ATTENDANCE MANAGEMENT SYSTEM USING FINGERPRINTAND VOICE RECOGNITION WITH GEOFENCE

Devendra Kumawat[1], Gauri Shrimali[2], Kalpit Malviya[3], Mayank Kataria[4], Palak Intodia[5,]Bhupendra Teli[6]

[1,2,3,4,5] UG Student, [6] Assistant Professor, Department of Computer Science & Engineering,Geetanjali Institute of Technical Studies, Udaipur, Rajasthan, 313001, India

Abstract: An Attendance Management System is a system used to monitor attendance in an organization, which maximizes the productivity of that workplace and minimizes loss. Not only is it important to maintain the attendance but also to simplify rolling out payrolls. Attendance clearly illustrates which employees are consistent at their jobs and who are taking their jobs for granted. This system makes use of fingerprint scanning, voice recognition in addition to geofence constraint. The admin has the authority to construct a geofence i.e. a virtual boundary around the office so that whenever an employee tries to mark their attendance, they can do so only when they are inside the geofence. This paper illustrates the improvement of the Attendance Management System based on biometrics verification for an organization.

Keywords: attendance management system, fingerprint, voice, biometric, geofence

I.   INTRODUCTION

The Attendance Management System is an integrated solution to track the attendance of an organization's employees in addition to keeping an account of all the late entries, early arrivals as well as absentees. An employee is an organization's asset. Thus it is crucial to monitor and analyze an asset to ensure the productivity of an organization. Attendance Management System is important to generate payrolls, record leaves, day-to-day monitoring of attendance, and calculation of overtime. There are many Attendance Management Systems available at the current time, some of which are described below:

Manual Recording System
It is the oldest Attendance Management System. An employee's entry and exit time are recorded in a register or an Excel sheet. Extra manpower is required to maintain the records and then summarize the attendance. As everything is manual, employees may even ask for favors to arrive late or leave early. There were more drawbacks than advantages of this system. As time unfolded, and more technologies came into the market, this method became obsolete.
Drawbacks:
- Extra manpower
- Obsolete methods
- Can be tampered with
- Time-consuming

Biometrics System
It provides identification and verification of an employee based on of their physiological or behavioral characteristics. The data of each employee is stored on hard disks or cloud and referred to every time employees try to clock in or clock out. Physiological characteristics can be a fingerprint, iris, face, etc. of a person and Behavioural characteristics can be the voice or signature of a person.
- Drawbacks:
- Lost mobile phone
- Marking attendance even if not at the office

Punch Card System
These are like identity cards, except they are used to mark a person's attendance. This digital card stores the personal details of the employee. The card needs to be swiped at the machine to clock in or clock out.
Drawbacks:

- Fingerprint Recognition
- Voice Recognition

An employee's data is stored in the database. Every time an employee needs to clock in, they need to provide the respective input which is then matched with their records in the database. If the records match, the employee is clocked in otherwise he's unable to mark his attendance. Other details such as time of clock in and clock out, late arrival, early departure, and absentees are also stored in a database table.

All these features come with the limitation of geofencing. Geofence can be considered as a virtual perimeter for a real-world geographic area. It is dynamically generated by the administrator. Thus an administrator can create a geofence using an organization's geo- location. Every time an employee tries to log in, he must be within the geofence otherwise he will not be able to log in.

India comes second when it comes to smartphone users around the globe. Taking these statistics as an advantage, this will be available as an application that can be used through any smartphone. If the person is not accessible to a smartphone, this application can be used via computers too. The system constructed is a cross-platform application.

All these features combined provide a robust system, where no fraudulent entries can be done. Thus, it is an efficient and authentic Attendance Management System.

II. LITERATURE SURVEY

Several pieces of researches have been done to develop an Attendance Management System such as Md. Shakil [1], Tamboli Shireen [2], Benfano Soewito [3], Mekshyam Z. Lanjewar [4], Aayushi Singh [5], and Akshay A. Kumbhar [6].

Akshay A. Kumbhar et. al [6] proposed a system that needed two apk files, one for the student and one for the teacher (a student is a regular user whereas a teacher is an administrator). These apk files were needed to be installed on their respective mobile phones. Students just needed to perform one-click to mark their attendance. The teachers could generate reports with just one click on the apk file. Though this was less time-consuming and needed less manpower, fraudulent entries can be possible as verification is done through username and passwords which can easily be shared.

Md. Shakil and Rabindra Nath Nand [1] proposed an improvement of the existing Attendance Management System based on fingerprint recognition. They introduced many new algorithms such as gender estimation, key-based one too many matching, removing boundary minutiae. This proposed system was faster and cheaper than the existing Attendance Management System. A similar system was brought forward by Benfano Soewito et. al [3] with the addition of voice recognition. This system uses smartphones to verify employees. In this research, they found that fingerprint verification has a false positive of 95% and the false negative of voice recognition is 5.88%.

However, some companies require employees to be present in the offices for security reasons. Thus, it is important to build a constraint so that employees cannot mark their attendance while sitting at home when they are required to be in their offices.

In our work, we addressed the problem of location. This Attendance Management System utilizes smartphones for monitoring the presence or absence of the employee. An additional constraint of geofence is added. Whenever an employee enters or exits the fixed perimeter, a timestamp is saved and updated in the records. Thus this provided extra safety and reliability of the system.

III. PROBLEM STATEMENT

Traditionally, many organizations today use manual attendance system, punch-card systems or biometric systems. All these require either external devices, such as a fingerprint scanner or punch card, or extra manpower. Maximum methods are time-consuming, which makes them obsolete in today's time. In addition, due to the COVID-19 pandemic, there should be minimum physical contact to prohibit the transfer of the virus. But there is a large probability of transferring viruses via fingerprint scanner. Thus, we need an Attendance Management System that minimizes physical contact in addition increases reliability and safety. An ideal Attendance Management System should reduce the workload of HR, by doing automated analysis.

IV. OBJECTIVE

The main objective of this paper is to propose an Attendance Management System which is suitable for industrial employees and does an automated analysis of attendance records.

Managing the attendance of thousands of employees manually is not possible in today's times and thus to overcome this problem, this Attendance Management System is proposed. Some of the aims are:

1.   Saving time
2.   Online employee attendance management
3.   No proxy attendance
4.   Thorough verification
5.   Transparency in attendance system
6.   Statistics of employee attendance
7.   Restriction using geofence

V.   METHODOLOGY

This Attendance Management System requires both software and hardware. The hardware used is easily available and maintainable. The proposed hardware requirements are:

1.   Smartphone with a working microphone or fingerprint scanner
2.   Computer with a working microphone or fingerprint scannerThe proposed biometrics are:

     a.   Fingerprint
     b.   Voice

(Face recognition in the COVID-19 pandemic is tough due to the coverage of face by mask).

Fingerprint Scanning and Analysis

Every human has unique fingerprints. A fingerprint is the most reliable, precise, and easy-to-use identification feature. They can also prevent proxy attendance. As employees use their smartphones for marking their attendance, no external costs are required for a fingerprint scanner. This also prevents transferring of any viruses, which is the most crucial concern during the COVID-19 pandemic.
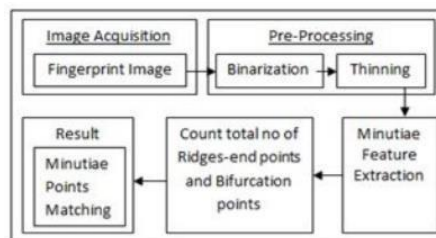

Figure 1. Fingerprint matching algorithm. Reprinted from "Smart Mobile Attendance SystemUsing Voice Recognition and Fingerprint on Smartphone", by Benfano Soewito et. al, 2016,

International Seminar on Intelligent Technology and Its Applications (ISITIA). July 2016, Page No. 177. Copyright 2016 by IEEE.

Voice Recognition and Analysis

Like fingerprints, every person has a unique voice. A voice's frequency, pitch, length, and tension combine to make it unique. In situations where employees are unable to give fingerprint as input (due to greasy hands, disabled employees, bruised hands, etc.)
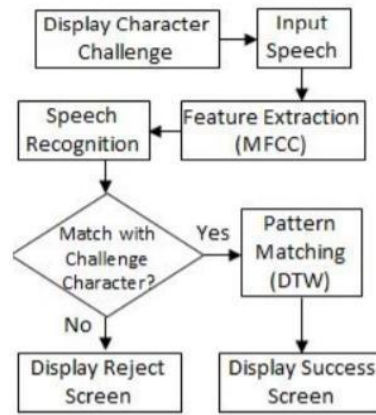
they can use voice as input.

Figure 2. Voice matching algorithm. Reprinted from "Smart Mobile Attendance System Using Voice Recognition and Fingerprint on Smartphone", by Benfano Soewito et. al, 2016, International Seminar on Intelligent Technology and Its Applications (ISITIA). July 2016 PageNo. 177. Copyright 2016 by IEEE.

Geofence

Geofence is a virtual boundary that utilizes GPS to characterize geological limits. An administrator can define a zone in the map which represents the respective organization. Several companies require their employees to come to the office on a strict basis. This Attendance Management System disallows an employee from clocking in/out when they are not in office parameters, thus preventing proxy attendance.

The course of actions required to mark one's attendance is:

1. If the employee is using the application for the first time, they need to sign up by filling in the required credentials such as their details and their fingerprint and voice inputs.
2. If the employee's account is registered, they need to log in using their email id and password.
3. If the credentials match, the employee will be redirected to their home page, else they will stay at the log in page.
4. Once logged in, they can mark their attendance using two options: fingerprint scanning or voice recognition.
a. Fingerprint Scanning:

On selecting this option, the employee needs to put their thumb/finger on the scanning area. This input will then be matched with the fingerprint stored in the database record of that person. If the fingerprints match, the employee is clocked-in/clocked-out.
b. Voice Recognition:

On selecting this option, the employee needs to speak a phrase written on the screen. This voice will be taken as input through the microphone and will be matched with the voice pattern present in the database record of that person. If the voice matches, the employee is clocked-in/clocked-out.

There are two constraints for clocking in/out:

1. First, the person should be within the geofence created by the administrator i.e. within the office premises.
2. Second, time should be within the shift timings of that person.

VI.   Software Design & Implementation

The purpose of this attendance system is to give the administrator the key to solve all the purposes in one system as it stores all the

necessary information about the employees including individual fingerprint and voice patterns. The system provides a way to verify the fingerprint or voice pattern. These inputs are given through the employee's smartphone. If the smartphone is not accessible due to any reasons, the system provides cross-platform operation i.e. it can be used on both smartphones as well as computers.

A geofence is created by the administrator to ensure that employees are present within the organization's perimeters. The administrator can check all the information about the entrance time and the exit time of any employee. Every branch of the organization can be kept on surveillance by just one attendance system.

The system is developed by using the following software:

Front-End
- Angular
- Ionic
- Ionic Capacitor -to configure our app on mobile phones

Back-End
- Cloud Firestore(NoSQL Database)
- Cloud Storage
- Node JS
- Angular Fire

APIs Used
- VoiceIT API
- Fingerprint-AIOAPI
- Google Maps JSAPI.

The design of this system involves series of phases in which the output of one phase provides the input to the next phase.
- In the first phase (requirement phase), the end-users, administrators, and employees are interrogated to discover their aim and objectives, requirements, and expectations from the application.
- In the second phase (design phase), the application is designed to meet the end-user's requirements. This entails the data flow diagram, context diagram, and use case diagrams.
- In the third phase (implementation phase), the graphical user interface of the system is designed with HTML, CSS, Angular, Ionic, and Ionic Capacitor used as front-end tools, while Cloud Firestore, Cloud Storage, NodeJS, and Angular Fire were employed as back-end design in addition with APIs such as VoiceIT API, Fingerprint-AIO API, and Google Maps JS API. The application interconnects with the database located on a remote server. It is to make sure that the application is mobile-responsive to make it easier for both the administrator and the employees to use the application.
- In the fourth phase (testing phase), the work of each component of the application designed was tested and is integrated into a system.
- Finally, in the last phase (deployment phase), we deploy the application we developed.

On implementing the above phases, the final result is as illustrated below:

Employee Clock-in or Clock-out

The employee needs to log in using their valid credentials (email id and password). On successful log in, the employee has the following options for marking their attendance:
1] Fingerprint Recognition
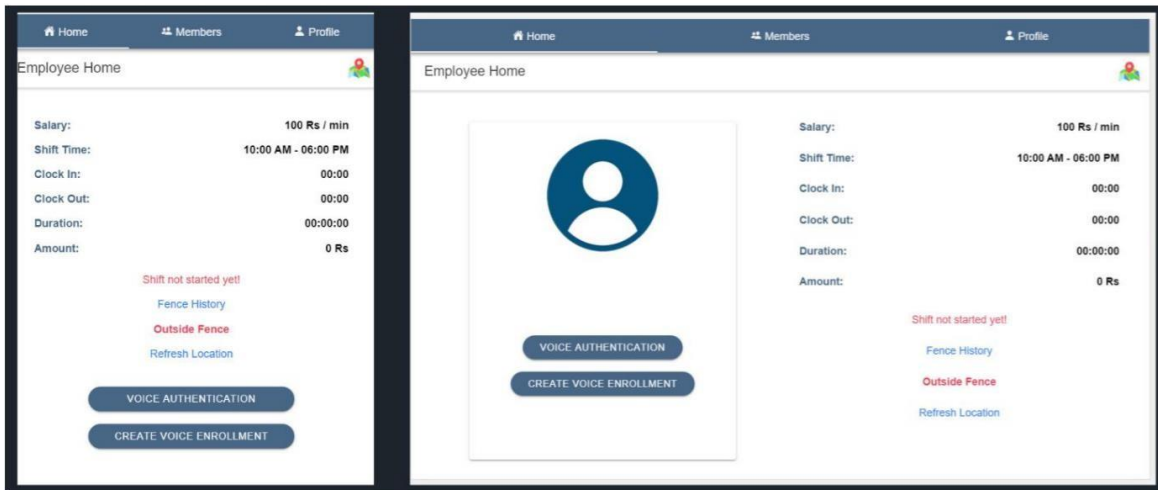2] Voice Recognition

Note: Geofence restriction is present.

Figure 3. Home Page After Logging In

Statistics

Statistics is a form of mathematical analysis that is used to gather, review, analyze and draw conclusions from given data. The administrator can view statistics such as the number of employees present or absentees, early leavers, latecomers. This data can be seen for a specific

duration (no. of days) of the year or the entire year. The statistics can be viewed in bar/line/pie representations along with the number of people present, absentees, early leavers, and latecomers on a particular day or in a particular month.
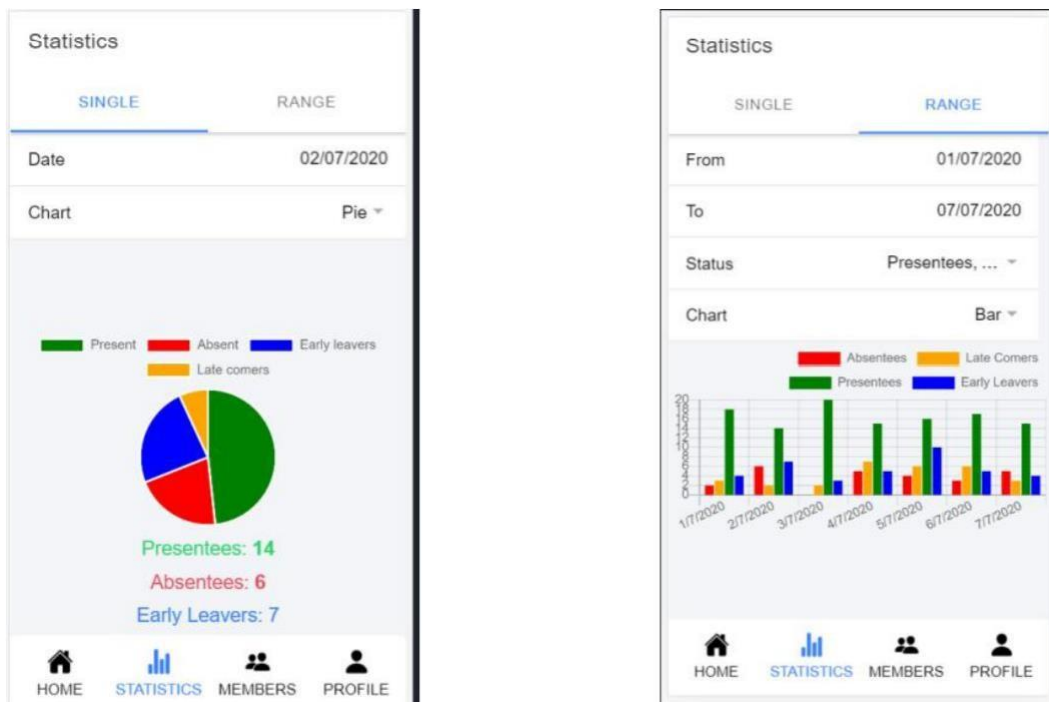

Figure 4. Statistics

VII. CONCLUSION

Every organization, whether big or small, has human resource challenges to overcome. This paper introduces an Attendance Management System which is designed to assist in strategic planning and will help ensure that the organization is equipped with the right level of human resources for their future goals. An important feature is a time and location tracking of employees which saves both time and money for the organization. The geofence prevents proxy attendance and thus ensures reliability. The system is economically efficient as no external devices are to be installed for recording the attendance. This system is cross-platform i.e. it canbe used on android smartphones as well as on computers which makes it accessible to every employee.

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