

Smart Classroom Attendance System using WEBCAM

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Abstract: Attendance tracking is a critical administrative task in educational institutions, yet conventional methods such as manual roll calls are inefficient, time-consuming, and vulnerable to proxy attendance. This project proposes a Smart Attendance System using Webcam that leverages computer vision and face recognition techniques to automate the attendance process. The system captures real-time video through a webcam, detects student faces using image processing algorithms, and recognizes them by comparing with previously stored facial datasets. A structured MySQL database is used to store student information and attendance records securely. The

application is integrated with a Tkinter-based graphical user interface, allowing easy student registration, dataset generation, and attendance monitoring. Image processing operations are performed using OpenCV and NumPy, ensuring fast and accurate face detection. The proposed system minimizes human intervention, improves accuracy, and provides a reliable and efficient solution for attendance management in academic institutions.

I. INTRODUCTION

In today's world of digital learning, technology plays a crucial role in shaping education's delivery and experience. Schools, colleges, and universities globally are moving past traditional teaching methods. Smart classrooms use digital tools and automation to make learning more interactive and efficient. Face recognition is a contactless biometric method that identifies individuals using facial features, making it ideal for real-time classroom attendance. Classical computer vision techniques such as Haar Cascade for face detection and Eigenfaces or LBPH for recognition are efficient, reliable, and suitable for real-time use on standard hardware [1].

Automated attendance systems based on face recognition offer an efficient alternative to traditional manual methods used in classrooms. Among various techniques, Principal Component Analysis (PCA) with Eigenfaces is a lightweight and computationally efficient approach for real-time face recognition. R. Femila Goldy et al. utilize PCA/Eigenfaces in a webcam-based system designed for small classroom environments, where hardware resources and training data are limited[2].

These images are compared with pre-stored photographs in a database using facial recognition algorithms. Once a match is found, the system automatically marks the student as present.

This removes the need for manual attendance sheets or roll calls and ensures that only the actual student is marked present, reducing the chance of proxy attendance. Additionally, the system can generate attendance reports instantly, enabling teachers and administrators to keep easily accessible digital records for future reference. This use of artificial intelligence and image processing brings convenience and accuracy to classroom management. The system can integrate with existing school management software, allowing automatic updates of attendance records across different departments. Different face recognition approaches exhibit varying strengths and limitations. Classical methods, including feature-based and appearance-based techniques, are computationally efficient and suitable for real-time applications but may suffer from reduced accuracy under challenging conditions such as illumination changes and pose variations[4].

The Smart Classroom Attendance System records attendance in a fair, reliable, and accurate manner because only the real student can be recognized by the webcam. Each face is unique, meaning no one can fake or duplicate another student's identity. This completely solves the issue of proxy attendance. Once the webcam captures and verifies each student's face, the system immediately records their attendance. Each piece of data collected is saved in an Excel sheet, which serves as a digital record. This sheet contains important details such as the

student's name, roll number, date, and time of attendance. Storing data in Excel allows teachers to organize, filter, and analyze attendance records without sifting through piles of paper. The Excel format also makes data sharing and integration with other software seamless. Besides keeping accurate attendance, the system can automatically generate daily, weekly, or monthly reports that teachers and administrators can access anytime. These reports help track each student's performance and identify attendance trends, such as frequent absences or late arrivals. The stored data is secure, easily backed up, and can be shared with parents or guardians to keep them informed about their child's class presence. Furthermore, the system can connect to the school's management software, allowing automatic updates of attendance information across various departments.

Dlib-ml, introduced by King (2009), is a general-purpose machine learning toolkit designed to support a wide range of algorithms while emphasizing computational efficiency and practical applicability. The library provides implementations of classification, regression, clustering, and computer vision techniques, making it suitable for both research and real-world deployment[8].

II. METHODOLOGY

This diagram shows how a pattern recognition system works, typically for tasks like identifying faces. It has two main stages. In the Training Phase, the system learns. An Input Image goes through Image Acquisition and Preprocessing, which cleans up and prepares the image data. The resulting pattern is then stored in a Database. Next, in the Testing Phase, a new Input Image follows the same initial steps to generate its pattern. This new pattern is sent to a Pattern Matching unit. This unit compares it against all the patterns stored in the Database. If a match is found, the system provides results, such as displaying names with timings. If no match is found, it might loop back or indicate a failure, suggesting it hasn't seen this pattern before.

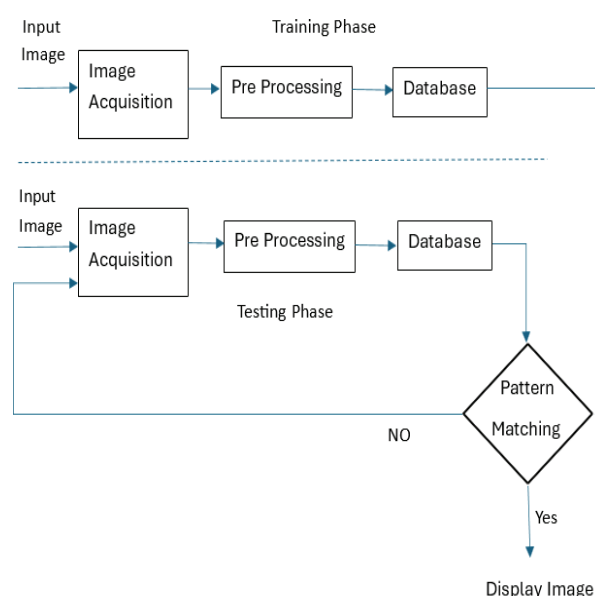
The standard face recognition pipeline described by Jain and Li (2011), consisting of image acquisition, face detection, preprocessing, feature extraction, and matching. Facial images are captured using a camera, detected and normalized, and then represented using efficient feature extraction techniques. The extracted features are compared with stored templates to identify individuals and evaluate recognition performance[9].

The schema is designed using embedding and referencing techniques to optimize query performance, reduce redundancy, and support scalability. This approach enables efficient data storage, retrieval, and updates while accommodating changes in application requirements without complex schema modifications[10]. Convolutional Neural Networks (CNNs) are then employed to automatically extract hierarchical features from the images. The extracted features are passed through fully connected layers for classification or recognition tasks. The model is trained using labeled datasets with backpropagation and gradient descent optimization, and its performance is evaluated using metrics such as accuracy, precision, and recall. This approach enables robust and automated feature learning for image-based applications[11]. A pattern recognition system is a computer-based setup that automatically identifies, classifies or recognizes patterns in

various types of data. This diagram shows how a pattern recognition system works, typically for tasks like identifying faces. It has two main stages. In the Training Phase, the system learns. An Input Image goes through Image Acquisition and Preprocessing, which cleans up and prepares the image data. The resulting pattern is then stored in a Database. Next, in the Testing Phase, a new Input Image follows the same initial steps to generate its pattern. This new pattern is sent to a Pattern Matching unit. This unit compares it against all the patterns stored in the Database. If a match is found, the system provides results, such as displaying names with timings. If no match is found, it might loop back or indicate a failure, suggesting it hasn't seen this pattern before.

Fig 1 : Block Diagram

This includes images, objects, faces. It operates in two main stages: training and testing. In the training phase, the system



first acquires input images or data through cameras, sensors, or scanners. These images are then refined using preprocessing techniques like noise removal, improving contrast, normalization, or segmentation to focus on important features. From these cleaned-up images, the system extracts features. The system stores them in a database with labels or identifiers, such as names. During the testing phase, a new input goes through the same preprocessing and feature extraction. Its features are sent to the pattern matching unit, which compares the new pattern with all stored patterns. If a match is found, the system identifies the pattern and may display extra information, such as names or timestamps. If no match is found, it indicates that the pattern is unknown.

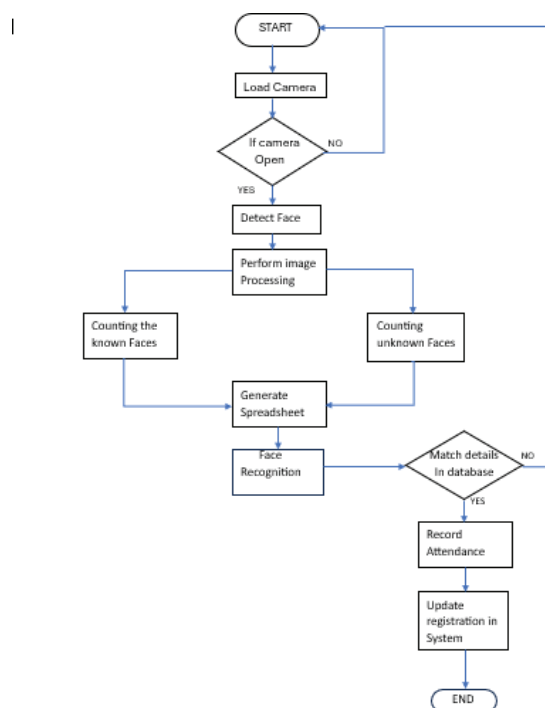


Fig 2 : Flow Chart

This flowchart outlines the entire process of an Automated Face Recognition Attendance System, which is built for continuous operation and high reliability. The system begins with an important hardware check. It tries to load the camera. If the device is not open, it enters a self-correcting loop that continues until the camera is ready. This ensures that operations can carry on without interruption.

Once the camera is active, the system focuses on visual input. It runs algorithms to detect faces in the captured frame. The raw face image undergoes image processing, which standardizes and improves the features while correcting issues like poor lighting or rotation. After processing the features, the system simultaneously performs two classifications. It counts known faces by matching features against registered templates and counts unknown faces that do not have a match. This initial data is compiled into a spreadsheet record. The key identification process, face recognition, then confirms the person's identity. It checks the last details against the database. A successful match completes the transaction and triggers the essential recording phase. First, it records attendance in the official log with a timestamp. Then it updates the registration system to keep all historical records and templates accurate. Finally, the execution cycle concludes, preparing to restart for the next attendance event.

This flowchart carefully details how the Automated Face Recognition Attendance System operates, with a focus on continuous, self-monitoring presence logging. It starts with a vital hardware check, trying to load the camera. If the camera is not open, an immediate feedback loop activates, retrying the load to ensure the system begins without failure. Once the camera is ready, the system shifts focus to the visual data, using algorithms to detect faces in the live feed and isolating human features from the background. The raw image then moves to image processing, which

standardizes and improves facial data. This makes recognition ready, regardless of small differences in capture. With the data optimized, the system runs two classification efforts at the same time. It counts known faces by matching features with its database templates and counts unknown faces that do not match any registered profile, compiling this attendance data into a spreadsheet record. The core of the system then handles face recognition, using matching techniques to assign an identity, which is verified in a final step that checks the database for full authentication. A successful match allows the system to complete two crucial steps: recording attendance in the official ledger with a precise timestamp and updating the registration system to maintain accuracy and integrity before ending the cycle. This ensures the system is ready for the next attendance event. The methodology of this research involves a classroom monitoring system using wired webcams to automate attendance. The system captures live video streams from each workstation and identifies students based on image processing and recognition techniques. Detected faces are compared with a pre-registered database to mark attendance automatically. The system also integrates communication protocols to record and transmit attendance data in real time, ensuring accuracy, efficiency, and reduced manual intervention in classroom management[18].

III. IMPLEMENTATION

A Smart Classroom Attendance System that uses a webcam offers an easy way to record student attendance without needing a manual roll call. First, the system requires one clear photo of each student. This allows it to learn and remember their faces. When the webcam is on in the classroom, it monitors the students and recognizes their faces in real time. Once it matches a student's face with the saved photo, it marks that student as present, including the date and time. All attendance data is stored automatically in a digital file or shown on a teacher's dashboard. This process makes taking attendance faster, more accurate, and completely hands-free.

When you first open the application, you'll see the loading page. Here, the system is busy getting everything ready—like loading important software, starting up the webcam, and connecting to the database. You'll notice a progress bar to let you know things are happening in the background. As soon as everything is set, you'll be taken straight to the login page, making sure your experience starts off smoothly and reliably.

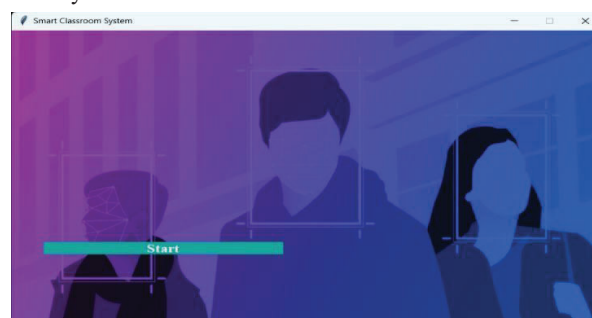


Fig 3 : Loading phase

Once everything has loaded, you'll land on the login page. Here, you just need to type in your username and password to get started. The system quickly checks your details against its records to make sure you're allowed in. If you've got the right credentials, you'll go straight to the main portal. If not, you'll see a clear error message and get another chance to try. There are also easy links to sign up as a new user or recover your password if you need to, making the process secure but still simple and flexible.

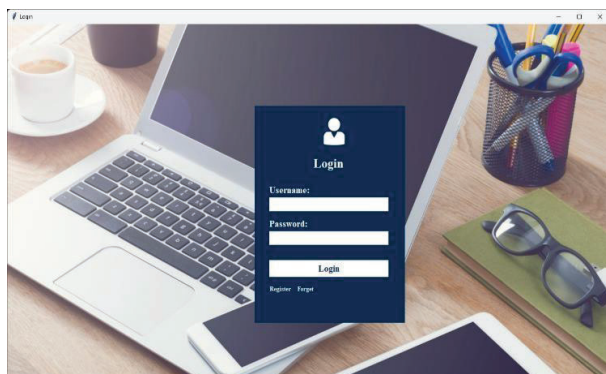


Fig 4 : Login phase

The registration part is basically for making a secure account so users can get into the Smart Classroom Attendance System. You have to put in some basic information like your first name, last name, phone number, and email. It seems like they want to make it safe, so there's this security question you pick and an answer for it, which helps if you forget your password later. Then you set up a password and type it again to make sure it's right. Oh, and you can't skip agreeing to the terms and conditions, that's required to keep going. After checking everything, you hit the Register button, and all that info goes into the MySQL database securely. This whole thing doesn't capture any face images or anything, it's just for setting up the account and handling logins..

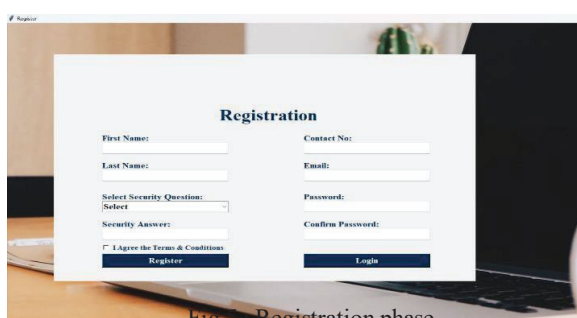


Fig 5 : Registration phase

When someone forgets their password, there's this forgot password part that lets them get back into the system somehow. It starts with entering the email they signed up with, and then picking the security question they chose before, plus answering it correctly. The system checks all that against what's saved in the MySQL database, I guess to make sure it's really them. If it matches up, they can pick a new password and type it twice to confirm. That seems like a way to keep things secure without messing up the whole safety or the data stuff.

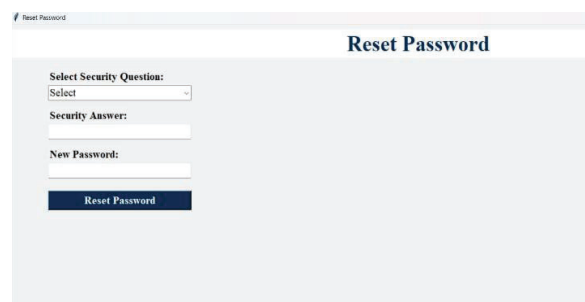


Fig 6 : Reset password

Once you log in successfully, it takes you to the main portal. That is basically the central spot for controlling everything in the system. From there, you can get into different parts like the student portal or the training module. There is also the face recognition thing for attendance, and options to manage the database. The main portal ensures organized system operation and smooth coordination between all modules of the attendance system.



Fig 7 : Main portal

The student portal gives users the ability to insert, keep, and modify the information of students like their names, roll numbers, and departments. The system during data entry provides a feature to take the student's picture which captures multiple facial images of each student using the webcam. The images are taken under different angles, expressions, and lighting conditions to create a robust dataset which is then kept with the student details in the MySQL database. Later on, this data is utilized for face recognition and taking attendance.

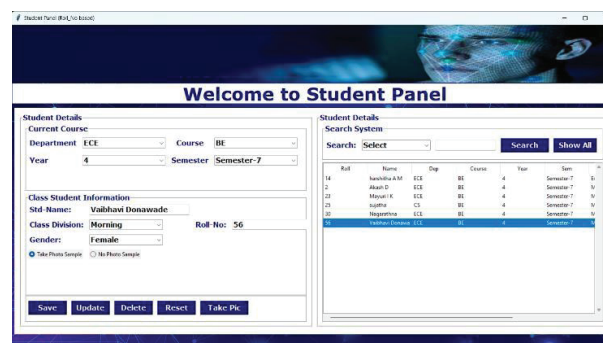


Fig 8 : Student Panel

During the training period, the system relies on the student images that were captured to train the face recognition model. The preprocessing of the images is followed by the use of OpenCV for extracting facial features. These

characteristics are subsequently taught and saved by the system, resulting in the formation of a trained dataset which allows for the precise identification of students taking the attendance.

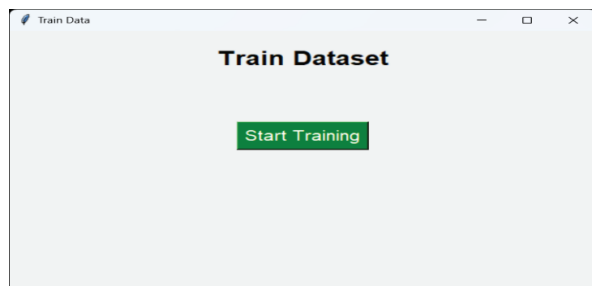


Fig 9 : Training Phase

In this phase, the system employs the webcam to continuously capture live video frames. Processing of each frame is done to detect faces, and then the faces are preprocessed to attain uniformity in size and lighting conditions. The distinguishing features of the faces are weighed against the trained dataset kept in the database. In case of a match, the student's particulars are fetched and authenticated. Thus, this method guarantees precise and instant identification of students for automatic attendance marking and at the same time prevents proxy attendance.

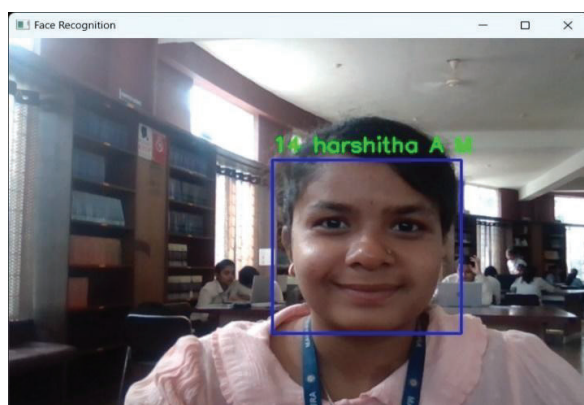
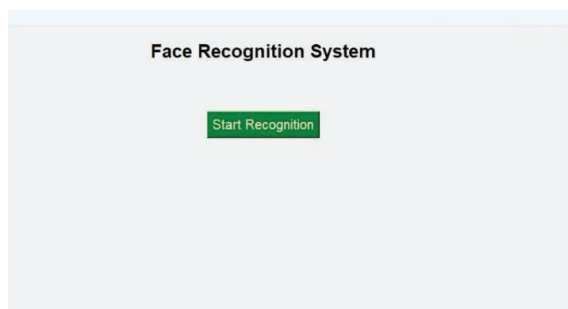


Fig 10 : Recognition of student

During the attendance record phase, the system recognizes the student's face successfully, the attendance is marked automatically in real-time. The student's identity, date, and time of recognition are recorded with precision and no manual intervention is involved. This attendance information is stored

securely in the MySQL database and is accessible later through the student or admin portal. This phase guarantees accurate attendance monitoring, prevents proxy attendance, and lessens administrative work.

Roll No	Name	Date	Time	Atten
Unknown	Unknown	2025-12-03	19:38:05	Present
14	harshitha A M	2025-12-03	19:44:35	Present
25	sujatha	2025-12-03	19:44:36	Present
56	Vaibhavi Donawade	2025-12-03	20:38:50	Present
23	Mayuri I K	2025-12-03	20:38:57	Present
56	Vaibhavi Donawade	2025-12-04	11:27:14	Present
23	Mayuri I K	2025-12-04	11:36:13	Present
14	harshitha A M	2025-12-04	11:41:46	Present
2	Akash D	2025-12-04	12:31:37	Present

Figure 5: Storing Data Of Students

Here, when all the processes (like User Registration, Students Data Management, Image Capture, Training of Face Recognition Model, Real-time face recognition, Attendance Recording) have been executed, a user can exit securely from the portal. Herein, at the time of exit, the system checks that all the ongoing processes are completed and none of them result in data loss.

All information that is generated in the process of using the system is persisted in the MySQL database. Student details include roll number, name, department, and facial image references, which are stored in a table called the student table. Captured facial images are stored in structured folders whose file paths have been maintained in the database for efficient access.

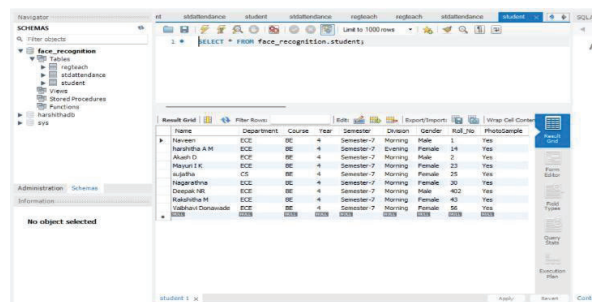
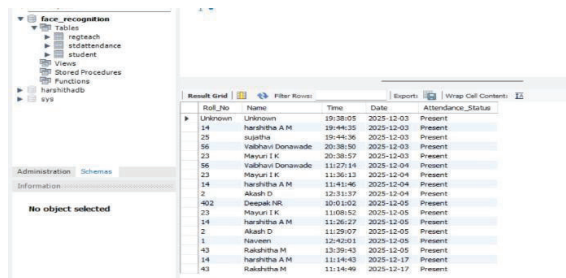


Fig 11 : MySQL Students data stored

Attendance shall be recorded separately in an attendance table, maintaining the student ID, date, time, and attendance status. Proper relationships between tables maintain data integrity, avoiding duplication. This well-structured schema allows administrators to retrieve records, draw up reports of attendance, and maintain long-term data in security even after the session of the system is closed.



Roll_No	Name	Time	Date	Attendance_Status
14	Unknown	19:38:05	2025-12-03	Present
23	haraditha A.M	19:44:35	2025-12-03	Present
56	sujeetha	19:44:36	2025-12-03	Present
23	Vidhant Donawade	20:38:50	2025-12-03	Present
23	Mayuri I.K	20:38:57	2025-12-03	Present
56	Vidhant Donawade	11:27:14	2025-12-04	Present
23	haraditha A.M	11:36:13	2025-12-04	Present
14	haraditha A.M	11:41:46	2025-12-04	Present
2	Alakh D	12:31:37	2025-12-04	Present
402	Deepak NR	10:01:02	2025-12-05	Present
23	Mayuri I.K	11:08:52	2025-12-05	Present
14	haraditha A.M	11:26:27	2025-12-05	Present
1	Alakh D	11:29:07	2025-12-05	Present
1	Naveen	12:42:01	2025-12-05	Present
43	Rakshit M	13:39:43	2025-12-05	Present
14	haraditha A.M	11:14:43	2025-12-17	Present
43	Rakshit M	11:14:49	2025-12-17	Present

Fig 12 : MySQL Students Attendance data

IV. RESULTS AND DISCUSSION

The proposed smart classroom attendance system utilizing a webcam would provide an accurate and efficient attendance-tracking process by automatically recognizing the faces of the students in real-time. The results demonstrate that Dlib-ml provides efficient and reliable implementations of various machine learning algorithms for tasks such as classification, regression, and clustering. Overall, Dlib-ml proves to be a versatile and practical framework for developing machine learning systems with consistent and reproducible results[22].

In contrast to the traditional attendance-taking procedures such as calling names or signing sheets, this system saves a tremendous amount of time and can be used to mark the presence of the whole class within seconds. This does not allow for proxy attendance as only registered faces are recognized. This makes the records reliable and secure. Attendance is recorded digitally in a file or database, making it easy to regularly access, retrieve, and report whenever necessary. It will detect and recognize multiple faces at the same time. It is suitable for large classrooms and contains a user-friendly interface with a live video feed and a listing of the identified name. In sum, this system will illustrate that a face recognition system on a webcam improves accuracy, saves time, and enhances accountability in managing attendance in the classroom. The results of this study demonstrate that deep convolutional neural networks (CNNs) can achieve highly accurate face recognition across large-scale datasets. The proposed deep face recognition model outperformed traditional methods in both verification and identification tasks, showing robustness to variations in pose, illumination, and facial expressions. Experiments indicate that the learned deep features provide strong discriminative power, enabling reliable recognition even in challenging real-world scenarios[23].

V. CONCLUSION

Webcam-based face recognition for attendance is a modern efficient method of tracking attendance. The conventional methods of calling over names or filling up the attendance sheets are usually slow and prone to errors. The study highlights that digital image processing techniques are essential for extracting, enhancing, and analyzing visual information in a wide range of applications. By applying

methods such as filtering, transformation, and feature extraction, images can be processed efficiently to improve accuracy in tasks like pattern recognition, object detection, and computer vision.

The research concludes that a systematic approach to image processing not only enhances data quality but also provides a foundation for developing advanced automated systems in areas such as face recognition, medical imaging, and multimedia analysis[27].

The way it works is that the webcam captures faces, which are matched with a pre-stored database. Advanced algorithms analyze facial features with great accuracy to correctly identify each person, even in large groups. This speeds up the attendance and ensures every individual is recognized accurately. Another big advantage is convenience. Teachers and administrators will not have to take attendance on their own, saving precious time. The system records attendance digitally and updates the records in real time for easy and organized monitoring and reporting. Moreover, this technology strengthens security and responsibility. Conventional methods include signing sheets or ID cards, which can be misused through "buddy punching." Facial recognition can never allow such practices because every individual has unique face features that are difficult to forge. Consequently, only the authorized person present is marked and hence provides accurate, secure, and tamper-proof attendance records. The OpenCV is a practical and accessible tool for developing real-time computer vision applications across domains such as surveillance, robotics, and face recognition[30].

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Harshitha A M an Electronics and Communication Engineering (ECE) student with a strong interest in the field of VLSI, embedded systems, Computer Vision, IoT applications, digital electronics, and automation. The academic work includes the design and development of a Smart Attendance System,

focusing on the automated attendance management through efficient hardware–software integration. Hands on experience includes working with Arduino and ESP32 platforms, sensor interfacing, Python & Java programming and electronic design tools. With a strong motivation towards research innovation and practical problem-solving, the research focus is on developing reliable, efficient, and scalable real-world embedded solutions, with an active inclination toward applied research, innovation, and academic publications in the field of Electronics and Communication Engineering

Mayuri I K. an Electronics and Communication Engineering student at Maharaja Institute of Technology, Thandavapura, with a strong and well-rounded foundation in programming and computational skills. Demonstrates proficiency in Python, C, and MATLAB, enabling effective analytical problem-solving and practical implementation.

Academic development is strengthened by certifications in Artificial Intelligence and Machine Learning from Maharaja Institute of Technology, Thandavapura, reflecting a solid understanding of data-driven technologies and intelligent systems. Has also enhanced technical and professional communication skills through Python Fundamentals and Business English certifications from Infosys Springboard. Additionally, participated in the Intel India STEM Skills Program for Women, conducted by Intel Technology India Pvt. Ltd., provided valuable exposure to industry-relevant knowledge, hands-on learning, and professional skill development, supporting her interest in real-world applications and emerging technologies.

Vaibhavi Donawade an Electronics and Communication Engineering student at Maharaja Institute of Technology, Thandavapura, with a strong technical foundation and interdisciplinary skill set. Has completed certified training in Artificial Intelligence and

Machine Learning from Quantum Learnings, Bengaluru, gaining foundational knowledge in AI and ML concepts. Has also acquired hands-on experience in embedded systems through Arduino training conducted by IIT Bombay. Additionally, strengthened her programming and professional communication skills through Python Fundamentals and Business English courses via Infosys Springboard. Further enhanced domain knowledge by participating in the Intel India STEM Skills Program for Women on VLSI and by undergoing training in PCB design using Altium, gaining practical experience in schematic design and PCB layout. Technical training reflects a strong interest in applied engineering, research, and emerging technologies.

Deepak N R a final-year Electronics and Communication Engineering student at Maharaja Institute of Technology Thandavapura. Primary research interests lie in Embedded Systems, VLSI and PCB design. I actively participated in academic projects and technical activities, demonstrating problem-solving skills, teamwork, and a commitment to continuous learning.

This work reflects the academic interests and practical exposure gained during the course of study.