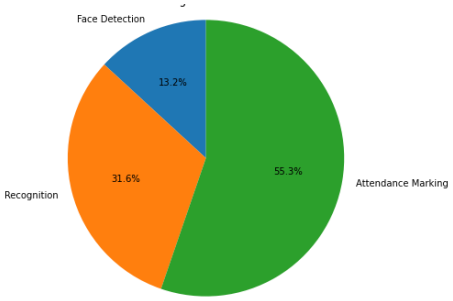

Fig 2: Processing Time Distribution

The Fig 2 presents the relative contribution of face detection, recognition, and attendance marking to the reported processing times. Attendance marking represents the largest portion, followed by recognition and face detection. The visualization highlights that end-to-end attendance processing requires more time than individual detection and recognition stages, while still achieving an average response time of 2.1 seconds.

Table 2: System Resource and Scalability Results

Parameter	Result
CPU Usage	65%

Memory Usage	52%
Scalability Increase	5%
System Uptime	98.5%

Table 2 presents resource utilization, scalability, and reliability results. During continuous operation, CPU usage reached 65% and memory usage reached 52%, remaining within the specified limits. Increasing the student database to more than 500 profiles resulted in only a 5% recognition-time increase. The system also achieved 98.5% uptime, demonstrating stable long-duration operation.

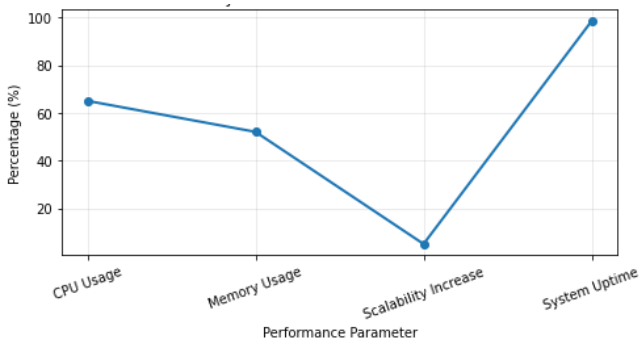

Fig 3: System Performance Indicators

Fig 3 presents the major system-performance indicators reported in the study. The system recorded 65% CPU utilization, 52% memory utilization, a 5% increase in recognition time during scalability testing, and 98.5% uptime. The results indicate stable resource utilization, limited performance degradation with increased database size, and reliable operation during continuous attendance monitoring.

VII. CONCLUSION

The proposed Face Recognition Based Attendance System Using Machine Learning provides an efficient, automated, and contactless approach for managing student attendance. The system integrates webcam-based image acquisition, Haar Cascade face detection, image preprocessing, CNN-based feature extraction, and machine learning classifiers for student recognition. The evaluated results demonstrate overall recognition accuracy of 92–95%, while low-light conditions produced 78–82% accuracy. The system achieved an average attendance response time of 2.1 seconds and supported real-time processing of multiple students. Resource utilization remained controlled, with 65% CPU and 52% memory usage during continuous operation. The system also demonstrated reliable long-duration performance and generated attendance records in an organized format. Overall, the proposed approach reduces manual effort, minimizes paperwork, supports automated attendance recording, and provides a practical solution for educational institutions.

FUTURE SCOPE

The proposed system provides an automated and contactless solution for student attendance management using facial recognition. Its main features include student registration with multiple facial images, real-time face capture through a webcam, face detection using Haar Cascade, image preprocessing, facial feature extraction using CNN, and student identification using SVM and KNN classifiers. The system supports multiple-face detection, automatic attendance marking with student name, date, and timestamp, and prevention of repeated attendance entries. It also provides attendance record viewing, Excel report generation, attendance percentage calculation, and secured access for administrators and faculty. The system is designed to operate under different facial expressions, poses, camera distances, and lighting conditions. Performance evaluation covers recognition accuracy, processing time, scalability, resource utilization, reliability, and usability, making the system suitable for classroom attendance automation.

REFERENCES

[1] L. Li, X. Mu, S. Li, and H. Peng, “A review of face recognition technology,” IEEE Access, vol. 8, pp. 139110–139120, 2020, doi: 10.1109/ACCESS.2020.3011028.

[2] Y. Huang, Y. Wang, Y. Tai, X. Liu, P. Shen, S. Li, J. Li, and F. Huang, “CurricularFace: Adaptive curriculum learning loss for deep face recognition,” in Proc. IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR), Seattle, WA, USA, 2020, pp. 5901–5910.

[3] J. Deng, J. Guo, E. Ververas, I. Kotsia, and S. Zafeiriou, “RetinaFace: Single-shot multi-level face localisation in the wild,” in Proc. IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR), Seattle, WA, USA, 2020.

[4] Dattatreya Goud (2025). URL-Based Phishing Detection Using Hybrid Machine Learning. American Advanced Journal for Emerging Disciplinaries (AAJED), ISSN: 3067-

[5] K. Mridha and N. T. Yousef, "Study and analysis of implementing a smart attendance management system based on face recognition technique using OpenCV and machine learning," in Proc. 10th IEEE Int. Conf. Communication Systems and Network Technologies (CSNT), 2021, doi: 10.1109/CSNT51715.2021.9509614.
[6] P. M. Kumara, M. Tahmasebi, and D. Sethu, "Automatic attendance recording system using facial recognition," Malaysian Journal of Science and Advanced Technology, vol. 1, no. 2, pp. 68–71, 2021, doi: 10.56532/mjsat.v1i2.12.
[7] Q. Meng, S. Zhao, Z. Huang, and F. Zhou, "MagFace: A universal representation for face recognition and quality assessment," in Proc. IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR), 2021, pp. 14225–14234.
[8] M. Dattatreya Goud (2025). CyberKids: A Video Game to Promote Cybersecurity Awareness Among Children. American Online Journal of Science and Engineering (AOJSE), ISSN: 3067-1140.
[9] K. Hajji, A. Cenadi, and F. Ahmad, "Machine learning based human face recognition for attendance system," in Proc. 4th Int. Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA), Ankara, Turkey, 2022, pp. 1–7, doi: 10.1109/HORA55278.2022.9799883.
[10] X. An, J. Deng, J. Guo, Z. Feng, X. Zhu, J. Yang, and T. Liu, "Killing two birds with one stone: Efficient and robust training of face recognition CNNs by Partial FC," in Proc. IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR), 2022, pp. 4042–4051.
[11] M. Kim, A. K. Jain, and X. Liu, "AdaFace: Quality adaptive margin for face recognition," in Proc. IEEE/CVF Conf. Computer Vision and Pattern Recognition (CVPR), 2022, pp. 18750–18759, doi: 10.1109/CVPR52688.2022.01819.
[12] M. Dattatreya Goud (2025). Analyzing Data Breach Factors Through Modern Crime Theory: A Structural Equation Modeling Approach. European Advanced Journal for Science & Engineering (EAJSE), p-ISSN: 3050-9696.
[13] P. Netinant, N. Akkharasup-Anan, and M. Rakhiran, "Class attendance system using unimodal face recognition system based on Internet of Educational Things," in Proc. 6th IEEE Eurasian Conf. Educational Innovation (ECEI), 2023, pp. 67–70, doi: 10.1109/ECEI57668.2023.10105374.
[14] V. Chaudhari, S. Jain, R. Chaudhari, T. Chavan, et al., "Real time face recognition based attendance system using multi task cascaded convolutional neural network," in Proc. Int. Conf. Emerging Smart Computing and Informatics (ESCI), 2023, doi: 10.1109/ESCI56872.2023.10099879.
[15] S. Rathi, S. Kapadnis, G. Sonar, G. Sonar, and S. R. Vispute, "Multi-facial automated attendance system using Haar Cascade, LBPH, and OpenCV-based face detection and recognition," in Proc. 7th Int. Conf. Computing, Communication, Control and Automation (ICCUBEA), 2023, doi: 10.1109/ICCUBEA58933.2023.10392248.
[16] A. Alqadhi and A. Khmag, "University students' attendance by utilizing face recognition approach based on deep learning technique," in Proc. IEEE 11th Int. Multi-Topic Conf. (INMIC), 2024, vol. 11, pp. 515–519, doi: 10.1109/MI-STA61267.2024.10599676.
[17] A. K. Kamalapur, B. Srikanth, A. S. Yadav, B. Yashwanth, and V. Duraivelu, "Face recognition using OpenCV—use case on student attendance system," in Proc. 15th Int. Conf. Computing Communication and Networking Technologies (ICCCNT), 2024, doi: 10.1109/ICCCNT61001.2024.10725378.
[18] P. Bajeli and V. S. Gutte, "IoT-enabled face recognition attendance system using Raspberry Pi and OpenCV," in Proc. IEEE Int. Conf. Emerging Trends in Computing and Communication (ETCOM), 2025, doi: 10.1109/ETCOM66606.2025.11436752.
[19] M. Dattatreya Goud (2025). Network Intrusion Detection Using Supervised Machine Learning with Feature Selection. EAJSE, 3(3). https://doi.org/10.5281/zenodo.15862974
[20] X. An, X. Zhu, Y. Gao, Y. Xiao, Y. Zhao, Z. Feng, L. Wu, B. Qin, M. Zhang, D. Zhang, and Y. Fu, "Partial FC: Training 10 million identities on a single machine," in Proc. IEEE/CVF Int. Conf. Computer Vision (ICCV) Workshops, 2021.