Android Application for Attendance Management System

Submitted in partial fulfillment of the requirements
of the degree of

BACHELOR OF ENGINEERING

in

INFORMATION TECHNOLOGY

by

Group No: 19

Roll No.
55 - Roshan Manglani

56 - Kapil Nagrani

57 - Kamal Bulchandani

Supervisor:

DR. GOPAL PARDESI
(Professor, Department of Information Technology, TSEC)

THADOMAL SHAHANI
TSEC
ENGINEERING COLLEGE

Information Technology Department
Thadomal Shahani Engineering College)
University of Mumbai

CERTIFICATE

This is to certify that the project entitled **"Android App for Attendance Management System"** is a bonafied work of

Roll No.

55	Roshan Manglani
56	Kapil Nagrani
57	Kamal Bulchandani

Submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the degree of **"BACHELOR OF ENGINEERING"** in **"INFORMATION TECHNOLOGY"**.

_____

Dr. Gopal Pardesi

Project Guide

_____   _____

Dr. Arun Kulkarni   Dr. GT Thampi

Head of Department   Principal

Project Report Approval for B.E

Project report entitled **Android Application for Attendance Management System** by

Roll No.

55	Roshan Manglani
56	Kapil Nagrani
57	Kamal Bulchandani

is approved for the degree of ***"BACHELOR OF ENGINEERING" in "INFORMATION TECHNOLOGY"***.

Examiners

1._____

2._____

Date:

Place:

Declaration

I declare that this written submission represents my ideas in my own words and where others' ideas or words have been included, I have adequately cited and referenced the original sources. I also declare that I have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in my submission. I understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

1) _____
   (Signature)
   _____
   Roshan Manglani - 55

2) _____
   (Signature)
   _____
   Kapil Nagrani - 56

3) _____
   (Signature)
   _____
   Kamal Bulchandani - 57

Date:

Acknowledgement

We would like to express our gratitude and thanks to **Dr. Gopal Pardesi** for his valuable guidance and help. We are indebted for her guidance and constant supervision as well as for providing necessary information regarding the project. We would like to express our greatest appreciation to our principal **Dr. G.T. Thampi** and head of department **Dr. Arun Kulkarni** for their encouragement and tremendous support. We take this opportunity to express our gratitude to the people who have been instrumental in the successful completion of the project.

Roshan Manglani

Kapil Nagrani

Kamal Bulchandani

Abstract

Mobile Attendance Application is a cross platform mobile application where students can mark attendance from their smartphones. This application takes multiple parameters into consideration to determine if the student is physically present in the class. This application also has the functionality to generate the attendance sheets in excel format to the instructor. The application is aimed to save class time at no extra cost of purchasing any special peripheral devices. User authentication is one of the important factors in this proposed system. Every student is authenticated based on his/her unique user identification number. If a student does not have access to a mobile device or if the device battery is dead, then he/she can indicate to the instructor who can mark the attendance in the instructor's smartphone.

Table of Content

List of Figures

List of Tables

Chapter1

This chapter explains the aim, objectives and the scope of the proposed system

1.1   Introduction

Attendance Management System is software developed for daily evaluation of students in their continuous assessment record, and performance in accordance with the principle of the institution. It is facilitated to access the performance and information of attendance of a particular Student in a particular semester of study. The information is sorted by the teachers, instructors and advisors, as provided by the student for a particular day throughout a complete semester. This system will also enable the evaluation of student regular presence in various lectures which will determine the eligibility of the student to sit for a semester examination. Attendance Management System basically has three main modules for proper functioning

• First module is admin which hold the key for editing and updating information. The admin has absolute right to all the users which are the Teachers and Student.
• Second module is handled by the user which can be a Teacher or Instructor. This user has a right of making daily attendance, updating, editing and generating reports to the students.

1.2   Aim & Objectives

The main goal of our project was to develop an application for Android mobile phones that calculates and displays the attendance of students for that particular subject, term or year depending on the user's criteria. This application is designed specifically for teachers to enter and monitor their student's attendance.

Create a Window application to be used in place of old paper based
user Employee Salary manage process.

➢ Use the technologies and Server technology used in here to create strong and secured database connectivity.
➢ Incorporate the server software within the code.
➢ Runtime package and deployment instructions are given.
➢ Eliminate duplicate data entry and errors in time and attendance entries
➢ Eliminate paperwork and save time.
➢ Automatic calculation of attendance

➢ To Increase security.

1.3 Scope

The application has been developed using Android Studio, Java and XML. The entire application is very easy to use and intuitive so as to attract users with a very simple user interface. A menu bar, which can be accessed by sliding from the left side of the screen, will be used to access the various different features of the application. The user can maintain multiple profiles on the application to keep track and record various different attendances ranging from college to tuitions etc.

Chapter 2

REVIEW OF LITERATURE

This chapter explains the concepts and techniques of Application Development. The existing solution and the software and hardware requirements have also been discussed in the chapter.

2.1 Domain Explanation

Android is a Linux based Operating System that was developed by Android Inc., which was bought by Google later on. Android OS is designed mainly for smart phones and tablets that have touch screens/motion detectors. Despite being primarily designed for touchscreen input, it also has been used in game consoles, digital cameras, and other electronics. To give competition to Apple's iOS, Google made Android as open source and releases code under Apache License. In last few years, Android has become the most widely used operating system in the market and having open source has just increased its popularity many folds. Android code is written primarily in Java programming language, and is compiled with the help of Android SDK tools. On compiling, it generates an Android package (commonly known as .ask) file which is used to install the application on android device.

App Components: To aid in android development, there are mainly four types of components. Each component serves a distinct purpose and allows system to interact with your application in different ways. Broadly speaking, there are four types of components.

- Activity
- Services
- Content provider
- Broadcast receivers

2.2 Types of Application Components

Android helps to create applications using these components. This will help to understand how one can build the components which will be the building blocks of the application. 3.1.1 Activities An activity represents a single screen with a user interface. For example, in this Attendance Tracker application, activities include adding a course, scanning student to register presence or viewing student's attendance record. "Main" activity is the activity that is launched when any application starts. Different activities can start from one activity, keeping the previous activity in stack although the activity is stopped. Activities follow LIFO (Last In First Out) mechanism.

- **Activities**

An activity represents a single screen with a user interface. For example, in this Attendance Tracker application, activities include adding a course, scanning student to register presence or viewing student's attendance record. "Main" activity is the activity that is launched when any application starts. Different activities can start from one activity, keeping the previous activity in stack although the activity is stopped. Activities follow LIFO (Last In First Out) mechanism. Following are the callback methods available in activity to perform necessary tasks [1]. onCreate(): This is called when the activity is first created. This is always followed by onStart(): This is called just before the activity becomes visible to the user. This is followed by onResume() if the activity comes to the foreground, or onStop() if it becomes hidden

OnResume(): This is called just before the activity starts interacting with the user. This is always followed by onPause(). onPause(): This is called when the system is about to start resuming another activity. And this is followed either by onResume() if the activity returns back to the front, or by onStop() if it becomes invisible to the user.

onStop(): This is called when the activity is no longer visible to the user. This is followed either by onRestart() if the activity is coming back to interact with the user, or by onDestroy() if this activity is going away The Android Life cycle [1] for Activity looks like :
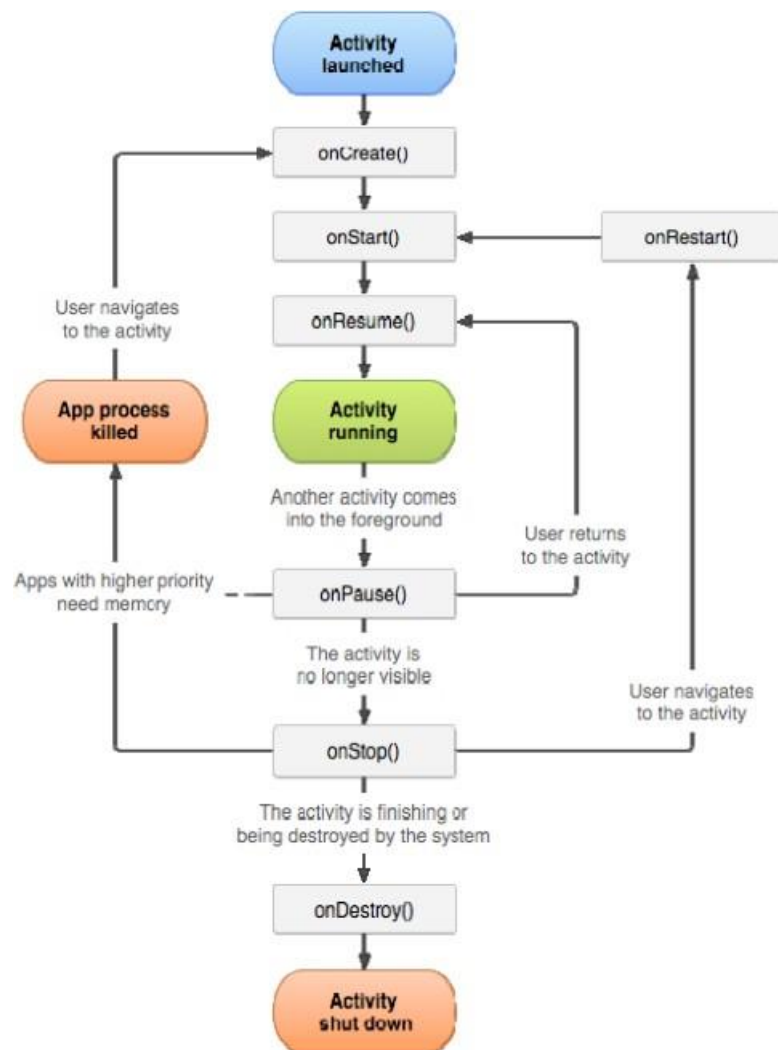
Figure 3.1 Android Lifecycle for Activity

onRestart(): This is called after the activity has been stopped, just prior to it being started again. This is always followed by onStart(). OnDestroy(): This is called before the activity is destroyed. This is followed by nothing. The life cycle of an activity can be described diagrammatically as in the figure.

2.2 Existing Solution

Problems with Existing System -

The following table illustrates the comparison among the mobile applications in the market (Attendance, Attendance Tracker) compared with the proposed Attendance Management

Application.

Table 1. Comparison between Existing and Proposed Applications.

Table 1. Comparison between Existing and Proposed Applications

Attendance	Attendance Tracker	Coyote-Attendance
Not a cross platform application only available for Android operating system.	Not a cross platform application only available for Android operating system.	It is a cross platform mobile application available for iOS, Android and Windows operating systems.
Students cannot mark their own attendance.	Students cannot mark their own attendance.	Students mark their own attendance
Time consuming because the instructor calls each student to mark their attendance.	Time consuming because the instructor calls each student to mark their attendance.	Not time consuming because students mark their own attendance.
No functionality to generate attendance in excel sheet format.	No functionality to generate attendance in excel sheet format.	Has functionality to generate attendance in the excel sheet format.

2.3. Hardware & Software Requirements

Android Studio is the official integrated development environment (IDE) for Android application development. It is based on the IntelliJ IDEA, a Java integrated development environment for software, and incorporates its code editing and developer tools.
To support application development within the Android operating system, Android Studio uses a Gradle-based build system, emulator, code templates, and Github integration. Every project in Android Studio has one or more modalities with source code and resource files. These modalities include Android app modules, Library modules, and GoogleAppEngineModules.

Android Studio uses an Instant Push feature to push code and resource changes to a running application. A code editor assists the developer with writing code and offering code completion, refraction, and analysis. Applications built in Android Studio are then compiled into the APK format for submission to the Google Play Store.

The software was first announced at Google I/O in May 2013, and the first stable build was released in December 2014. Android Studio is available for Mac, Windows, and Linux desktop platforms. It replaced Eclipse Android Development Tools (ADT) as the primary IDE for Android application development. Android Studio and the Software Development Kit can be downloaded directly from Google.

Android phones run on Linux operating system. Java safeguards the native code from memory leaks and each platform in the Java language is used to compile for different functionalities in the Android development. Android apps can be developed using the different programming languages like Java, C, C++, HTML, python etc. There are so many new tools used for the mobile development like flow up, stetho, Jbel for android, Gradle please, android asset studio, leak canary, dry run, slides code highlighter, instabug, takt, android debug database, source tree, geny motion, vysor, android wifi ADB, find bugs, drawable optimizer, scalpel, block canary, nimble droid, methods count, android tool for Mac, DevKnox, JSONSchema2POJO, ADB IDEA, Key promoter, Fabric, Classyshark, APK DeGuard, and Cordova. These tools take care of the different functionalities in the mobile development.

All the data in the application is stored on an internal SQLserver which has been implemented using SQLite. Most Android apps need to store data somewhere and the most common way to store data on Android is using a SQLite Database.

2.3.2 Hardware Requirements

Windows

64-bit Microsoft® Windows® 8/10

x86_64 CPU architecture; 2nd generation Intel Core or newer, or AMD CPU with support for a Windows Hypervisor
8 GB RAM or more

8 GB of available disk space minimum (IDE + Android SDK + Android Emulator)
1280 x 800 minimum screen resolution.

Chapter 3

ANALYSIS

3.1 CHALLENGE & WEAKNESSES OF CURRENT SYSTEM.

In the present system all work is done on paper. The whole session attendance is stored in register and at the end of the semester the reports are generated and it takes more time in calculation. By the way we are not interested in generating report in the end of the semester but during the semester for the student to take note of his situation, and the department to know what action to take on students with poor attendance even before Exam. So, we are not able to get student regularity report and take necessary action on students whenever we want because of having very time-consuming process.

Weaknesses in Current System

1. Not User Friendly: The existing system is not user friendly because the retrieval of data is very slow and data is not maintained efficiently

2. Difficulty in report generating: We require more calculations to generate the report so it is generated at the end of the semester. And the student doesn't get a single chance to improve their Attendance.

3. Manual control: All calculations to generate report are done manually so there is greater chance of errors.

4. Lots of paperwork: Existing system requires lot of paper work. Loss of even a single register/record led to difficult situation because all the papers are needed to generate the reports.

5. Time consuming: Every work is done manually so we cannot generate report in the end of the semester or as per the requirement because it is very time consuming.

Improvements

● Calculating attendance is a very time-consuming affair and this will help teachers and students save a lot of time. Accurate – More accurate than standard old methods of attendance tracking

● No chance of mistake.

● Reduce staff work and paper work.

● Additional boost for students with various features like timetable and notes to help them out

● Data will be readily available to user at all times.

●

● Simple to use and easy to understand.

Chapter 4

DESIGN

4.1 Design Consideration

The ER Diagram
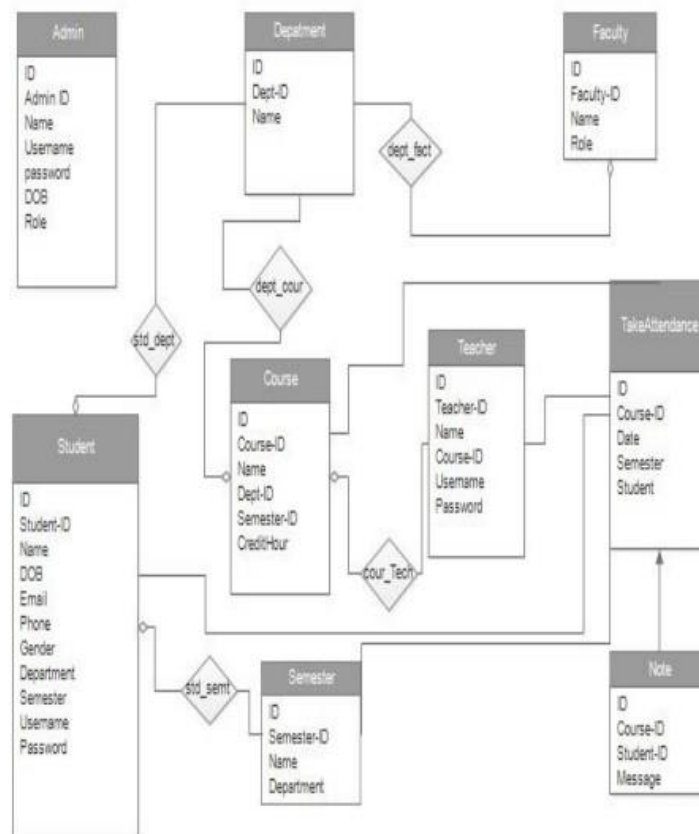
Fig: Flowchart Diagram of Teacher Module.
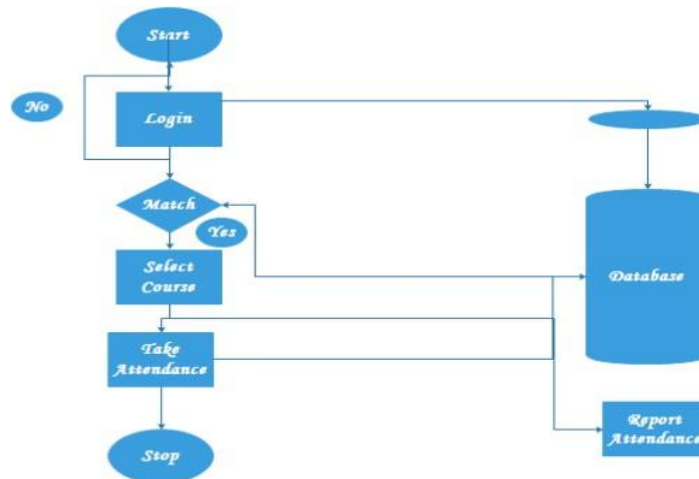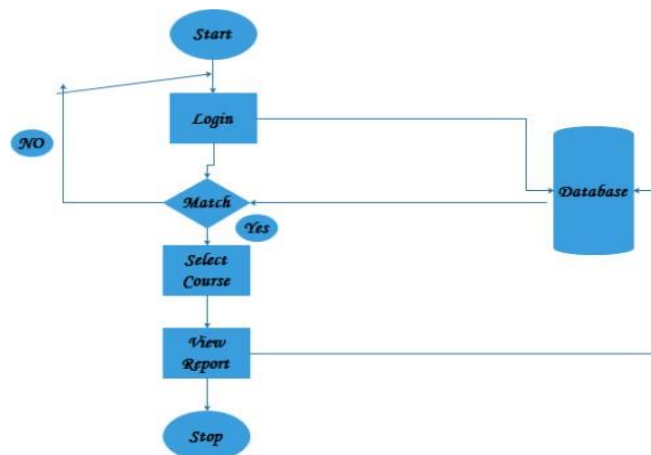

Fig : Flowchart Diagram of Student Module.

Fig: Flowchart Diagram of Admin

Flowchart Diagram of Admin
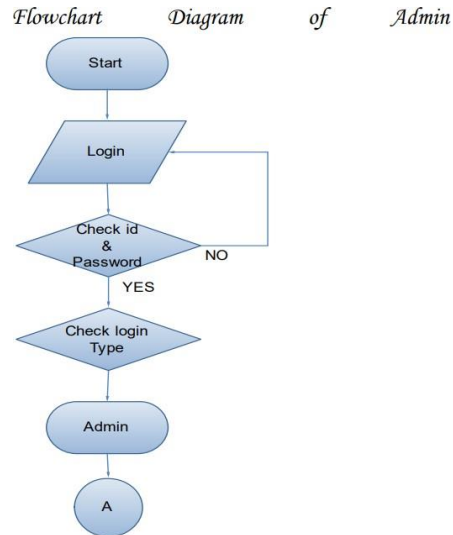
Start

Login

Check id
&
Password   NO

YES

Check login
Type

Admin

A

Table 2:

Admin Table:

S.No.	Field name	Data Type	Description
1.	User name	Text	Store user name for checking correct username
2.	Password	Text	Store password corresponding to username
3.	User Type	Text	User Type Administrator or User

Table 3:

Student Table:

S.No.	Field name	Data Type	Description
1.	Student ID	Number	This is the roll no of the student
2.	Student Name	Text	This is the name of student
3.	Course	Text	This is the course in which the students are studying .By default course is MCA
4.	Semester	Text	This is the semester in which Students are Studying. By default Semester is IV sem

Table 4:

Teacher Table:

S.No.	Field name	Data Type	Description
1.	Teacher Id	Number	Unique key for Every Teacher
2.	Teacher Name	Text	Name of Teacher

4.2 Graphical User Interface

Admin Module

- Add Student, Faculty and Teachers

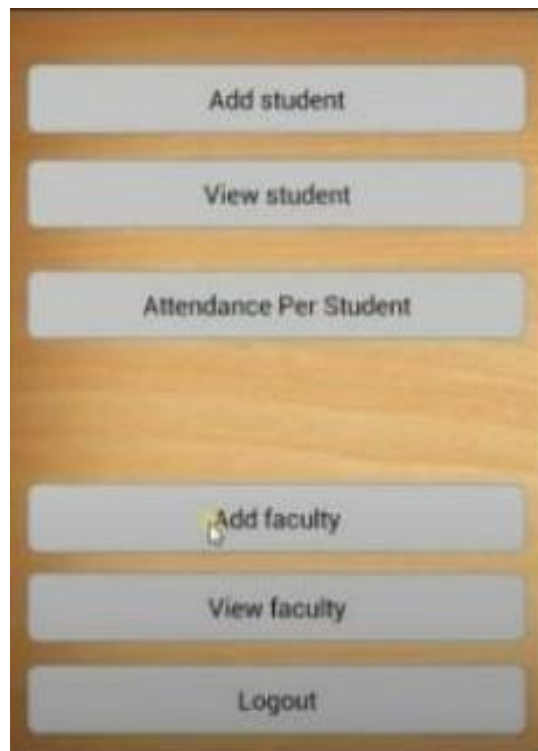- View Student, Teacher, Student Attendance and Individual Attendance.

Teacher Module

- Take class wise attendance, add student, view or edit student attendance, Save Notes subject wise.

- The teacher module has various functionalities which are developed from the teacher's requirement perspective in order to make the rudimentary techniques more robust; this indicated that the attendance can be recorded by the teacher according to the students Year in the Course and on the basis of the Department they belong to

- The teacher is also capable of editing each student's attendance if they want to for some valid reason after they have marked their attendance on a particular day

- The students are also provided with a function to save their notes that they list down during the class times or while preparing for their exams

- These notes can be jotted down according to each subject in order to make the organization process much easier and so that students can recall or skim through their notes just before their exam

Fig: Login Page

- The figure above shows the Login Page that a user first encounters when they start the Android application
- This page asks for 2 main credentials that are unique to each user that can be created by either the admin or by the Teacher (students are listed in the database by the Teacher)
- After confirming the username and the password the application proceeds to the next page

Fig: Select the Module

Fig : Faculty Registration

Fig: Mark Attendance

Fig: View Attendance

Fig: Select Branch

The first page is the login page here we can select to login as an administrator or as faculty member. the user may enter the appropriate login name and password to proceed when we login as admin, we can see the page to the right.

The admin can add or view both students as well as faculty members, once registered they will be saved.

The admin can also view total students' attendance as well as individual attendance of students.

On the left is the add faculty page which is used to register teachers along with their details such as mobile no. and address, as well a username and password for the respective teacher

On the right is the add student page, where a student name, address and contact number may be registered, along with the year and department they are in.

Note that the ADD faculty and Student function is exclusive to the administrator, and may not be accessed by faculty.

On the faculty login page, a user may login using the username and password assigned by the admin

Upon logging in as faculty, there are options to Add and |View students Attendance, as well as view total attendance for a subject/year/branch

There is a calendar and text entry field to enter the desired date of attendance

The admin also has an option to view individual students attendance as well as their details.

4.3 Design Detail

The entire application has been designed using Android Studio. The language used for coding is Java. The structure and framework of the application was designed using XML. All the data in the application is stored on an internal SQL server which has been

implemented using SQLite. The database has been made in accordance to the subjects and years so as to make the options easier to pick for teachers or head of departments (users). The working and demo of the application with screenshots has been shown previously. The various features in the application have been implemented using various Activities in Android studio for performing multiple tasks like taking input from user and storing in database. The admin controls the majority of the application and the admin name and password are fixed in the database.

Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on JetBrains' IntelliJ IDEA software and designed specifically for Android development. It is available for download on Windows, macOS and Linux based operating systems or as a subscription-based service in 2020. It is a replacement for the Eclipse Android Development Tools(E-ADT) as the primary IDE for native Android application development. SQLite is a relational database management system (RDBMS) contained in a C library. In contrast to many other database management systems, SQLite is not a client–server database engine. Rather, it is embedded into the end program.

Chapter 5
CONCLUSION AND FUTURE WORKS

Attendance tracking is an essential function for all educational institutes. Our application aims to be the ultimate application for teachers to use to simplify this tedious and time-consuming process with maximum efficiency. Additional features can be added into the application to aid users even further and make it a more complete application. Users will have access to their attendance at their fingertips. Teachers can also maintain multiple student's profiles to monitor students more closely and reduce their work.

Students can keep track of classes they have missed and closely monitor their attendance criteria without any worries. Various additional features like Notes will only boost the functionality of the application. This application has a lot of potential and could become a standard application for both students and teachers alike to regulate and record attendance.

Being the Final year students of Thadomal Shahani Engineering College, we were able to implement what we learnt in our Android App Development, Data Structures and Algorithms class into practice. We were able to attain our set objectives, and this helped us gain confidence in writing our own code and our own applications. We worked as a team, and gained some experience on how professional programmers work in the industry. There is always room for improvement, and this application we created can also be improved.

Future works

This section contains recommendations and advanced functionalities for the application in the future based on the feedback collected from the study and research on additional technology available which would provide the application with more functionality but making sure its simplicity in usage is maintained as sometimes added functionality would slowly create a more complex application.

The system works on face recognition where each student in the class is photographed and their details are stored in a server. The teacher can then record the attendance by just clicking some pictures of the classroom. The system will recognize the faces and verify the presence or absence of each student.

The application meets all non-functional and functional requirements. However, the most critical work for the future is distributing the application to Ahead, collecting feedback, and verifying functionality on multiple devices using varied Android versions. Android is open-source, and the system behavior may vary, depending on the device, as shown in the analysis part.

Adding new features from which students' benefit can motivate them to install and use the application. Such a feature can be adding a list of all students with contacts. Therefore, a user would easily search for friends and quickly find the necessary contact information.

Future work can also be done on the application's security, for example, adding fingerprint technology to establish two-factor authentication to prevent unauthorized access to the application. Future improvement in the project by making this Biometric Attendance System in order to make more advanced and increase its reliability and effectiveness. Biometrics is automated technique of identifying a person behavioral or

physiological characteristic. A fingerprint scanner has two basic tasks which are,

i. It requires to get an image of a person finger.

ii. It requires identifying and diagnosing that whether the pattern of ridges and valleys in current image matches the pattern of ridges and valleys of previous scanned images.

Future work can also include adding new methods in controlling attendance. For example, retrospective check for the previous day, if the user forgot to record leaving.

References

1. Workplace Time Tracking Habits [online]. California, United States: Intuit Inc. [visited on 2020-04-17]. Available from: https://www. tsheets.com/resources/time-tracking-survey.

2. Study Reveals Majority of Small Businesses Struggle with Timesheet Errors [online]. California, United States: Intuit Inc. [visited on 2020-04-17]. Available from: https://blog.tsheets.com/2017/ news/timesheet-errors.

3. PANG, Albert; MARKOVSKI, Misho; ZDRAVKOVSKI, Martin. Top 10 HCM Software Vendors, Market Size and Market Forecast 2018-2023 [online]. Dublin, Republic of Ireland: APPS RUN THE WORLD, 2019 [visited on 2020-04-18]. Available from: https: //www.appsruntheworld.com/top-10-hcm-software-vendors#and-market-forecast/.

4. CHEW, Cheah Boon; CHIANG, Kam; TAN, Wei; SINGH, Man#meet Mahinderjit. Sensors-enabled Smart Attendance Systems Using NFC and RFID Technologies. International Journal of new computer architectures and their applications. 2015, vol. 5, no. 1, pp. 19–28. ISSN 2220-9085. Available from DOI: 10.17781/P001645.

5. BRAGG, Steven. Buddy punching definition [online]. Accounting#Tools, 2020 [visited on 2020-04-18]. Available from: https://www. accountingtools.com/articles/2018/2/3/buddy-punching.

6. Types of Time Recorders [online]. Newcastle-upon-Tyne, England: workclocks.co.uk, 2020 [visited on 2020-04-18]. Available from: http://www.workclocks.co.uk/types.html.

7. Bundy Manufacturing Co. [online]. Armonk, New York, United States: IBM, 2020 [visited on 2020-04-18]. Available from: https: //www.ibm.com/ibm/history/exhibits/vintage/vintage_ 4506VV2006.html.

8. Card recorder mechanisms [online]. Auburn, New York, United

States: International Time Recording Company, 1927 [visited on 2020-04-21]. Available from: https://www.ibm.com/ibm/ history/exhibits/cc/pdf/cc_2407CED3.pdf.

9. JAIKLA, T.; PICHETJAMROEN, S.; VORAKULPIPAT, C.; PICHET#JAMROEN, A. A Secure Four-factor Attendance System for Smartphone Device. In: 2020 22nd International Conference on Ad#vanced Communication Technology (ICACT) [online]. Piscataway, New Jersey, United States: IEEE, 2020, pp. 65–68 [visited on 2020-04-22]. ISBN 979-11-88428-04-5. ISSN 1738-9445. Available from DOI: 10.23919/ICACT48636.2020.9061431.

10. GHODEKAR, Vaishali. Automated Attendance system with RFID through SMART CARD. International Journal of Engineer#ing Research Technology. 2013, vol. 2, no. 10. ISSN 2278-0181. Available also from: https : / / www . ijert . org / research / automated- attendance- system- with- rfid- through- smart#card-IJERTV2IS100739.pdf.

11. DURAKI, S.; MEHRAT, A.; DEMIRCI, S. A Mobile Application for Wireless Attendance System. In: 2019 1st International Infor#matics and Software Engineering Conference (UBMYK) [online]. Piscataway, New Jersey, United States: IEEE, 2020, pp. 1–6 [vis#ited on 2020-04-22]. ISBN 978-1-7281-3992-0. Available from DOI: 10.1109/UBMYK48245.2019.8965554.

12. MONDAY, H. N.; DIKE, I. D.; LI, J. P.; AGOMUO, D.; NNEJI, G. U.; OGUNGBILE, A. Enhanced attendance Management System: A Biometrics System of Identification Based on Fingerprint. In: 2018 IEEE 9th Annual Information Technology, Electronics and Mobile Communication Conference (IEMCON) [online]. Piscataway, New Jersey, United States: IEEE, 2019, pp. 500–505 [visited on 2020-06-27]. ISBN 978-1-5386-7266-2. Available from DOI: 10.1109/ IEMCON.2018.8614776.

13. TSAI-CHENG, Li. The study of Biometrics Technology Applied in Attendance Management System. In: [online]. Piscataway, New Jersey, United States: IEEE, 2012 [visited on 2020-06-27]. ISBN 978-0-7695-4772-5. Available from DOI: 10.1109/ICDMA.2012.223.

14. LI, T.; WU, H.; WU, T. The Study of Biometrics Technology Ap#plied in Attendance Management System. In: 2012 Third Inter#national Conference on Digital Manufacturing Automation [online].

Piscataway, New Jersey, United States: IEEE, 2014, pp. 943–947

[visited on 2020-06-27]. ISBN 978-1-4799-2361-8. Available from DOI: 10.1109/ICDMA.2012.223.

15. RON Software [online]. Karviná-Hranice: RON Software, 1992–2020 [visited on 2020-07-27]. Available from: https://www.ron.cz/.

16. GPS Applications [online]. National Coordination Office for Space#Based Positioning, Navigation, and Timing, 2014 [visited on 2021-01-08]. Available from: https://www.gps.gov/applications/.

17. MONMONIER, Mark S.; COLLIER, Peter; HARLEY, J. B.; WOOD#WARD, David; EDNEY, Matthew H. The history of cartogra#phy. Journal of Historical Geography [online]. 2015, vol. 6 [vis#ited on 2021-01-08]. Available from DOI: 10 . 7208 / chicago / 9780226152127.001.0001.

18. Trilateration Exercise [online]. National Coordination Office for Space-Based Positioning, Navigation, and Timing, 2014 [vis#ited on 2021-01-08]. Available from: https : / / www . gps . gov / multimedia/tutorials/trilateration/#:~:text=Distance% 20=%20Rate%20%C3%97%20Time,your%20location%20on%20the% 20planet..

19. [online]. Federal Aviation Administration, 2020 [visited on 2021-01-08]. Available from: https://www.faa.gov/about/office_ org / headquarters _ offices / ato / service _ units / techops / navservices/gnss/gps/howitworks/.

20. SAYS: Sriram; SAYS: David Siler; SAYS: Zinnware; SAYS: GIS#Geography; SAYS: Stanley Achieno Oguto; SAYS: Al; SAYS: Joe; SAYS: Matt. Trilateration vs Triangulation - How GPS Receivers Work [online]. 2021 [visited on 2021-01-08]. Available from: https://gisgeography.com/trilateration-triangulation-gps/.

21. Military GPS Is Not Necessarily More Accurate than Civilian GPS:

CAST Navigation [online]. CAST Navigation, 2020 [visited on
2021-01-08]. Available from: https://castnav.com/military#gps-not-necessarily-accurate-
civilian-gps/.

22. KOS, Serdjo; BRČIĆ, David; MUSULIN, Ivo. Smartphone ap#plication GPS
performance during various space weather con#ditions: A preliminary study. In:
International Symposium on
Electronics in Transport (ISEP) [online]. 2013, vol. 21 [visited
on 2021-01-08]. Available from: https : / / www . researchgate .
net/publication/236684692_Smartphone_application_GPS_
performance_during_various_space_weather_conditions_A_
preliminary_study.

23. MERRY, Krista; BETTINGER, Pete. Smartphone GPS accuracy
study in an urban environment. PloS one [online]. 2019 [visited
on 2021-01-08]. Available from DOI: 10.1371/journal.pone.
0219890.

24. RADAR [online]. Microsoft, 2017 [visited on 2021-01-08]. Avail#able from:
https : / / www . microsoft . com / en - us / research /
project/radar/?from=http://research.microsoft.com/en#us/projects/radar/6.

25. BRENA, Ramon F.; GARCÍA-VÁZQUEZ, Juan Pablo; GALVÁN#TEJADA,
Carlos E.; MUÑOZ-RODRIGUEZ, David; VARGAS#ROSALES, Cesar;
FANGMEYER, James. Evolution of Indoor Po#sitioning Technologies: A Survey.
Journal of Sensors [online]. 2017
[visited on 2021-01-08]. Available from: https://www.hindawi.
com/journals/js/2017/2630413/.

26. LIU, Hui; DARABI, Houshang; BANERJEE, Pat; LIU, Jing. Sur#vey of Wireless
Indoor Positioning Techniques and Systems. Sys#tems, Man, and Cybernetics, Part C:
Applications and Reviews, IEEE
Transactions on [online]. 2007, vol. 37, pp. 1067–1080 [visited on
2020-10-18]. Available from DOI: 10.1109/TSMCC.2007.905750.

27. LESSER, A. M.; OKONIEWSKI, M.; NIELSEN, J. A modified
fingerprinting technique for an indoor, range-free, localization
system with dynamic radio map annealing over time. In: 2012
IEEE International Conference on Wireless Information Technology and

Systems (ICWITS) [online]. 2012, pp. 1–4 [visited on 2021-01-08].

Available from DOI: 10.1109/ICWITS.2012.6417818.

28. LE DORTZ, N.; GAIN, F.; ZETTERBERG, P. WiFi fingerprint
indoor positioning system using probability distribution com#parison. In: 2012 IEEE
International Conference on Acoustics, Speech

and Signal Processing (ICASSP) [online]. 2012, pp. 2301–2304 [vis#ited on 2021-01-
08]. Available from DOI: 10.1109/ICASSP.2012.
6288374.

29. LEE, S.; KOO, B.; JIN, M.; PARK, C.; LEE, M. J.; KIM, S. Range#free indoor
positioning system using smartphone with bluetooth
capability. In: 2014 IEEE/ION Position, Location and Navigation
Symposium - PLANS 2014 [online]. 2014, pp. 657–662 [visited on
2021-01-08]. Available from DOI: 10.1109/PLANS.2014.6851428.

30. OCTAVIANI, P.; CE, W. Inventory Placement Mapping using
Bluetooth Low Energy Beacon Technology for Warehouses. In:
2020 International Conference on Information Management and Tech#nology
(ICIMTech) [online]. 2020, pp. 354–359 [visited on 2021-
01-08]. Available from DOI: 10 . 1109 / ICIMTech50083 . 2020 .
9211206.

31. YOHAN, Alexander; LO, Nai-Wei; WINATA, Doni. An Indoor
Positioning-Based Mobile Payment System Using Bluetooth Low
Energy Technology. MDPI [online]. 2018 [visited on 2021-01-08].
Available from DOI: https://doi.org/10.3390/s18040974.

32. BHATTACHARYA, D.; CANUL, M.; KNIGHT, S. Hawaii Inter#national
Conference on System Sciences. Case Study: Impact of the
Physical Web and BLE Beacons [online]. 2017 [visited on 2021-
01-08]. Available from DOI: 10.24251/HICSS.2017.516.

33. AFANEH, Mohammad. An overview of Bluetooth Beacons - Part 1
[online]. Novel Bits, 2020 [visited on 2021-01-08]. Available from:
https://www.novelbits.io/overview- bluetooth- beacons#part-1/.

34. TORRES, Santiago. Theseus: Indoor Positioning Using Bluetooth Low
Energy Beacons [online]. 1970 [visited on 2021-01-08]. Available
from: https://www.theseus.fi/handle/10024/333108.