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Wireless Communications and Application to School Attendance: A Case Study

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Abstract: Attendance and punctuality are very critical for a good operation of every organization. This paper proposes a way of taking school attendance using an android device and a web application connected via a Local Area Network (LAN). The student data are stored in an android phone which is to send attendance to the web application when the student comes into the coverage area of the LAN. The web application then displays the attendance data in an interactive interface with attendance grading.

Keywords: LAN, Wi-Fi, Android Phone, WEB Application, School Attendance, IoT

1. Introduction

Tracking is the use of various methods of workplace surveillance to gather information about the activities and locations of staff members so as to enhance efficiency of the organisation [1]. With the increasing rate of dishonesty and unpunctuality, most organizations are investing more money into staff follow-up [2]. Since the deployment of third generation networks in Cameroon, the number of people using smart phones has increased exponentially. According to Mobile Telecommunication Network (MTN) Cameroon financial statement released at the end of June 2016, the number of smart phone users in Cameroon increased to 2.6 million with a 34.1 percent increase [3]. These mobile phones are equipped with very sophisticated and useful modules as seen in [4] and can be very useful in user tracking and follow-up if properly programmed. It is pragmatic to make use of these phones for attendance and tracking of students. In fact, lateness and absenteeism are the major causes of low percentage passed and weak lessons mastery in Cameroon's schools and Universities; first year students are more affected because for most of them it is their very first time to live alone and far from the family. Advancements in technology have enabled coverage distance of wireless networks to be controllable such that a network can be confined within a limited geographic area like a building, classroom or a few blocks on the access point used [5]. This advantage is already exploited in limiting the coverage area of Wi-Fi networks and so attendance can be taken based on that. This paper is intended at producing an android based application which can be used for attendance taking in an organisation or school. The android application is a student based application which is intended to support Wi-Fi Login and attendance taking services such that the attendance of a student can be taken through the phone when he enters the intended local area network. The web application is an administrator based application which is intended to display statistical attendance data of every student on a simple-to-use interface. The two applications will function together.

The first section of this work gives a review of related work that has been done in tracking and attendance, with their advantages and drawbacks. The second section lays out the various methods used to cover the full functionalities of the system; these include the hardware and software interfaces as well as the algorithms used for the two applications. The third section reveals lucidly the implementation, tests and results obtained from this system. The last section discusses the weaknesses and strengths of the system as well as the work that can be done to improve upon the system functionality.

2. Tracking Systems and Description

There are some case studies of indoor tracking mechanisms deployed by some organizations, such as Biometric Scanners, Access Cards, Camera Video Surveillance and GPS tracking.

2.1. Biometric Scanners

Biometric Scanners are automated methods of recognizing a person based on a physiological or behavioural characteristic [6]. Among the features measured are face, fingerprints, hand geometry, iris, retina and voice. Biometric templates are difficult to reverse-engineered and recreate personal information and they can hardly be stolen and used to access personal information [6]. The most popularly used biometric scanners are the fingerprint and iris scanners. Iris scanners are becoming more common in high-security applications because people's eyes are so unique; they also allow more than

200 points of reference for comparison, as opposed to 60 or 70 points in fingerprints [7]. Iris recognition works with clear contact lenses, eyeglasses, and non-mirrored sunglasses [8]. Also, the system faces some drawbacks such as being easily fooled by a high quality image of an eye [9].

2.2. Access Cards

Another indoor tracking mechanisms deployed by some organizations is Access Cards which is similar to a credit card, containing data on an embedded magnetized strip that can electronically unlock a door or activate a machine[10]. The systems can be as small as one door controlled locally and expanded to include hundreds of doors and the potential to remotely control multiple locations. Figure 1 shows an example of an access card control system controlling multiple doors through one Host Computer.
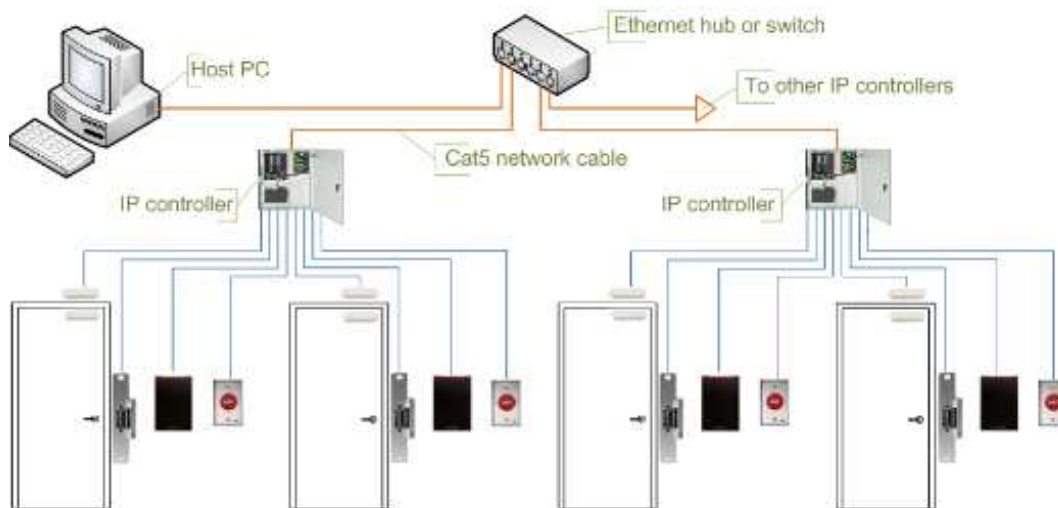

Figure 1. Access Card Control system [11].

As limitations, this access control systems can be hacked since they use magnetic tape to store information about the user; logging in with the card does not guarantee that the access card holder is the one logging in since another person can login using the same access card; it can also be stolen and used to login. It is very costly to install and manage.

2.3. Camera Video Surveillance

Video Surveillance is also used as a tracking mechanisms deployed by some organizations. With their wide range of styles and features, security cameras are common in most industries around the world. By combining advanced camera features with outdoor housings or discreet camera design, an IP camera can be installed in almost any location. This makes them ideal for monitoring inside and outside of businesses and offices, recording in remote locations, or recording high quality video to identify suspicious people.

Some advantages of the video surveillance system include the fact that surveillance feeds can be accessed from anywhere on internet which is very convenient. In addition to attendance taking, the footages and audio can be used to detect crime like

theft or harassment. This system also faces some drawbacks. Some of which include its high cost; also, the camera security always cause privacy issues in an organization which some employees find unacceptable.

2.4. Ctrack Outdoor Vehicle Tracking System

Ctrack Outdoor Vehicle Tracking System is an Australian company that specializes in providing GPS vehicle tracking solutions to fleet operators across Australia [12].

Figure 2. CTRACK geo-positioning structure [12].

They provide real time GPS vehicle tracking and fleet management systems that can be customized to suit fleet specific needs. Figure 2 shows the structure of the Ctrack vehicle tracking system.

An Employee's vehicle is equipped with a GPS tracking device which sends the location of the car at all times to the company's main server through cell towers or through satellite service. The data is then sent to the specific client network and can be used to monitor his Employees. As advantages, this system keeps track of Employees and so helps to curb employee excessive use of vehicles and time for personal purposes. It can keep track of Employee driving habits and help to clamp down Employees who consistently over speed.

An overview of the attendance tracking systems used all over the world has been presented above. Their advantages as well as their disadvantages have also been presented. In the following section the design method for the LAN-school attendance system using an android and web application will be presented.

3. Methodology and Design

This LAN-school attendance system will use the Waterfall software development model defined in [13] which divides a software application life-cycle into requirement analysis, system design, implementation, testing, deployment and maintenance. This section will focus on the requirement analysis and system design.

3.1. System Analysis

For complete functionality of this system, several requirements are mandatory both for the mobile (android) side and the server side of the application. The android device is to pick up the specific Wi-Fi SSID and send attendance to the server automatically through the Local Area Network. For this to be fully operational, the android device is to support Wi-Fi equipped with WPA encryption standard. This encryption standard was released in 2003 by the Wi-Fi Alliance and the android devices released after that can support the standard [14]. The phone (through the application) should be able to automatically connect to the LAN and send attendance data with the student identification number. The server receiving this data will record the sending time of the data along with the student identification information. The server is to store data in the form of text and therefore will be a light weight server. The LAN coverage area is supposed to be limited to the geographical area corresponding to the classroom vicinity. This will require specific Access Points configured with specified properties so as to meet this need.

3.2. System Requirements

Tables 1, 2, 3 and 4 show the hardware, communication and software interfaces needed for the system.

- *Software interfaces*

Table 1. Web Application Software Interfaces.

Software	Details
Application Server	Apache
Database	MySQL
Web Browser	All Browsers
Languages	PHP, JavaScript, HTML5, CSS
Framework	Laravel

Table 2. Android Application Software Interfaces.

Software	Details
Database	SQLite
Languages	Java, xml
IDE	Android Studio

- *Hardware interfaces*

Table 3. Android Device Hardware Interfaces.

Hardware Name	Details
Android Version	Version 3.0 and above
RAM	500MB
Hard disk	100MB

Table 4. Server Hardware Interfaces.

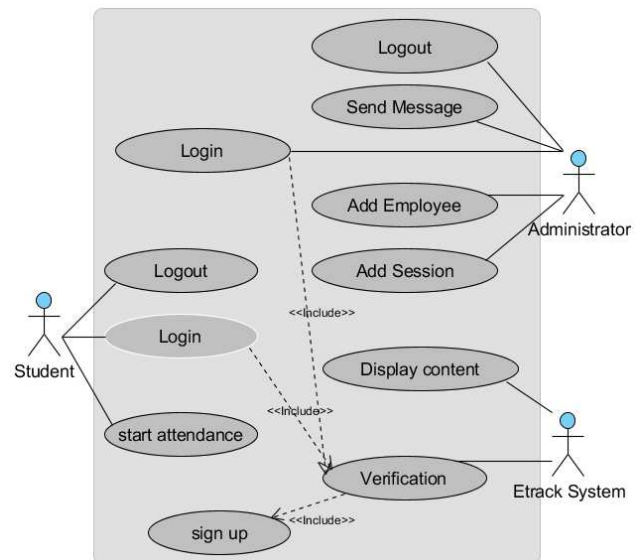| Hardware Name	Details
RAM	8GB
Hard disk	5GB

Figure 3. Etrack use case diagram.

- *Use Case Diagram*

Use case diagram represents the functionality of the system from the user's point of view. Use case diagrams are used to show the functionality that the system will provide and to show which users will communicate with the system in some way to use that functionality. It also shows the actors of a system and their different functions. An actor is represented by a stick figure while functions are represented by an ellipse. Figure 3 displays the use case diagram for the system drawn on Visual Paradigm 10 software. There are three actors in the system: the student (or employee), the lecturer (or employer) and the Etrack system. The student is a verified user who has

the android application running on his mobile phone. He can log into the system and start recording his attendance. He can as well logout from the system if he does not want his attendance to be taken. An administrator (Lecturer or Employer) is also a verified user who has the ability to view attendance of all students/Employees through the built web interface. He has the ability to send messages to students/employees, add new sessions to the system and also add new students/employee data into the system. This Etrack system verifies a user and the administrator. It also displays the database data in a simple and interactive interface including session addition, user addition and message sending.

- *Database Structure*

The model used to structure the database is a hierarchical model which organizes data in a tree structure. There is a hierarchy of parent and child data segments which are linked together by links called foreign keys. The various records are divided into tables in the relational model and the individual records are called rows. To create links between these record types, the hierarchical model uses Parent Child Relationships which are mainly one to many mapping relationships. Figure 4 shows the relational database structure designed for this system. This is a simple database structure which is easier to manage and queries can be done much easier than other structures because of its hierarchical structure. Tables 5 to 9 show the details of the various tables created in the database. The size limitation of every field is presented in the Type column in brackets.
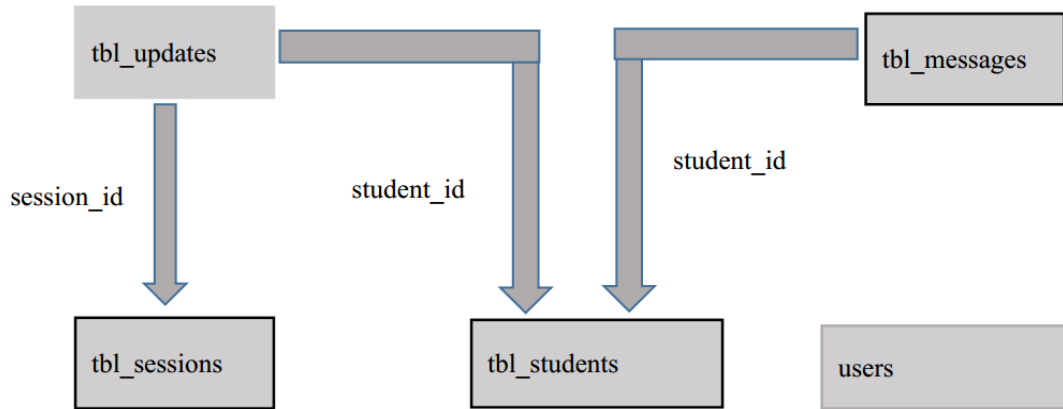

Figure 4. *Relational Database structure.*

Table 5. *tbl_student.*

Column Name	Type	Properties
id	int(4)	primary,auto_increment,
student_name	varchar(40)	
student_id	varchar(10)	unique
student_email	varchar(30)	unique
student_password	varchar(50)	

Table 6. *tbl_updates.*

Column Name	Type	Properties
id	int(11)	primary,auto_increment
student_id	int(11)	foreign key(tbl_student id)
Session_id	Int(11)	foreign key(tbl_sessions id)
created_at	timestamp	
updated_at	timestamp	

Table 7. *tbl_messages.*

Column Name	Type	Properties
id	int(11)	primary,auto_increment
student_id	int(4)	foreign key(tbl_student id)
title	varchar(50)	
message	varchar(500)	
alldata	int(1)	
created_at	timestamp	
updated_at	timestamp	

Table 8. *Users.*

Column Name	Type	Properties
id	int(1)	primary, auto_increment
admin_name	varchar(30)	
admin_email	varchar(30)	unique
password	varchar(50)	

Table 9. *tbl_sessions.*

Column Name	Type	Properties
id	int(11)	primary,auto_increment
Start_time	datetime	
End_time	datetime	
Created_at	timestamp	
Updated_at	timestamp	

This section has laid down the various designs that will be used in system implementation. It has also presented the various hardware and software interfaces needed for proper functionality of the system. The next section will be about the implementation of these designs and the various tests carried out to validate the system.

4. Implementation, Tests, Results and Discussions

This section exposes the various methods used in the

system implementation as well as the various forms of testing done to assert its validity. The results of the system after implementation and testing are also explained in details in this section along with some discussions on its functionality.

4.1. Implementation

The system design was realised with Visual Paradigm 10.0 and implementation was done on Android Studio and Sublime text using Windows 8-64bits operating system. The system contains two separated but connected modules which run on different Operating Systems.

a - The first module runs on Android operating system in an Android mobile device and is in charge of sending user attendance to the web module. This module is implemented on Android Studio using Java and XML programming languages.

b - The second module runs on Windows 8 operating system which acts as the Server (back end) of the application and also provides the user interfaces (front end) for user interaction with Server. The module was implemented with the help of the Laravel Framework and the programming languages used were PHP, JavaScript, CSS and HTML5.

Table 10 shows the various tools that were used in the implementation for both the web and the android application.

Table 10. *Tools Used.*

Case	Tool/Language
Programming Environments	Android Studio, Sublime text
Programming Languages	Java, XML,PHP, JavaScript, HTML5, CSS
Framework	Laravel
Design Tools	Visual Paradigm 10.0

4.2. Tests

The first module(android application) was tested using an emulator of android studio running on android version 6.0 Operating System followed by an actual device running on Android version 4.1 Operating System. The following tests were carried out.

a. Automatic connection to configured access point.
b. Timing service for automatic update of attendance when user is within the LAN.
c. Actual attendance sending with student id inclusive.

The testing on module two (web application) was done using a computer running on Windows 8 operating system. Firefox, Google Chrome and Windows Explorer browsers were used. The following functionalities were tested.

a. Adding of new sessions.
b. Sending of messages to all or some students
c. Viewing of statistical data on attendance.
d. New students Addition.

4.3. Results

The following section shows the various interfaces obtained at the end of the implementation and testing of the system.
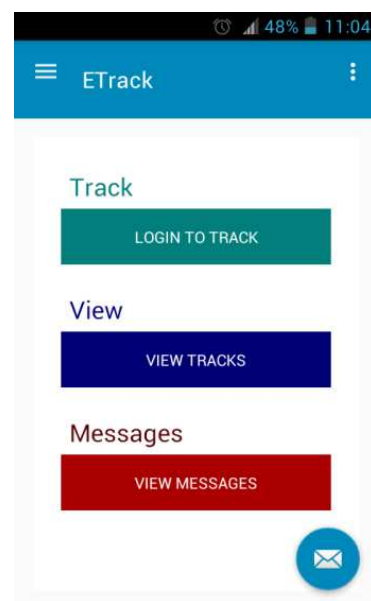
- Android Application Views

Figure 5-(a) is the home view of the android application

taken on Android Version 4.1.2 which is the first page when application is launched. Figure 5-(b) is the login screen which permits a user to log into the Local Area Network when application is first installed. This is to get the user (student) identification information into the local database to be used for attendance taking.

Figure 6-(a) shows the view used to commence attendance taking during a session. The ''START ATTENDANCE'' button is pressed to take attendance for a particular session (in this case, student attendance is sent immediately rather than waiting for regular timing update).

Figure 6-(b) is the Message home view which shows in short all messages that have been received from the student starting with the most recent one. It displays the title of the message, the date, time sent and the message body.
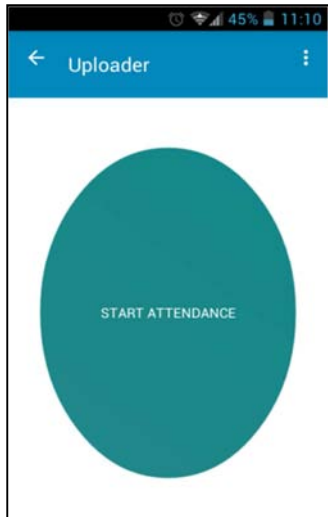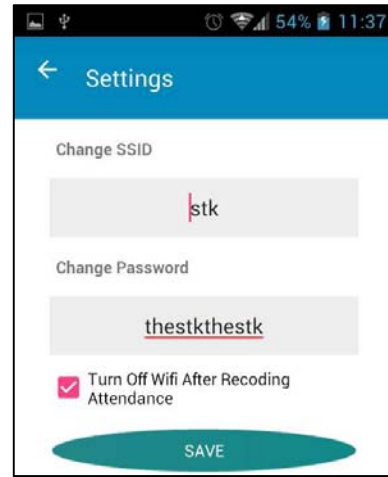

(a) Android Home View
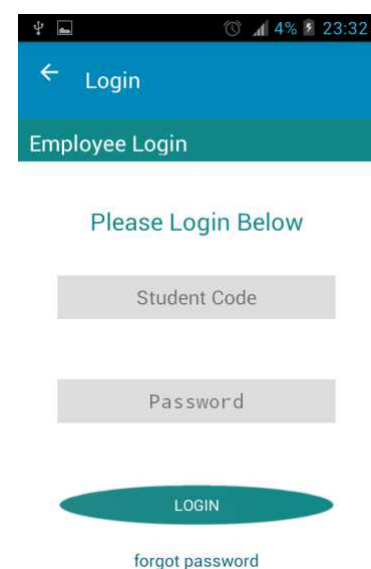
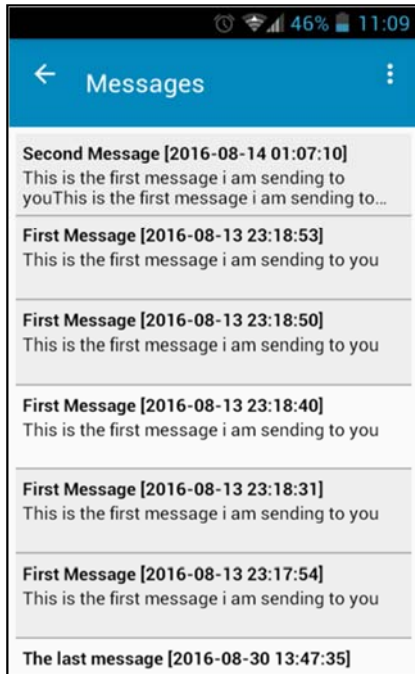

(b) Login view

Figure 5. *Android Application Views.*

(a) Start Attendance view

(b) Message Home View

Figure 6. *Student attendance sub-system interfaces.*

(a) Message Detail View

(b) Settings View

Figure 7. *Message Details and Settings views.*
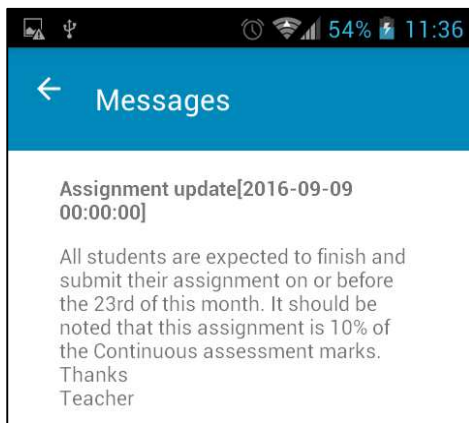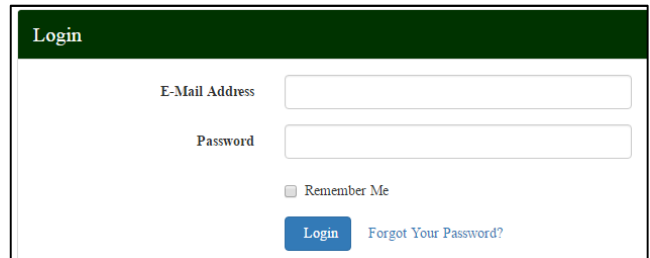
- Web Application Views
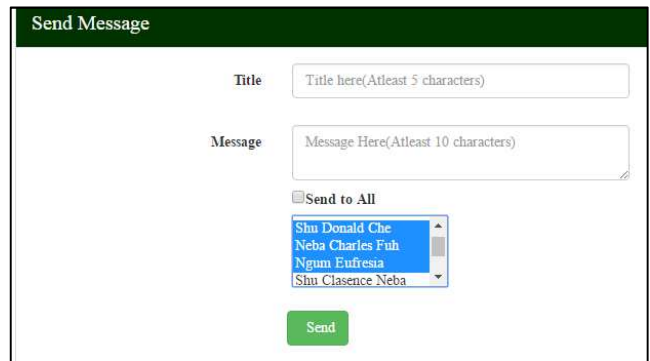

Figure 8. *Login Screen for Etrack.*

Figure 9. *Message Screen.*

Figure 7-(a) shows the details of a message when the message is tabbed on the message home screen. Figure 7-(b) shows the settings view. This page is used to set the SSID and the password of the Local Area Network generated by an access point. This view also provides an option to turn off the Wi-Fi after taking attendance. This option helps in battery conservation since Wi-Fi consumes a lot of energy.

Figure 8 is the Login screen for a lecturer. A lecturer who is logged in can perform all tasks supported by this web application. A person who is not logged in can only view the home screen of the application.

Figure 9 is the Message Screen used by a logged in lecturer to send messages to all students or to specific students.

Figure 10. Add student screen.

Figure 11. Add new Session View.

Figure 10 shows the page used to add a new student into the Etrack database. Input information includes the student name, student Identification number and his email address. Figure 11 presents the user interface used to add a new session to the database and also to view the recently added session to the database. Figure 12 displays the attendance details of every student in a session.

Figure 12. Daily attendance page.

These details include the time the student came in and when he left the LAN, the number of students who were present for the session and the date and time when session started and when it ended. The colors on the screen show the degree of lateness of a student; their programming nomenclature is presented in Table 11.

Table 11. Colours programming nomenclature.

Color	Meaning
Early	Between 0 and 20 minutes late
Late	Between 20 and 30 minutes late
V.Late	Above 30 minutes late
Absent	No attendance was taken for session

Figure 13 shows the total attendance statistics for all students. This includes the total number of sessions that have held and the number of times the student has attended.
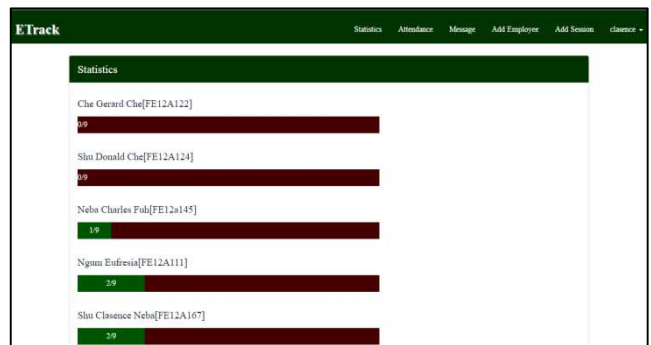

Figure 13. Statistics view.

5. Conclusion

The android application as expected automatically turns ON Wi-Fi services in a phone, connects it to the configured network and sends attendance to the LAN concerned. These functionalities were accomplished along with the messaging. The web application was also expected to display the content of the attendance database in an easy-to-use interface which also provides interfaces for adding new students, adding new sessions and sending text messages. These functionalities were fully realised with a user friendly interface as shown in section 4.

This paper has provided another way of utilizing the rich content of mobile devices for attendance taking in order to curb cost while enhancing simplicity. Students always have their phones on them and so they can be used to take their attendance in school. This system can be applicable in other scenarios like meetings attendance taking, company or organisation attendance taking, and automatic opening of gates or doors by verified users. Despite the limitations of the system like user forgetting his/her phone, misplacing the

phone, forgetting to turn ON Wi-Fi on time, a limited number of phones able to be connected at the same time to the computer and also sending somebody else with his/her phone, the system still remains a viable option in many cases especially if the following improvements can be made.

Adding alarm service to both student and lecturer on the next scheduled sessions. This service will be able to use the session data set by the lecturer to notify students and the lecturer of next coming sessions.

Adding interactive and bidirectional messaging between student and lecturer and amongst students across the LAN. File sharing can also be implemented across the LAN.

Incorporating fingerprint recognition with the android phone in order to assert that the user starting the attendance is actually the verified user.

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