



SMART ATTENDANCE MANAGEMENT SYSTEM USING GEO-FENCING AND MACHINE LEARNING

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Abstract: This paper describes about an App that is an Intelligent Attendance Management System that uses the most efficient Geo-fencing concept and Face recognition application of Machine Learning.

The idea of geofencing is a location-based service where a mobile application or other software programs uses radio frequency identification (RFID), GPS, cellular data or Wi-Fi to generate a targeted action, such as sending a text, email, ads of social media or network or app notifications, when a targeted mobile phone or any other device enters or exits the virtual - geographic boundary region we build around (perimeter) called geofence.

Considering Facial recognition systems as the most practical solution available for enterprises to make workforce attendance contactless, they continue to get becoming more and more popular. Face recognition is a touchless method of relating to, identifying, and validating employees and drop-ins in contrast to other forms of current attendance management systems like biometric fingerprint identification systems, which records an individual's identity by touch. As they help facilitate and process people's entrance and leave motions in a safe and efficient manner, touchless systems are one of the essential preventative measures in today's scripts. A facial recognition-based attendance system leverages face recognition to record attendance and attempt automatic verification of the person's identity.

While this application is being built on these two concepts, not only the companies can use it but also it mainly focuses on school and colleges attendance management with efficient features to reduce the workload for faculty by using face recognition, it is also reducing the probability of proxy's to avoid the duplicates in attendance which makes it different from any other existing applications.

Keywords – Geo-fencing, Geolocation, GPS Monitoring, Machine Learning, Face Recognition, Desktop/Mobile Application.

I. INTRODUCTION

A proper attendance management system, especially in schools and colleges is needed to help assess not only the attendance but also a major aspect like discipline of students. Some attendance systems that have been built based on the biometrics detection, barcodes detection and QR codes detection are not proven to be able to lessen the process of queues and waiting or simplify the attendance process. This is because employees or students still need to manually do some of the attendance-related updates to finish the work for that day.

Among the benefits of this project include reducing manual labor: Since the whole process is automated, mortal intervention is minimal. So, appended staff no longer need to manually do this. The fineness of the data is the key aspect in these systems since it decreases the cost while increasing functional effectiveness with a reliable and error free performance. Time management and keeping an eye on all departments of an organization are the most common problems in associations. Hence, this system fulfils its purpose by keeping accurate time and attendance.

Reports generated by face recognition-based attendance management system are more precise and error-free since real-time tracking is implemented. With attendance systems grounded on face recognition, completely automated entry, and exit tracking can be enforced. Without the need for physical verification or typical human participation, the system's sophisticated algorithms are able to detect and recognize faces. The management of public spaces and workplaces during outbreaks like Covid 19 can be improved by reducing physical contact. Following the outbreak, there has been a huge surge in the favorable reception and use of contactless technology. As a result, businesses have begun utilizing attendance systems and facial recognition technology together in sync to address a range of issues.

The facial recognition app for mobile and desktop devices can be used to monitor the attendance and time factors. As a result, a facial recognition attendance system requires no new hardware to operate and hence no maintenance. In contrast with other biometric systems, this is cost effective and convenient. The data acquired by the facial recognition-based employee attendance system is precise and up to date (real-time). As a consequence, the organization saves money in a big way.

In addition to the advantages mentioned in above context, The Facial Recognition System has a number of other benefits, including increased authenticity and security. When face recognition technology is put throughout a firm, it makes it easier to identify authorized personnel and limiting access only to them. Geofencing also offers many advantages such as –

If we consider the case of the marketing sector better targeting: By targeting people in a precise geographical zone and filtering that area by certain targeting criteria we want or set, we're much more likely to be aware of the prospects and instructions. A geofencing system can dramatically enhance attendance control by minimizing buddy punching and falsework hours. An attendance system with significantly greater flexibility is the goal of the project discussed in the paper.

Using a mobile or desktop app based on geofencing and facial recognition, this attendance system may streamline and accelerate the procedure. Because of this, universities or other institutions are spared any extra expenses of purchasing a special equipment or the time-consuming task of manually updating attendance each day at the end of classes. The specified geofencing area will be designated for each employee or student. A virtual boundary's location is determined by the workplace or college management admin or authorities. When taking attendance, the application sends a facial image of an employee or student to a server, where it is recognized using appropriate Machine Learning techniques.

II. LITERATURE REVIEW

This paper is an overview of the study whose main goal is to develop an Attendance Management System based on Face recognition technology for educational institutions in order to monitor, improve and update the present AM systems into more efficient one's than the existing older versions. To all the issues mentioned till now and the issues that are going to be discussed in further sections, Face recognition will come into rescue together with the Geo fencing technology. One of the natural characteristics that may be used to distinguish one person from another is their face [14]. Due to the limited likelihood that a face would vary or be copied, it is used to track identification. Now, let's dive deep into this study.

For any organization, from schools to colleges, establishing and maintaining an efficient attendance management system has always been a challenge. Smartphones have been adopted for attendance with a variety of technologies, including facial recognition and fingerprint-based attendance. Here in this paper, we are also addressing the issues with the attendance management system (AMS). This work offers a geofencing-based student attendance management system for universities and colleges that combines Face Recognition, Google Location Services, Google Play Services for geofencing API, Firebase and Geopandas, shapely geometry dependencies & also plotting libraries like matplotlib, plotly_express. The system does this by tracking students' real-time whereabouts like their live location and the pre - set up geo-fence around the classroom. It also uses facial recognition for preregistered students, and it takes attendance when a student spends over the given time within the determined geo-fence: a classroom in this case.

Institutions of higher learning are worried about students' attendance consistency. Attendance is a significant problem in schools and colleges even in a pandemic condition. Calling out the roll call or having students sign a piece of paper are the two main traditional ways to record attendance [19]. For the instructor to operate the class smoothly, attendance is a critical component of daily evaluation of the classroom. The instructor often checks attendance at the beginning and end of class, but with a manual approach, it may look that they missed someone or that some of the students answered more than once. For computer vision applications, machine learning has recently received a lot of attention. Both of these required more effort and time. Consequently, a computer-based attendance management system for students is needed, which will let the faculty keep track of attendance automatically [19]. The intention to build a facial recognition-based automated attendance system is anticipated in this study. Because the program is entirely software-based and features facial recognition, it may be deemed environmentally friendly because it uses less paper and saves time.

If attendance is kept manually, it can be a significant load on the teachers. The use of an intelligent and automated attendance management system is being made to address this issue. However, with this system, authentication is a significant problem. Biometrics are typically used to implement the smart attendance system. One biometric approach to enhancing this system is face recognition. Facial recognition is a key component of biometric authentication and is widely utilized in a variety of applications, including network security, video surveillance, access systems at doors, human-computer interaction, and video monitoring [15]. This paradigm makes it simple to address the issue of students and proxies being marked present even when they are not present physically there. The model should be able to perform face detection and then recognizing the detected face well.

One of the most effective, reliable and sophisticated image processing applications, face recognition - is crucial in the technical world [11]. The identification of the human face is an active problem for authentication purposes, particularly in the context of student attendance. The process of identifying individual employees or students using a face biostatistics system based on high level monitoring and other astonishing software technologies is called a face recognition-based attendance management system [11]. The

creation of this system aims to digitally replace the outdated method of collecting attendance by calling the names of individuals and keeping handwritten records [11]. The methods which existed before the development of this Face recognition system to take attendance are lengthy and laborious. Manual recording makes it easier to alter attendance data. Current biometric methods and the old method of keeping attendance are both prone to proxies [11].

Face recognition technology is essential in practically every industry in our digital age. One of the biometrics that is utilized the most is face recognition. It has numerous other benefits in addition to being used for security, identification and authentication. Despite being less accurate than iris and fingerprint identification, it is nonetheless often used since it is a non-invasive, contactless technique [10]. This system attempts to create a facial recognition-based system for tracking class attendance because the current manual approach is time-consuming and difficult to maintain. Additionally, the possibility of proxy attendance exists. As a result, this mechanism becomes more necessary. This system has four processes which include 1. database creation, 2. face detection, 3. face recognition, and 4. attendance updation [10]. Use of the Haar-Cascade classifier, face detection and recognition are accomplished neatly. Following the session, attendance will be forwarded to the relevant professors.

This study analyses the present attendance system, which has numerous drawbacks like being labor-intensive, time-consuming, and inefficient. This study then suggests an attendance management system (AMS) based on facial recognition & GPS monitoring and placement. In order to address the issue of students requesting leaves and showing up late for attendance, we can build up a variety of functionalities in this system in addition to adding a manual component. The system can accommodate the fundamental requirements of attendance in the classroom simultaneously. When the teacher is ready to begin taking the attendance, students can sign in as directed by the teacher. The student's identification can be confirmed by facial recognition, and the teacher and student's locations are ascertained further through GPS tracking and positioning on mobile devices. The sign-in can be accomplished if the required range is satisfied. The advantages of this new approach to attendance are that it is accurate and more effective and makes up for all the other short comings which we can possibly face with traditional mode of attendance systems.

We can say that, Before the mobile device hit the market, attendance methods were already established. Both the traditional method system and the web-based system are accepted widely and are used to monitor employee attendance. Some businesses launch pricey and secure systems like Radio Frequency Identification and thumbprint technology. With the arrival of GPS-enabled smartphones, it is necessary to setup a smart phone as a medium of employee attendance tracking to sign in and out, especially for those who work remotely. "In this application, GPS data can be sent to a remote server and tracked on the map. After the data sent using GPRS technology is saved to the database, it can be actively used in different applications. However, it takes a certain time for the signals received from the satellite to be received and sent to the remote server. This delay varies between 3 - 8 seconds in the device we use" [5].

The paper outlines and defends a framework model with value-based criteria based on the benefits and drawbacks of geofencing in mobile marketing management. The version shows how the sender and the recipient interact as well as the benefits of marketing management. By presenting the various factors of Geo-Fencing, exposing readers to specific information about the techniques and management perceptions, and providing a framework model version that defines new novel inquiries for marketing principle and managerial practice, this paper provides insight into mobile marketing management principles. A geo-fence is a virtual barrier that surrounds a physical region. A geo-fence can be created based on the user's requirements by taking various radius factors into account, or it can simply be a predetermined set of limits given as boundaries [9]. This geo-fencing makes use of geo-fence to process all of this. The global positioning system (GPS) is a characteristic that is used to determine geographic borders or boundaries. It has a vastly expanding range of scope. Few mobile and stationary applications employ geo-notifications, which are designed to alert users proactively about their location-specific information. Geo-fencing is the name of this technology that underlies with the above proactive location-based services [9].

"The geofence has come out to be the application which helps in the protection of the machine and the jobs that need to be carried out both inside the fence or backyard the fence. This surely helps the employer to hold music of the gadget and the jobs that are being carried out from the devices, which increases the effectivity in the experience that the system is utilized in a suitable manner. One of the features of the product is Fencing where all the units will be given sure jobs which can only be performed when interior the fence and some jobs which will be active only backyard the fence. These points were already present in the Android Application side, now it needs to be applied in the Linux side. The approach that we have used is the geofencing API in the android side, however getting the geolocation of the laptop alongside with the latitude and longitude differs with the precise location" [12].

According to some sources, geo-fencing capabilities can work wonders in many other applications besides attendance management systems. For instance, they can enable a system to easily monitor and track the location of the vehicle and possibly be able to send out an alert when the vehicle leaves the given geofence area [6]. The hardware and software components of this system can be divided into two independent components. we can check by testing the prototype moving it around the selective perimeter. The outcomes may display the vehicle's precise position and an email notice when it entered or departed the bounds. If the system is properly built and operated, it may provide better accuracy than the real existing map on our devices.

2.1 Mobile marketing:

Each and every person in our digital age owns an Android phone. Growth of a business is dependent on consistent employee attendance. One of the key aspects of the business is figuring out and managing the details frequently they show up. The firm employs a large number of people, therefore using RFID and fingerprint technologies to track attendance for every employee would be impossible. It takes a lot of time.

With the help of the location-based geofencing service, businesses may reach out to mobile users with messages when they enter a certain region. With the help of a cutting-edge tool called geofencing, mobile marketing has been raised to a new level. This technology allows businesses to target prospective clients inside a certain geographic area with targeted advertisements. The term "geofencing" refers to the creation of a virtual 2 2 2 8 perimeter around a business site using a variety of technologies. One of these technologies is the global positioning system (GPS), a satellite navigation system that gives us location and time data. The Bluetooth

technology known as RFID, or Radio Frequency Identifiers, connects devices by transmitting radio waves. A geofencing region can range in size from 50 meters to an entire metropolis. It can generate a radius of interest in which a geo enabled phone or other portable electronic device can take a particular action, as the geofencing technology creates a virtual border around a physical geographic location. By alerting us when a potential customer is passing by our firm, or by one of our competitors', or entering a specific targeted region, geofencing aids us in maintaining control of our enterprise.

III. PROBLEM STATEMENT

It is required to develop a smart attendance capturing mobile app with the following features:

- It should record the most basic information about both students and staff, including their name, designation, ID or employee number, gender, and headshot.
- After successfully recognizing the student or employee, it should enter the pertinent information, including the entrance time, into the system while simultaneously recording the attendance (entry).
- In a similar manner, upon leaving the office, the employee will be identified by his or her face, and the exit time will be recorded in the system.
- The software should only record attendance within a geofenced region and should automatically record the GPS location where the attendance is being recorded.
- The mobile application must integrate computer vision with machine learning to recognize faces.
- That ought to reduce proxy.
- Under manual attendance methods and basic attendance management systems, students may occasionally merely show up once to give their attendance and then attempt to leave the class, which causes them severe academic loss. It ought to offer a remedy for that.

IV. PROPOSED SOLUTION

As discussed in the above sections, the wholesome solution for covering all these problems is developing a Smart Attendance App by implementing the concept of Geofencing and face recognition - which is one of the exciting and wonderful applications of Machine Learning. There may be several AMS models available for distributed staff among the companies and offices which are currently in use but there are less efficient AMS systems available for faculties of Schools and Colleges to ease their less or more manual work. Hence, we can try to make a smart attendance management system that will concentrate on reducing the burdens of offices as well as schools and colleges by diving a little deep into the concept of geofencing and implementing some additional required features according to the situations that arise in educational institutions.

This mobile or desktop application comes to the rescue as it records all the most basic information of any of the individuals according to the system the user selects i.e., if the user implements it in the office, then it will keep the track of employees or if the user chooses to implement it in the college, then the administration and faculty will be able to record the basic information of all their students such as their names, ID numbers, gender, etc. First, it successfully recognizes the individual and then compares the pertinent information to check the authenticity of his/her's identity and then it records the significant information such as entry time while simultaneously recording the attendance. Similar to the point mentioned in the problem statement, it also does the finishing process in the same manner, like when the student or employee is leaving the office, they will be identified by their face and the exit time will be recorded.

Through geofencing, we can make the above process more exact and efficient by customizing the AMS model according to our customs and instructions. Like as for students and employees, it automatically minimizes or prevents the proxies because of the facial recognition application but the problem arises when he/she tries to leave the particular premises after getting their attendance registered for that day or as it is a mobile application it will also be a troublesome thing if they try to scan their face being at home or while they are on their way to office/college, when they are late sometimes, some of them may try to scan it early to avoid being marked absent. But here when Geofencing comes into the scenario together with the facial recognition system it restricts the above problems. Geofencing sets the virtual perimeter around the preferred location as per our instructions in some shapes and watches over that distance to notify about the records of people's entries and exits over the given time period.

We can optimize the model by implementing the features of setting the instructions clearly for example, the individual should be in the preferred perimeter for 90% (or any % we would like) of the given time period to get the attendance for the day or to notify the faculty or superior when he/she exits the perimeter more than 3 times (or any number of times we prefer), etc. This is how we can save the more or less manual work done by the faculty of educational sectors at the end of every day or week in updating the attendance by implementing the geofencing and the machine learning application such as facial recognition, simultaneously as it allows them to customize the model according to their own customs and needs and also helps in disciplining the students in regulating their attendance and saves them more time to relax and concentrate on other important things.

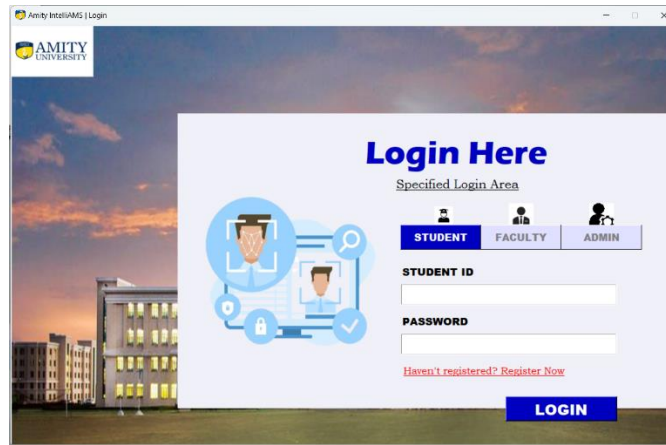


Fig.1 Registration Page

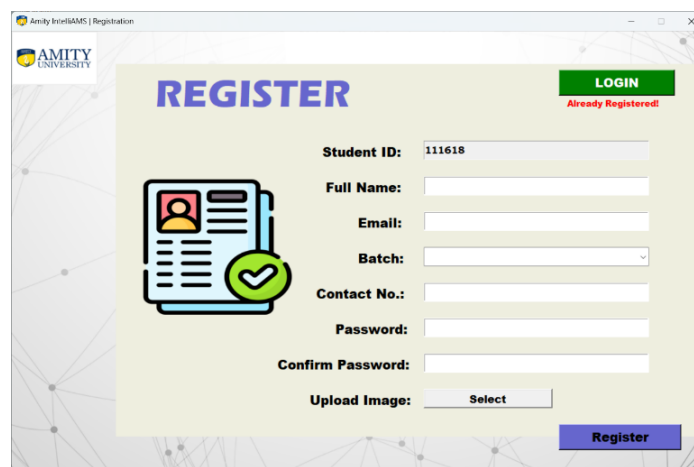


Fig.2 Login Page

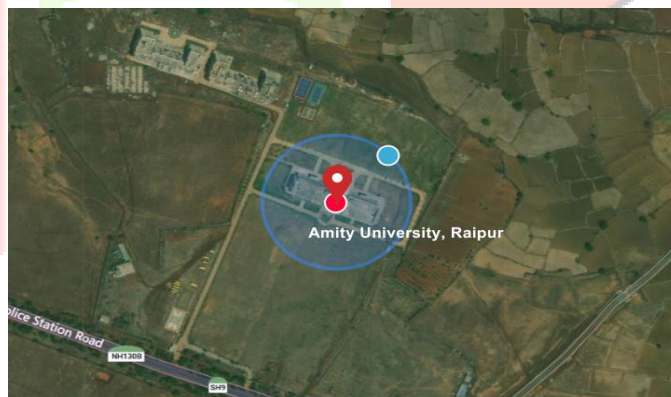


Fig.3 Geofence created

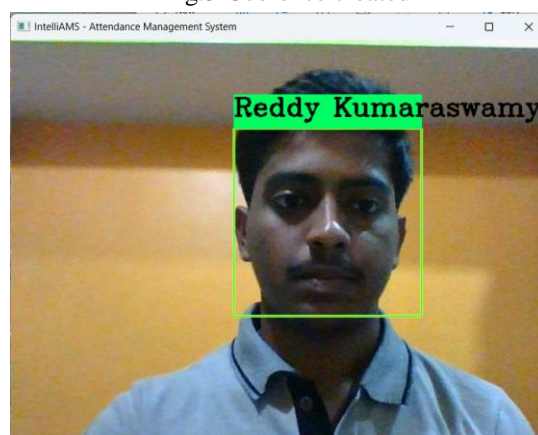


Fig.4 Facial Recognition System

VI. CONCLUSION

The paper concludes that, with the combinational use of the many astonishing technologies, we can implement many efficient daily usage systems for the betterment of millions of lives. one of such systems is the Attendance Management System using Facial Recognition and Geofencing, which can be implemented using various technologies like Python which again includes best front-end interfaces such as Tkinter, and also modules to support geofencing such as pandas, geopy and geopandas etc., JavaScript, Firebase, Machine Learning, Google API and many other API's.

We can make the list of features we are going to need in our model and the order of steps we are going to follow for the overall model building at the beginning of the model implementation to make sure we aren't missing any essential aspects.

We can continuously develop the application more to our benefit by incorporating many things like adding as many as possible separate icons, tabs, sections in the Front end of the application to make it more flexible and easily understandable and may be an alarm sound for the professors to start the time for attendance of that particular period as it acts an reminder and also the advanced development as the notification system we have discussed about which triggers a warning to the students if they are out of the perimeter more than the permitted chances or the certain % of time period and sends a notification about the incident to the teacher by also providing an option to whether allow or reject the permit to be out of the class according to the circumstances.

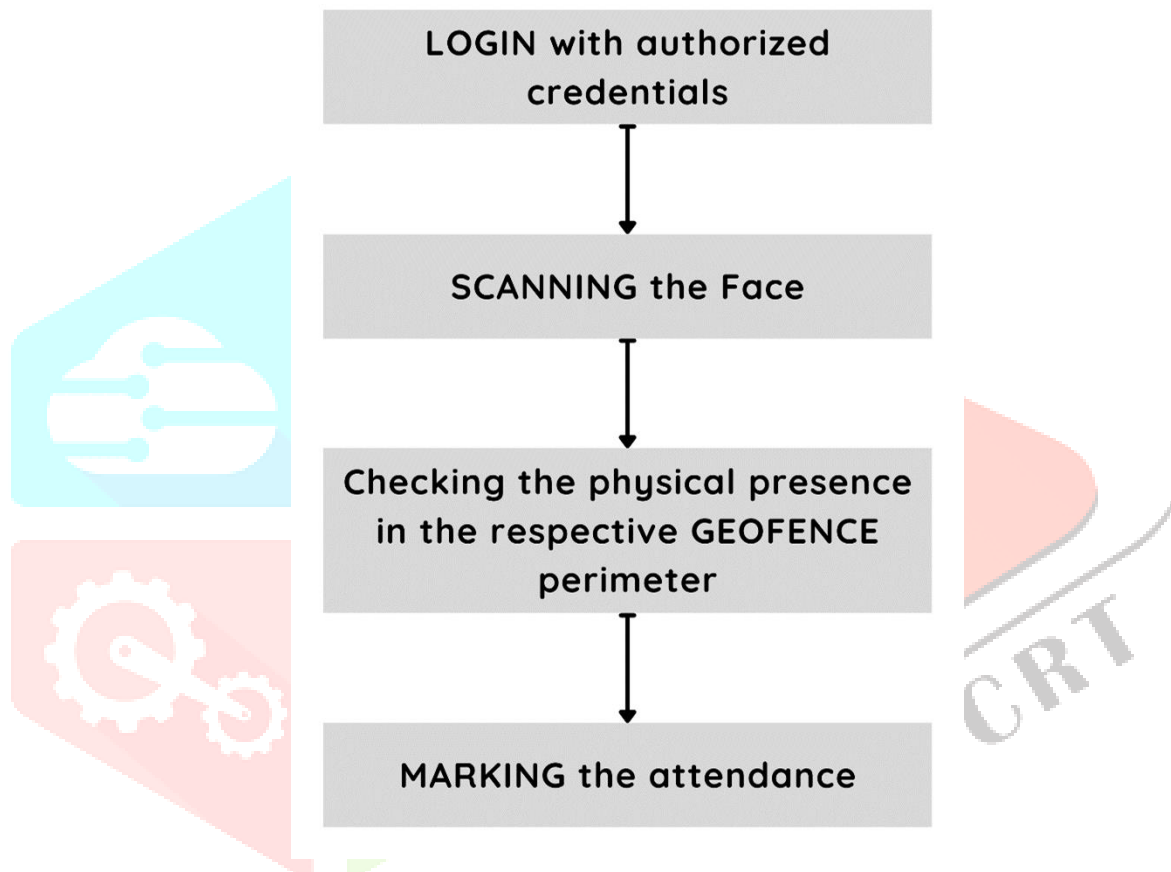


Fig.5 Flow chart of the project

After we have built this amazing model, we now have the single solution for all the problems we have discussed in our problem statement such as preventing the proxies as the person must be recognized as well as should be physically present in the respective virtual perimeter, manual labor etc., and we will also have an efficient database with all the data entries with respect to our organizational requirements.

VII. FUTURE WORK

- In geo-fencing we can try to understand and work with certain sensors which cooperate in improving the accuracy of location tracking with even better distances than usual.
- Try to work more on notification system for proper warnings, alerts and also for better user interface experience.
- As a part of advanced development in future, we will try to implement Anti-Spoofing by which the model will be able to differentiate between the original person and an image.
- To make the automated attendance system more understandable we can try to implement some simple features like, representing the ones who followed the customs correctly in some specific colour (e.g., green) and the ones who didn't followed will be shown in some contrast colour (e.g., red) so that the superiors / faculties find it easy to differentiate and upload.
- We can also try to implement Leave Management System in this smart AMS model so that the students will be able apply for leaves with appropriate reasons and the faculty will be able to view it. The permission controls will be with the faculty

members whether to allow it or not and according to the resulting approvals the attendance can be automated making it easy for the faculty to keep the records of the leaves granted to the students with their proper reasons.

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