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ATTENDEX: AI-based Face Recognition Attendance System for Smart Campus Automation

Samay M
Department of Computer Science and Engineering, NMAM Institute of Technology, Nitte, Karnataka, India
Email: samaymonu25@gmail.com

***Abstract*— Attendance tracking and leave approval in schools and colleges are still largely managed through manual processes, which are time-consuming and often prone to errors. These traditional methods also allow loopholes such as proxy attendance or forged signatures, making the system unreliable. To address these issues, this project introduces ATTENDEX, an AI-powered solution designed to streamline attendance and leave management. The system uses camera-based facial recognition to automatically record student attendance in real time. In addition, it provides an integrated leave management module where students can submit leave requests digitally, and faculty members can review, approve, or reject them. Email notifications are also generated automatically to keep students informed about the decision.ATTENDEX is developed as a modern smart-campus tool, suitable for today's academic institutions by improving efficiency, accuracy, and transparency in attendance and leave workflows.A webcam records a video for attendance. The purpose of this live video is to identify faces. The system makes use of a facial recognition tool. The system looks for a face and attempts to identify who it belongs to. It does this by looking at the face in a certain way. This method is known as the Local Binary Patterns Histogram. To accomplish all of this, the system makes use of a unique library called OpenCV and the programming language Python. A unique type of file contains all the details about who is attending and when. This file can hold a lot of data, much like a list.We refer to it as a SQLite database. The student's name and the time they attended are stored in this database by the system. The timestamp and the student's identity are included in the attendance records. ATTENDEX uses data for more than just taking attendance.. It also has a module for managing leaves. Students can use the application to ask for leaves. Then faculty members, like administrators or professors can log in to say yes or no to these requests. When a decision is made the student gets an email to let them know what it is. This email is sent automatically using a password with Gmail. The people who made ATTENDEX tried it out in an environment to see how well it works. They found out that it can recognize faces from the front, about 85 to 90 percent of the time. It also works well for managing leaves from start to finish. ATTENDEX is a system that uses attendance and it has a leave management module. We have a key thing here that are important, to this project. These are face recognition and attendance system and smart campus. Leave management and artificial intelligence and automation and SMTP notification. The main things we are talking about are face recognition and attendance system and smart campus. Leave management and artificial intelligence and automation and SMTP notification.**

***Index Terms*— Face recognition, attendance system, smart campus, leave management, artificial intelligence, automation, SMTP notification.**

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I. INTRODUCTION

We need to keep track of attendance and manage leaves in a clear way. This is important for keeping students in line and making sure everyone follows the rules of the school. It also helps when we are figuring out the internal assessment marks for the students. Attendance and leave management are crucial, for this. Traditional processes depend on people taking attendance by calling out names using paper to ask for time off or keeping track of things in spreadsheets that the teachers must update.

It can be difficult to oversee large classes. These techniques are very time-consuming. They are challenging to deal with. The issue is that using these techniques can lead to mistakes. Important information can occasionally be obtained. It might even be intentionally altered by someone. For instance, someone may record their attendance by marking that they were in class even though they weren't. When they wish to take a leave of absence, they may falsify their signature on a document, which is undesirable. Due to numerous issues, such as proxy attendance and fraudulent signatures on leave forms, these methods are not very effective.

Intelligence and computer vision are examples of new technologies that are constantly improving. This implies that we are capable of creating extremely intelligent systems. These intelligent machines are capable of tasks that were previously performed by humans.

They can even improve people's performance at work. This is being made possible by artificial intelligence. Artificial intelligence is transforming human behaviour, Face recognition is popular because it's simple to use and doesn't require touching anything. It is also good, for watching what is happening all the time with cameras. Face recognition is popular now.

Attendance systems that use recognition are really helpful. These systems can do a lot of things on their own. They can reduce the work that people must do. Attendance systems that use recognition are also more reliable and secure. Facial recognition makes attendance systems better.

Most systems there only deal with taking attendance. They do not do important things like handling leave applications, approvals and notifications. These things are all connected to attendance, like the attendance system. Leave applications. The attendance system and notifications should work together. In schools and colleges going to classes and taking time off are connected. Students need one system to show they are in class and to ask for time off.

To address these challenges, this paper proposes ATTENDEX, a smart campus system that uses AI-based facial recognition to automate attendance marking and leave management. The platform is designed to modernize institutional workflows by combining attendance tracking with a structured leave approval process.

ATTENDEX records attendance automatically through real-time face recognition, eliminating the need for manual entry. It also includes role-based access features, allowing students to submit leave applications digitally, while faculty members and administrators can review, approve, or reject requests through the system. Once a decision is made, students are notified immediately via automated email updates.

II. LITERATURE REVIEW

The traditional systems helped reduce some amount of manual effort. However, they still required human involvement and were vulnerable to misuse, such as card sharing or proxy attendance marking.

To improve security and prevent identity fraud, biometric-based systems have been introduced. Technologies such as fingerprint and iris recognition are increasingly being used because they offer more reliable identification and help address security concerns.

Fingerprint based attendance systems are always known for their accuracy. However, it requires physical contact with the sensor, which can raise hygiene issues and especially in large classrooms where many students use the same device. This contact-based nature can therefore become a limitation of fingerprint attendance systems.Iris-based systems are really good, at getting things right. They can be very pricey and are not that easy to use every day in a classroom setting. Iris-based systems are great and all. The cost is a big problem and they are not very user-friendly for teachers to use with their students on a daily basis.

The thing about face recognition is that it has become really popular, for taking attendance. This is because it is not annoying and it works well with the cameras we already have. Face recognition is getting better and better with computer vision and deep learning. So now people like to use face recognition for attendance because it's easy and does not bother us.

People have used Haarcascade classifiers for a time to detect faces in real time. This is because Haarcascade classifiers do not need a lot of computer power to work. They are good, for detecting faces. Haarcascade classifiers are a choice when you need to detect faces in real time.

Recently, learning-based detection methods have gained popularity.
In face recognition systems, techniques such as Eigenfaces, Fisherfaces, and Local Binary Patterns Histograms (LBPH) are commonly used to identify individuals. Face recognition plays a crucial role in biometric systems, and these algorithms help the system accurately distinguish between different faces. Among them, LBPH is especially suitable for classroom environments, as it performs well in real-time conditions.. This is because LBPH works with low quality pictures from webcams. LBPH does not need a computer part called a GPU to work fast. LBPH is good to use in classrooms, with low-resolution webcam images. It does not need GPU acceleration.
People have made some prototypes that show how LBPH-based attendance systems work. These systems record who is present, in a database or a spreadsheet. The LBPH-based attendance systems are used to keep track of attendance.
Leave processes are usually done on their own with paper forms or emails or special websites. This makes a mess and people have to manually fix attendance and leave records. The leave processes are, over the place and it is hard to keep track of them. Leave processes need to be organized.
You do not see systems that have biometric attendance and digital leave workflows and role-based authentication and automated notifications all in one place. The thing is, attendance and digital leave workflows and role-based authentication and automated notifications are usually separate.
It would be really great to have a system that has all of these things together, like biometric attendance and digital leave workflows and role-based authentication and automated notifications in a single compact system.
The new ATTENDEX system is going to fix this problem. It uses intelligence to recognize faces for attendance. The ATTENDEX system also has a part where students can ask for leave and teachers can say yes or no. When a teacher makes a decision, the student gets an email. The ATTENDEX system keeps all this information in one place

III. Proposed System

The ATTENDEX platform is built around two main functional components: a biometric-based attendance module and a digital leave management module. These modules are tightly connected within a single application framework to provide an efficient and unified system for campus use.
For attendance purposes, the system relies on a webcam to capture live video input. The captured frames are continuously analysed to detect faces and recognize students using computer vision techniques. Face detection is carried out through a Haarcascade frontal face classifier.
After detection, the system applies the Local Binary Patterns Histogram (LBPH) recognition method to identify the student by examining the extracted facial region. Once a match is confirmed, attendance is marked automatically and the student's ID, along with the corresponding date and time, is stored in an SQLite database.
In addition to attendance automation, ATTENDEX includes a dedicated leave management workflow. Access to this module is protected through user authentication, ensuring that only authorized individuals can interact with the system. Students can log in to submit leave requests by specifying the reason and duration of absence.
Faculty members after logging in with their credentials, are able to review pending applications and either approve or reject them. The system updates the request status in the database, allowing all leave activities to be properly monitored and maintained.
The email notification component is connected to the Gmail SMTP account that we have already set up.
When a student puts in a leave request and it gets approved or rejected the system sends an email to that student. This email tells the student what the decision is and gives them the details about the leave request. The system does this automatically for every leave request. The student gets to know what is happening with their leave request because of this email, from the system about the leave request.
The whole thing is done using Python. It has a menu that you can use to get things done. You can also use an interface that looks like a normal computer program. You start it all up by running the script, which is called main.py. This is where you begin with the Python solution.
The database part is done using SQLite. This is a choice because SQLite is simple and it works well. It stores things without needing another server just for the database.
The way ATTENDEX is set up makes it really easy to get ATTENDEX running on a laptop or desktop computer.
At the time ATTENDEX is still able to handle a lot of users so it works well in a classroom or for an entire department, at a school.

IV. METHODOLOGY

The way ATTENDEX works is that, when people sign up and we get their information teaching the system marking attendance in time handling requests for time off people, in charge saying yes or no and sending emails to let people know what is going on with ATTENDEX.

A. Face Data Collection and Enrollment

When we are enrolling someone the system takes a lot of pictures of each student using the webcam. The Face Data Collection and Enrollment process is really about getting these pictures of the students. The system uses the webcam to capture images of each student during this enrollment phase, for the Face Data Collection and Enrollment.

For each video frame we use the Haarcascade face classifier to find the face regions in that frame. The Haarcascade frontal face classifier is really good, at detecting faces. So we use it to look at each video frame and find the face regions.

The faces that the system finds are cut out changed to black and white and stored in a folder. This folder is organized in a way that makes sense. It has labels that match the unique identifiers of each student. The labels help us know which student each face belongs to. The system does this for every face it detects. It saves them in this special folder with their corresponding student identifiers.

Collecting multiple samples per student under slightly varying conditions improves recognition robustness.

B. Face Recognition Model Training

We use the stored face images to train a face recognition model that is based on the Local Binary Patterns Histogram technique, which is also known as the LBPH face recognizer to train the Face Recognition Model. The Face Recognition Model is trained using these stored face images.

The Local Binary Pattern Histogram method takes each picture of a face. Turns it into a special set of features. This is done using binary patterns. The Local Binary Pattern Histogram method uses these binary patterns to make a feature representation of each face image.

The recognizer is something that learns to connect these sets of numbers called feature vectors with the names of students. It then saves the trained model in a format so it can be used again later. The recognizer stores this trained model, in a way that it can be loaded again so the recognizer can keep using the student labels it learned from the feature vectors.

This trained model is something that we use later when we want to recognize faces. We load the trained model during the part where we are trying to figure out who people are and it helps us classify faces when things are happening in time using the trained model to make it all work.

C. Real-Time Face Detection

When the system is running in attendance mode it gets pictures from the webcam all the time. The system is always looking at these pictures to find faces.

The Real-Time Face Detection is what helps the system to do this. The system uses the webcam to get these pictures. It does this when it is, in attendance mode.

We use a tool to find faces in pictures. This tool is already trained to look for faces. It helps us figure out where the faces are. Sometimes we double check the faces it finds using another method called Haarcascade.

This hybrid approach improves performance in challenging conditions, such as noisy backgrounds and slight changes in lighting. As a result, the system becomes more robust and reliable under real-world variations.

The system focuses only on the regions of the image where a face is detected. These extracted facial areas are then passed to the recognition module to accurately identify the individual. This way the system does not have to work hard and it saves time. The face recognition part only gets the face regions, which helps to reduce the amount of work the system has to do.

D. Real-Time Face Recognition and Attendance Logging

When the system finds a face it uses the LBPH recognizer to figure out who the student is and how sure it is, about that. The LBPH recognizer looks at each face that is detected. It tries to match it with a student. It then gives a score that shows how confident it is that the face really belongs to that student. The system is looking at faces in time and it is trying to recognize the students and log their attendance at the same time.

When the confidence level is higher than the threshold, we have set the system considers that it has correctly recognized someone and it marks the student as being present, for that session. The system does this for the student and the session.

The student's identifier, name, date, time and recognition confidence are put into the SQLite attendance table. We are talking about the student's identifier and the students name and the date and the time and the recognition confidence of the student. The student's details are stored in the SQLite attendance table, for the student.
The system includes a mechanism to prevent duplicate attendance entries for the same student during a particular class session or meeting. This logic ensures that each student is marked only once per session, keeping the records clean, accurate, and well organized. Avoiding repeated entries is important for maintaining reliable attendance data.

E. Database Management

The ATTENDEX system uses SQLite as the main database for storing and managing all application-related information. Since SQLite is lightweight and efficient, it is well suited for handling the complete data requirements of the platform.
The database is organized into multiple tables, including separate tables for student information and attendance logs.
It also contains an authentication table that maintains login credentials for different user roles such as students, faculty members, and administrators. In addition, a dedicated table is used to store and manage leave request records.

F. Leave Management and Workflow Processing

When you start the application you can use the leave management feature. It is available soon as the application is up and running. You can use the leave management feature to manage leaves. It is a key part of the workflow processing. The leave management and workflow processing go hand, in hand.
When students log in and get authenticated, they can send in requests to take a leave. They have to give details like the dates they want to take off. The reason they need to take a leave. The leave requests will have the date range and the reason, for the students leave.
The leave requests are kept in a table called the leave requests table. At first the status of these leave requests is always 'Pending'. The leave requests stay in the leave requests table until something changes.
The faculty members and the administrators have to log in with their credentials. They do this to look at the leave requests that are still pending.
Then they can approve the leave requests. They can reject the leave requests. They have the power to decide what to do with the faculty members and the administrators leave requests. The faculty members and the administrators make these decisions when they log in with their credentials.
The decision is stored back, into the database. Any optional remarks are also stored back into the database. Then the request status is updated to show what is happening with the request. The database has the decision and the request status is updated.

G. Email Notification using SMTP

ATTENDEX has a way to send people emails when something happens which's really helpful and makes things clear. This is because ATTENDEX wants to make sure that people know what is going on and can stay up to date with the information, from ATTENDEX.
The system uses Gmail to send SMTP email notifications. It does this with a password that is just for the app. This way the email notifications can be sent without putting the account details at risk. The Gmail service is set up with a password that is only, for this one thing so the main account credentials are safe.
The system uses Gmail to send emails. It does this by using a password that is just, for the app. This way the system can send emails without using the Gmail password. This makes sure that emails are delivered safely and reliably. The system is using Gmail SMTP authentication with this app password.

H. Execution Environment

This system is made completely using Python.
You can run this program from the terminal on a laptop that has a webcam. For example you can do this by running the main.py file. The laptop is an one so it should work just fine.
The main Python script starts up a window on the computer or a website that students and faculty can use. This window or website is, like a door for students and faculty to interact with the program. The main Python script is what makes this happen for students and faculty. No GPU or high-end hardware is required, which makes the solution practical and cost-effective for educational institution.

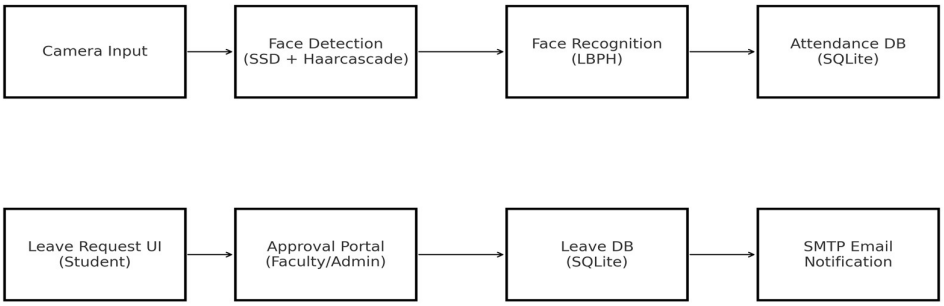

Fig 1

V. Results and Discussion

The ATTENDEX system was tried out in a setting using a regular laptop that had a built-in camera or a separate camera that you can plug in.

Many student faces were added to the system using the data collection part. The LBPH recognizer was taught using these student faces. The student faces were used to train the LBPH recognizer so it can know what the student faces look like.

When we were testing the system it was able to find and recognize the faces of students away. The system did this in time. It also marked the attendance of students automatically in the SQLite database. The system was really good at recognizing student faces. It made sure that the attendance of students was marked correctly in the SQLite database.

We tried out the system with a bunch of students. It worked pretty well. The system was able to recognize faces from the front with about 85 to 90 percent accuracy when the lighting, in the room was normal.

The performance of face recognition is not as good when faces are covered up a bit taken from the side or when the light behind them is really strong. This happens because face recognition works best when it can see the face clearly. When faces are partially occluded or captured at angles the face recognition performance gets a little worse. It also does not work well under backlighting which is when the light is shining really brightly from behind the face. The face recognition performance degraded slightly in these situations like when facesre taken from the side or when there is a lot of light, behind them.

So, in a classroom where the students are facing the camera the performance of the camera is good enough. The students face the camera and the camera works fine in these classroom scenarios.

We checked the attendance logs against the records we keep by hand to make sure they are correct. We also made sure that the same person does not appear more than once in a period of time. This way we can control entries, for the attendance logs. The attendance logs are accurate because of this process.

The company took a look, at the leave management and the email notification modules too. They wanted to see how well the leave management and the email notification modules were working.

The students were able to log in to the system. They could submit requests, for leave. The students could also view the status of their leave requests. This made it easy for the students to keep track of their leave requests.

The faculty and the administrators can log in with their credentials. They can then look at the leave requests that are pending. The faculty and the administrators can then decide to approve the leave requests or reject the leave requests.

When a decision is made the Gmail SMTP service that we set up sends an email to the students email address. This email tells the student what happened with their request. The Gmail SMTP service does this every time a decision is made so the student always knows what is going on with their request.

This closed-loop workflow demonstrated that ATTENDEX can handle not only attendance but also related administrative processes effectively.

VI. Conclusion and Future Work

This paper presented ATTENDEX, a face recognition–based attendance and leave management system. The proposed solution combines real-time face detection and recognition with a secure database framework and role-based access control. With attendance monitoring, ATTENDEX also provides a digital leave management workflow where students can apply for leave online and faculty members can approve or reject requests through

the application. Email-based notifications further ensure that students and staff remain updated while reducing additional administrative burden.

The system was implemented and evaluated in classroom settings, where it showed consistent performance under normal operating conditions, confirming its practicality for real academic use. By reducing manual workload, limiting errors, and maintaining transparent digital records.

The system can further enhanced with more advanced recognition methods such as CNN-based face embeddings to improve accuracy in difficult scenarios, including low lighting, angled faces, and partial occlusions. Expanding the platform to support mobile and remote access would also increase usability for off-campus users. Furthermore, adopting cloud or edge-computing infrastructure could make ATTENDEX scalable for large campuses with high student populations. Integrating analytical features such as attendance pattern monitoring, absence prediction, and early-warning systems for at-risk students can further strengthen its role in academic planning and decision-making.

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