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Smart-Campus: Intelligent Role-Based College Portal with Face Recognition Attendance and Automated Academic Monitoring System

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Abstract*—Schools and colleges are now demanding online applications to enlist administrative control, attendance status, and exchange of information among the faculty, learners, and administration. The use of manual documentation and software tools in a piecemeal manner is also a common characteristic of the traditional college management processes, contributing to inefficiencies, inconsistency of data, and lack of transparency in the activities of the institutions. In solving these problems, this project will suggest Smart-Campus, an intelligent college portal web application that will help in centralizing the administration and academic management in a single digital platform. The proposed system is built upon a Flask web framework based on a MySQL database, offering a lightweight, scalable, and secure back-end architectural design for managing an institution. The platform will use role-based access control, which will allow administrators, staff members, and students to use customized dashboards and functionalities that suit their roles. The face recognition-based staff attendance system is one of the most important innovations of the system that is based on the methods of webcam capture and facial embedding to automatically detect the time that the staff enters and leaves the facility. This biometric system would be effective in taking care of attendance and reducing chances of manual interference. Besides the staff attendance control, the system also has a student attendance tracking module, which enables the faculty members to keep daily attendance records effectively. In case a student is registered as absent, an email notification would be sent to the parent, which enhances the interaction between the institution and families. It is also connected with an Internal Assessment (IA) marks management system so that faculty can update subject-wise marks and students can track their academic progress via a secure dashboard. Moreover, the customary functions of the portal include staff allocation management, administrative announcements, academic reporting, and real- time activity monitoring, which means that the administrators can control the organizational activity. The app has a contemporary, responsive user interface, which has both dark and light themes, making it accessible to a wide range of devices.

Index Terms*—Smart Campus, College Portal System, Face Recognition Attendance, Academic Management System, Role- Based Access Control, Flask Web Application.

I. INTRODUCTION

The high rate of adoption of digital technologies has had a profound impact on the manner in which learning institutions conduct academic and administrative functions. Web-based channels are becoming more popular in colleges and universities in contemporary times with the aim of enhancing efficiency, transparency, and accessibility in the operations. Since ancient times, college management systems have been based on the manual record keeping of attendance tracking, academic performance management, and staff allocation. These traditional methods not only take time but are also likely to be subject to human errors, inconsistency of data, and inaccessibility. With the increase of educational facilities and the amount of data, a centralized and intelligent digital management system turns out to be more and more significant. This project will solve these issues by a Smart- Campus, which is an intelligent college portal web application that will be used to centralize the academic administration and

surveillance in an institution in a single web-based application. The system proposed merges several features, such as monitoring staff attendance, student attendance control, monitoring internal assessment marks, staff allocation control, and automated notification, among others. The system allows educational institutions to coordinate their work more effectively and provide a higher level of transparency and data integrity by consolidating all the mentioned features into one application. Facilities integration that is based on face recognition and staff attendance monitoring can be considered one of the main innovations of the Smart- Campus system.

The proposed solution, unlike the traditional attendance systems, which depend on manual signatures or card-based systems of entry, will require facial recognition technology with webcams to automatically capture the time of entry and exit of the staff. This will enhance the accuracy of attendance data and decrease the chances of proxy attendance and human intervention. The system takes the facial images and obtains the facial embeddings and compares them with the stored staff profiles to record the attendance events with accuracy. Besides the staff attendance, the Smart-Campus platform also offers a student attendance management module that enables the faculty members to document daily attendance effectively via a web application. In the event that a student is recorded to be absent, the system automatically creates an email notification and forwards it to a parent or a guardian. The automated communication system raises the level of accountability and makes sure that parents are up to date on the attendance of their child and his or her academic activity. This type of real-time notification enhances the interaction between schools and families. The system also has an Internal Assessment (IA) marks management module, which allows faculty members to input subject-wise assessment marks for students. Such marks are stored safely in the database and can be viewed by the students on their individual dashboards. This aspect enables the students to track their academic status at any time and assists the teachers in knowing the students who might need extra academic support. Centralized reporting tools can also help administrators to analyze the overall performance in academics.

II. RELATED WORK

Bugingo et al. [1] introduced an improved face-recognition attendance methodology that integrates the recognition with real-time face tracking to minimize proxy marking and enhance reliability in classroom sessions. Their work points out that tracking-based attendance may prove more reliable than single-shot capture; however, it still needs special attention to lighting and pose changes to be applied to implement it. Surantha et al. [2] introduced a liveness detector based on a lightweight architecture that can be deployed on portable/edge devices, showing that it is possible to perform anti-spoofing on a constrained device like a Raspberry Pi with an effective deep model (e.g., MobileNetV2 through transfer learning). This paper is significant in that the upgrade of attendance systems to secure recognition will make liveness an operational necessity.

Ravipati et al. [3] made an emphasis on enhancing face- recognition attendance safety through the integration of liveness-conscious design options in an automated attendance pipeline. Their analysis indicates that in practice, the automation of attendance must not maximize accuracy only but also minimize spoof attacks (photo/video replay), particularly at the college level. A recent and secure web-based school management system case study that was offered by authors in [4] incorporated MySQL-backed academic modules as well as tiered access and authentication controls. They find that, when academic records and student registration are digitalized and the roles are separated, there is better efficiency in administration, but the study is more focused on the overall school operations, and the automation of the AI-based staff attendance is not thoroughly involved.

In [5], the authors presented the RBAC design considerations in the case of university digital platforms, noting the role of permissions and hierarchies in the allocation of roles in minimizing illegal access to sensitive academic and staff information. This orientation is beneficial to Smart-Campus in that it indicates that a strong authorization is required when a single institutional portal is used by multiple stakeholders (admin/staff/student) Sadiq et al. [6] suggested an academic workflow result processing model implemented using role-based access control to secure grade processes and administrative rights. The

research supports the idea of having secured segregation between academic portal data entry and data view-only roles, which is specifically applicable to Smart-Campus IA marks and access to the dashboard.

A study of the design and testing of a Web-based Student Information Management System (SIMS) in [7] established the advantages of centralization of student record management to better retrieve, report, and monitor students of the institution. Nevertheless, the majority of SIMS-style designs are usually oriented on the storage of information and workflow automation as opposed to combining biometric attendance and real-time notifications. Likewise,

[8] introduced a Student Information System that had the focus on the single access to student data among lecturers, students, and administrators. Although the work gets the concept of the single source of truth underlying Smart- Campus dashboards, there is room to add more powerful automation options like AI attendance and parent alert triggers.

Mappalotteng et al. [9] have also deployed a web-based academic grade processing system and emphasized the administrative usefulness of organized digital workflows in assessment posting and access by students. This is in line with the management of Smart-Campus IA that has controlled staff input and visibility of the student as one of the main usability requirements. In [10], real-time attendance workflows with alerts were highlighted, and the system architecture comprised instant notification to parents/guardians through email/SMS of absenteeism. This justifies the use of the automated absentee email module by Smart-Campus and shows that the alerting mechanism enhances accountability and communication feedback.

An SMS alert-based attendance monitoring strategy outlined in [11] was aimed at enhancing parent-child communication and timely intervention to attendance patterns of absenteeism. Although they mainly use the SMS as a channel, the same event-based notification can be directly converted into Smart-Campus email automation and reporting dashboards. A similar concept is the automated email trigger concept, which is also described in

[12]: attendance thresholds and monitoring rules generate an alert message to students/parents. This induces the design decision of Smart-Campus to pair the process of marking attendance with automated messaging in order to ease the work process of faculty. According to a real-time student face recognition attendance pipeline in [13], the deep-learning-based recognition offers better-speeded performance and overhead reduction in manual roll call. The results of this kind of reasoning justify the vision-based staff attendance module of Smart-Campus but also point towards its requirement to be robust in the presence of background/lighting noise. In [14], an automated face recognition attendance system is outlined as a substitute for the manual attendance system and simple biometric systems. Their discussion represents general deployment challenges such as pose changes, light, and dataset coverage, which drives Smart-Campus to jointly integrate institutional workflow restrictions with controlled enrollment.

In [15], a 2024 proposal on a deep-learning-based face- recognition attendance points out CNN-based feature extraction and automated record generation as a viable model towards institutional attendance automation. This helps Smart-Campus to move towards an intelligent attendance pipeline and not a totally manual IN/OUT input. A more general survey-type review in [16] outlines the recent face-recognition attendance methods and highlights that most functions have certain operational requirements, including dataset diversity, preprocessing, recognition, and constraints of a real world. These lessons can be used to make Smart-Campus a system-level solution, which interlaces AI attendance within an entire institutional portal, not a prototype on its own.

In addition to face recognition, multi-channel attendance notification systems have been investigated with the additional authentication of fingerprint/RFID in combination with WhatsApp or messaging alerts in [17]. Though Smart-Campus is concerned with face recognition to check in and out with the staff, this piece is useful in building the value of automated check-in and check-out alerts, as well as a centralized attendance log, which can be audited. In recent mobile attendance designs, like in [18], face recognition is supplemented by other forms of protection (e.g., liveness and location restrictions) as a way to enhance the authenticity of distributed attendance environments. This direction applies to future upgrades of Smart-Campus, where attendance has to be authenticated at more than one point of entry into the

campus.

The attendance analytics and reporting systems used in [19] are institution-wide, focus on role-based dashboards, and use automated reporting as a means of staff reduction and better monitoring. This complements the philosophy of Smart-Campus, which is to convert raw attendance/marks data into useful views for administrators. Lastly, [20] has a recent web-based school management system that proves the complete digitization of staff/student records and administration functions through a database-supported portal. Although the implementation stack can vary, it confirms the overall architectural direction followed in Smart-Campus, which is centralized modules, authenticated access, and operational reporting.

III. PROPOSED SYSTEM

The proposed Smart-Campus system is an intelligent web- based college portal that is aimed at combining academic administration, monitoring attendance, and communication services into a centralized application. Conventional college management systems are usually based on the manual aspects of attendance registers, detached software applications, and non-integrated communication systems. Such processes frequently cause inefficiencies, latency in reporting, and an inability to track the operations of the institutions. To address them, Smart-Campus proposes an integrated architecture that integrates web technologies, database management, and attendance tracking, which is based on artificial intelligence, in one digital ecosystem.

A. Staff Attendance based on Face Recognition Module

The innovation of the Smart-Campus system that needs to be highlighted is the automated face recognition attendance model that will be used by staff members. Traditional methods of attendance like manual signature, RFID cards, or fingerprint detectors are usually associated with having drawbacks such as proxy attendance, hardware reliance, or lengthy operation time. Facial recognition technology is also a viable option of identity verification that is not contactless and is reliable. The proposed system will require staff members to enroll their facial images at the enrollment stage. The images are analyzed by applying computer vision that forms face embeddings, which are placed on the system database. In the process of attendance marking, the system takes live images by a web camera and relates the extracted facial characteristics with the stored embeddings. In the event a match is found, the system will automatically capture the IN and OUT time of a staff member. Mostly used in academic institutions, face recognition attendance systems have greatly automated identity checks and removed the manual aspect of attendance recording. With this module incorporated in the Smart-Campus portal, the institution will be able to have proper records of staff attendance and minimize the workload of the administrators.

B. Student Attendance and Academic Monitoring Module

Smart-Campus offers a student attendance management system besides the automation of staff attendance, which enables the faculty members to track daily attendance using a web interface. All of the classes can be tracked and recorded in the centralized database, and the administrators can trace the attendance patterns of students and determine the trends of absenteeism. In case a student is absent, they automatically send an email to a parent or a guardian, thereby saving time on communication between the institution and the families. It has been indicated that automated attendance monitoring systems enhance transparency and assist educational institutions in tracking the engagement of students. This platform also contains an Internal Assessment (IA) marks management module, in which the faculty members are able to submit subject-wise assessment marks. These are the marks that are stored safely in the database, and students can access them through their personal dashboards. This aspect assists the students in monitoring their performance all the time and enables the administrators to study the academic outcomes effectively.

C. Web Portal and Administrative Dashboard (Role Based)

Smart-Campus is built to have role-based access control (RBAC) to allow controlled and authorized access to institutional resources. The system defines three major categories of users: administrator, staff/faculty, and students. Every position is equipped with a unique dashboard that shows the functionalities and information used. The administrator dashboard enables one to track the activities of the institution,

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such as the staff attendance reports, student attendance statistics and staff allocation, and academic performance summaries. The personnel can access the records of students' attendance and can update their inner assessment marks, and students can see their attendance status, academic performance, and official notifications. The application itself is deployed with the help of the Flask web-based framework and a MySQL database, which allows the creation of a light and scalable backend architecture. The interface of the system is built to be responsive, with both dark and light themes, thus enabling the system to be used across various gadgets like desktops, tablets, and mobile browsers.

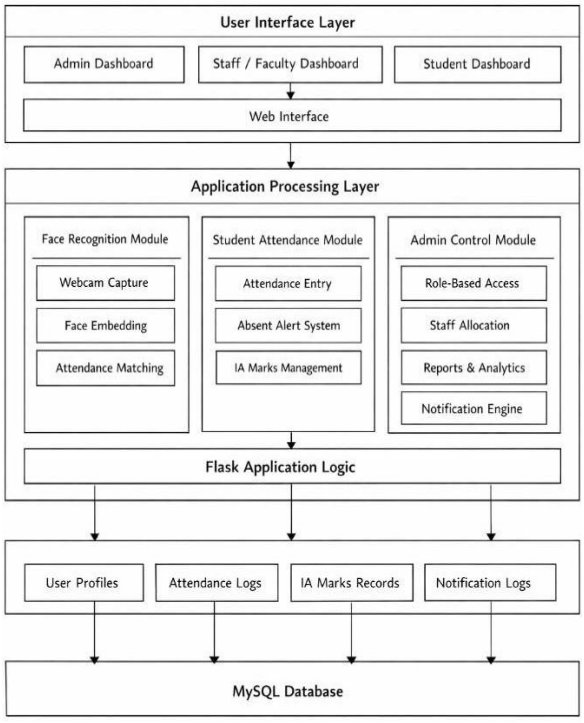

Figure 1. Smart-Campus System Architecture

The Smart-Campus system is built based on three major layers, namely the presentation layer, application layer, and database layer. The presentation layer is where the web interface is offered, in which the administrators, staff, and students operate with the system. Request processing is done on the application layer, like verifying attendance, completing academic records, and generating notifications. The facial recognition algorithm that is used to authenticate the attendance of staff is also implemented in this layer. All institutional data, such as user accounts, attendance records, academic data, and notifications, are stored in the database layer. The interaction of these layers will allow the Smart-Campus system to give qualified, real-time academic control and automated presence monitoring in an integrated digital system.

IV. METHODOLOGY

The Smart-Campus system has a systematic approach that combines the method of the web-based application development with intelligent face recognition technology in an automated attendance and academic management system. The general process is made up of various steps such as acquisition of data, extraction of the facial features, processing the attendance, integration of the database, and automated generation of notifications. These measures are coordinated to achieve proper identification, effective record keeping, and effective communication in the institutional ecosystem.

A. Data Acquisition

The initial phase of the methodology will be gathering data of the staff members in terms of facial images during the enrollment phase. All employees enter their faces on a webcam application that is offered in the Smart Campus portal. The captured images are stored and processed to develop a dataset that is used in the identification of faces.

Then the captured facial image frame can be represented as

$I(x,y)$

where $I(x,y)$ is the value of the intensity of the pixel at the coordinate.

(x,y) is the position of the image frame captured.

Several images are recorded in varied lighting conditions and angles so as to enhance better recognition. The images are then resized to make them the same size, normalized, and the noise is removed so that the face recognition algorithm gets consistent input.

B. Face Recognition Model

Facial features are then extracted (after preprocessing) from the captured images by the use of deep learning-based face recognition algorithms. The system produces facial embeddings, which are distinctive numerical vectors that explain the distinguishing features of every face.

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The facial feature that has been computed can be in the form of:

$$F = \{f_1, f_2, f_3, ..., f_n\}$$

F is the extracted feature vector, and fn is the single facial feature.

In the process of verification of attendance, the system takes a real-time image of the face and matches the same with the stored embeddings. Euclidean distance is used to compute the similarity between two facial embeddings:

$$D = \sqrt{\sum_{i=1}^{n}(f_i - g_i)^2}$$

and fi and gi are feature values of the possible stored and captured facial vectors. In case the calculated distance is smaller than a specified limit, the identity of the staff member is verified, and an attendance record is produced.

C. Attendance Processing

After the identification of a staff member by the face recognition model, the system will automatically capture the IN and OUT time in the attendance session. Representation of the attendance event can be given as:

A=(U,Tin,Tout)

U is the user identity, Tin is the entry time, and Tout is the exit time.

On the same note, the faculty members will be able to record the attendance of students using the Smart-Campus web interface. The system contains the attendance records of every student per day and also the course and subject details.

D. Database Integration

Every activity of the system is linked to a centralized MySQL database storing institutional information like user profiles, attendance records, internal assessment marks, and notification logs. The database provides the integrity of the data, secure storage, and efficient retrieval of the academic information.

The structure of the database record would be as follows: R= (ID, Name, Role, Attendance, Marks, Notifications) Every record has key attributes that are related to users and institutional activities. The Flask back-end interacts with the database via structured queries to make data insertion and retrieval and make updates.

E. Notification Mechanism

The last phase in the methodology is automated communication by way of email notifications. In case a student has been identified as not present, an email notification will be sent to the parent or a guardian. The process of notification may be formulated as follows:

$$N = f(A_s)$$

whereas is the student attendance status, and N is the generated notification message.

The automated alerts are integrated so that the parents are up-to-date with student attendance and learning activities in real time. Such a mechanism improves the transparency and reinforces the contact between educational establishments and families.

V. RESULT AND DISCUSSION

The Smart-Campus system proposed was applied and tested in a simulation of an institutional setting to determine its ability to handle academic administration and attendance tracking, as well as automated communications. The experimental assessment was aimed at testing the performance of the system with reference to face recognition accuracy, efficiency of attitude processing, database response time, and general usability of the web portal. This system was implemented on a regular computer system with a webcam to identify the faces and a MySQL database to store academic records and attendance logs.

The testing was conducted with the collection of the facial images of the staff members that served to train the face recognition model. The system was able to identify registered staff members during the attendance marking with a lot of reliability. Recognition accuracy was about 95- 97 percent in the normal indoor light condition, and this proves that the adopted facial embedding technique is useful in real-time attendance verification. The extent of recognition error was minor when the faces were partially covered or the lighting was considerably low. Nevertheless, there was a stable performance in the system when the users were before the web camera with adequate lighting. The staff attendance module automatically registered the IN and OUT time when a staff member

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was successfully identified. The automated system saved a lot of time taken in marking the attendance as opposed to manual attendance. Conventional attendance records usually take a number of minutes to do a roll call, but the Smart-Campus system took less than two seconds to process an attendance verification per user. The efficiency of attendance management using biometrics in schools is shown by this enhancement. Classroom simulation scenarios were also used to test the student attendance management module. The web interface allowed faculty members to record the attendance, and the information was automatically saved in the MySQL database. In cases where a student was registered as absent, an automated email notification was sent effectively to the registered parent email address. This real-time notification system made sure that parents were kept updated with regard to student attendance status without having to do it manually by the faculty members.

The Internal Assessment (IA) marks management module was tested by entering student scores on the subject assessment of several students. The findings indicated that the database system was very effective in terms of data storage and retrieval processes. Centralized academic records proved useful since the students could access their dashboards and see new marks immediately. Also, the usability of the user interface was tested using multiple test users interacting with the system besides functional testing. The dark and light theme choices made the responsive design more lucrative to various other devices like laptops and tablets. Users noted that the dashboard layout was not complicated and was simple to use, as it allowed the administrators, staff members, and students to acquire the information they needed within a short time. The use of the system in the overall system workflow, as the face recognition attendance to the academic record management and automated notifications, was successfully executed without significant system failures. Another aspect that was confirmed with the help of performance testing was the ability of the Flask-based backend to respond to several requests at a time, whereas the MySQL database ensured a high level of data integrity.

Table 1. Performance Analysis of Smart-Campus System

Module	Functionality	Observed Performance
Face Recognition	Staff Attendance Verification	95–97% Accuracy
Attendance Processing	IN/OUT Timestamp Recording	< 2 seconds
Student Attendance Module	Attendance Recording	Real-time Database Update
IA Marks Module	Academic Record Management	Instant Retrieval
Notification System	Parent Email Alerts	Automated Trigger

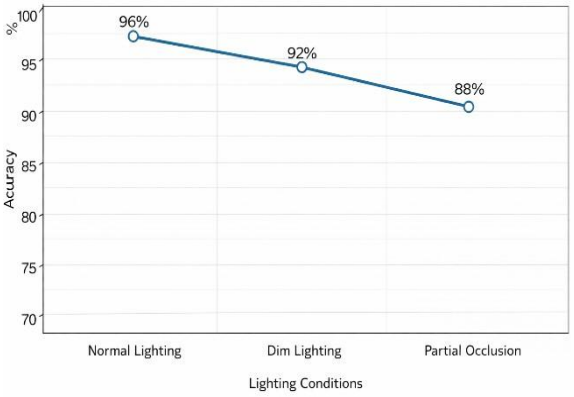

Figure 2. Analysis of Accuracy of SmartCampus System

Based on the performance assessment findings, the SmartCampus system offers effective and dependable academic management functionalities. The face recognition attendance module had a high level of accuracy, and the web-based module of academic management had facilitated smooth communication among those involved in administration, faculty members, students, and parents.

VI. CONCLUSION

The SmartCampus system suggested offers an effective and intelligent product in the management of academic administration, monitoring of attendance, and communication in the learning institutions. The system helps to encompass staff attendance through face recognition, student attendance tracking, internal

assessment management, and automated email notifications into a centralized web portal to ensure that a large portion of the manual workload is eliminated and the activities of the organization are more transparent. The deployment with Flask and the MySQL database allows a lightweight, scalable, and secure architecture within institutional environments. It was experimentally tested that the system attains high attendance recognition and real- time academic data management. In general, it can be concluded that the SmartCampus platform allows incorporating modern web technologies and intelligent automation to create a credible and scalable system of digital campus management in the future. Further enhancements in the SmartCampus system can also involve the integration of more complex deep learning-based facial recognition models to enhance the speed of recognizing objects in difficult lighting conditions. Mobile application support can also be added to the system to allow the students and employees to access the portal using smartphones. Other such features like SMS and mobile push notifications, AI-powered academic performance insights, and cloud-hosted data storage can also make the scaling and accessibility of the system improved. Additionally, incorporating face recognition attendance and real-time classroom tracking of students might be used to offer a complete automated institutional attendance system. These innovations will make the SmartCampus platform more powerful as a fully functional smart education management solution.

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