AUTOMATIC ATTENDANCE MANAGEMENT SYSTEM USING BLE TECHNOLOGY

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Abstract— In most of the educational institutions around the world, a minimum attendance requirement is a criteria and hence teacher should manually record the attendance of the students presence in the class. This work presents a design and framework for taking attendance in college at the end of every period within the classroom, for making troublesome process of taking and compiling of attendance simple and efficient. This system uses the Bluetooth Low Energy (BLE) 4.0 technology of beacons which communicate with an android mobile using an application. The android application will compare the data of the BLE device with its background mobile database. This system can also be used maintain attendance of Employees or workers in an organization and finding books in a library.

Keywords— Attendance, Bluetooth Low Energy (BLE), Beacons, Android application, Database

1. Introduction:

In every educational institutions, after completion of a class the respective teacher should take attendance at the end of every period which is time consuming and inaccurate. Hence there is a need for automation of the attendance management system. This work is using Bluetooth Low Energy (BLE) 4.0 technology. *E*very authorized student is allocated a unique MAC ID of beacon which can communicate with an android application database. Bluetooth Low Energy (BLE) technology can deliver accurate and precise data about scanned beacons that improves efficiency and this ability will bring many other benefits most importantly it helps in better management of the classroom attendance management system.

After completion of the class, the teacher switches on the android application and click on scan devices then after completion of scanning then click on view absentees list then automatically shows the absentees list with their respective roll numbers and names. This attendance management system can also adapt for attendance of employees in organizations and industries. Bluetooth low energy (BLE) module consumes low power 0.5 watts so life time nearly one year.

2. Bluetooth Technology:

Wireless LANs can be designed in many different ways depending on their applications, one kind is a wireless Ad-hoc network. An Ad-hoc network is a peer to peer network is a peer to peer network set up temporarily to meet intermediate need. In contrast to the majority of radio systems used today, it doesn't have centralized server. An Ad-hoc radio systems have been in use for sometime for example walky-talky systems are broadly used by police, military and fire departments. However Bluetooth system is first commercial Ad-hoc radio systems envisioned to be used on a large scale and widely available to the public.

The Bluetooth radio system began as an idea of Ericsson mobile communication in 1994, but today, it is the result of the joint effort of many large companies. The Bluetooth system is named after Harald Blat and a tenth- century Danish Viking king, who united Denmark and Norway. The name was adopted because Bluetooth wireless technology is expected to unify the telecommunication and computing industry. The main aim of Bluetooth is to widely available, inexpensive, convenient, easy to use, reliable, small and low power.

The Bluetooth network, which includes all the slaves and master is called a piconet. An FH Bluetooth channel is associated with the piconet channel by providing the hop sequence and the hop phase. All other units participating in the piconet are slaves. However, since the Bluetooth is based on peer communications, the master/slave role is only attributed to a unit for the duration of the piconet, the master also controls the traffic on the piconet. When the piconet is cancelled, the master and slaves roles are cancelled too. In addition to defining the piconet, the master also controls the traffic the traffic on the piconet and takes care of access control. The time slots are alternatively used for master and slaves transmission. In order to prevent collisions on the channel due to multiple slave transmissions, the master applies a polling technique, for each slave to master slot the master decides which slave is allowed to transmit. If the master has no information to send, it still has to poll the slave explicitly with a short poll packet. This master control effectively prevents collisions between the participants in the piconet, but independent collocated piconets may interfere with one another they occasionally use the same hop carrier. This can happen because units don't check for a clear carrier (no listen-before-talk). If the collision occurs, data are retransmitted at the next transmission opportunity. Due to the short dwell time, collision avoidance schemes are less appropriate for FH system.

Bluetooth devices operate at 2.4GHz, in the globally available, license-free, ISM band. The bandwidth reserved for general use by Industrial, Scientific and Medical applications worldwide. Since ISM band provides about 80MHz of bandwidth and all radio systems are band limited, there is a high probability that a part of the spectrum can be found without a strong interference.

2.1 Bluetooth Low energy Technology:

Bluetooth Low Energy (BLE, also marketed as Bluetooth Smart) started as part of the Bluetooth 4.0 Core Specification. Bluetooth Low Energy is a new technology which is very best technology for this application because as compared to classic Bluetooth it reduces power consumption (0.01-0.5w) and cost. Most of the mobile operating systems support Bluetooth Low Energy including

android**.** This Bluetooth Low Energy technology supports privacy, which allows a device to use private addresses and it can frequently change them as it has very tight security with 128-bit AES (Advance Encryption Standard) data encryption. This mechanism generates a short term key which is matched to the device and after which , a three 128-bit keys are generated for further communication among the devices.

Bluetooth specification covers both classic Bluetooth (which is used by wireless standard technology in many consumer devices for a number of years now) and Bluetooth Low Energy (the new, highly optimized wireless standard introduced in Bluetooth 4.0). These two wireless communication standard technology are not directly compatible.

The on-air protocol, the upper protocol layers, and the applications are different and the Bluetooth specification (4.0 and above) defines two wireless technologies.

BR/EDR (classic Bluetooth): The wireless standard that has evolved with the Bluetooth Specification since 1.0.

BLE **(Bluetooth Low Energy):** The low-power wireless standard introduced with version 4.0 of the specification.

And these are the two device types, those can be used with these configurations: **single mode** *(BLE, Bluetooth Smart) device*: A device that implements BLE, which can communicate with single-mode and dual-mode devices, but not with devices supporting BR/EDR only**. Dual mode** (BR/EDR/LE, Bluetooth Smart Ready) device: A device that implements both BR/EDR and BLE, which can communicate with any Bluetooth device.

2.2 BLE Protocols:

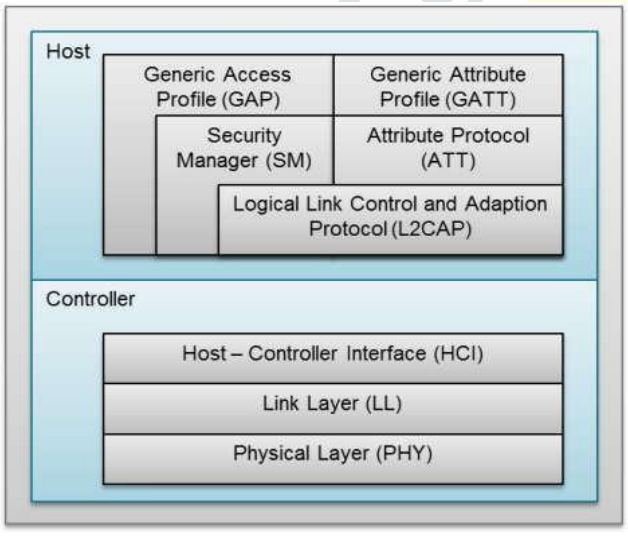

Figure 2.1 Bluetooth protocol stack basis

The Bluetooth Low Energy protocol provides stack and provides a list of APIs to interface with the protocol stack. The stack project and its associated files serve to it implement the Bluetooth low energy protocol most of the Bluetooth Low Energy protocol stack is object code in a single library file (TI does not provide the protocol stack source code as a matter of policy). A developer must understand the functionality of the various protocol stack layers and how they interact with the application and profiles. The version of 4.2 of the Bluetooth specification allows for two systems of wireless technology: Basic Rate (BR: BR/EDR for Basic Rate/Enhanced Data Rate) and Bluetooth Low Energy. The Bluetooth Low Energy system was created to transmit small packets of data, while consuming significantly less power than BR/EDR device.

2.3 BLE Beacons:

A beacon is a small Bluetooth radio transmitter, powered by batteries. Beacons are similar to a lighthouse in functionality. These small hardware devices incessantly transmit Bluetooth Low Energy (BLE) signals. The Bluetooth enabled smart phones are capable of scanning and displaying these signals. A beacon is a small Bluetooth radio transmitter, powered by batteries. Beacons are similar to a lighthouse in functionality. These small hardware devices incessantly transmit Bluetooth Low Energy (BLE) signals. The Bluetooth enabled smart phones are capable of scanning and displaying these signals. Central**:** the Computer/Tablet/Mobile device, also referred as GATT client. Scans, requests and uses the data given by the peripheral. Peripheral**:** the device broadcasting the data, also referred as GATT server. The data is structured as definitions of how to interact with its database**'**. Services**:** set of provided features and associated behaviors to interact with the peripheral. Each service contains a collection of characteristics. Characteristics**:** definition of the data divided into declaration and value. Using permission properties (read, write, notify, indicate) to get a value. Descriptor**:** an optional attribute nested in a characteristic that describes the specific value and how to access it.
UUID**:** Universally Unique ID that are transmitted over the air so a peripheral can inform a central what services it provides.

2.4 How BLE works:

Figure 2.2 BLE working

3. Hardware Components:

3.1 NRF51822 module(BLE Beacon):

Nordic Semiconductor nRF51822 Bluetooth low energy & 2.4GHz Wireless SoC offers a multiprotocol SoC suited for Bluetooth low energy and 2.4GHz ultralow-power wireless applications. Nordic Semiconductor nRF51822 Bluetooth low energy and 2.4GHz wireless SoC uses a 32-bit ArmCortexM0 CPU with 256KB flash and 16KB RAM.
The embedded 2.4GHz transceiver supports Bluetooth low energy and 2.4GHz operation, where the 2.4GHz mode is on air compatible with the nRF24L series products from Nordic semiconductor. A rich selection of analog and digital peripherals can interact without CPU intervention through the programmable peripheral interface(PPI) system.
It supports the S110 Bluetooth low energy protocol stack as well as 2.4GHz protocol stacks, including Gazell, both available free of charge in the nRF518 software Development kit.

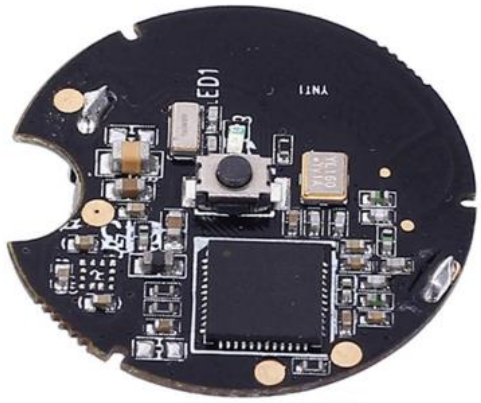

Figure 3.1 NRF51822 BLE module

NRF51822 requires a single power supply and gives the user the option of using on-chip linear regulators giving a supply range of 1.8V to 3.6V, a direct 1.8V mode and an on chip DC-DC buck convertor giving a supply range of 2.1V to 3.6V.

NRF51824 is an auto grade AEC-Q100 qualified Bluetooth low energy SoC ideal for intelligent automotive applications that may include alerts, collision detection, control and telemetry, wireless charging and infotainment.

3.2 CR2032 Coin Cell(Power supply):

Lithium button and coin cell batteries, such as the CR2032, are used to power small portable electronic devices such as wrist watches, pocket calculators, hearing aids etc..

Button and coin cell batteries are typically 5-25 millimeters in diameter and 1-6 millimeters in height. Lithium sizes can be determined from their reference numbers. The first two digits refer to the diameter of the battery in mm and second two digits give the height of thickness of the battery in tenths of mm,

Lithium batteries cost a bit more than alkaline, but last longer, weigh less and can operate in a much wider temperature range(extreme heat and extreme cold) compared to alkaline batteries.

CR2032 Lithium ion coin cell battery is used for NRF51822 Ble module which is durable for almost an year.

Battery	Size Diameter x Height	Nominal capacity mAh	Voltage Range	Cost
CR1220	12.5mm x 2mm	40 mAh	3.0 – 2.0V	$0.9
CR1620	16.5mm x 2mm	75 mAh	3.0 – 2.0V	$0.98
CR2032	20mm x 2mm	220 mAh	3.0 – 2.0V	$0.34
CR2450	24.5mm x 2mm	620 mAh	3.0 – 2.0V	$1.19

Table 3.1 Different coin cell batteries

Figure 3.2 CR2032 lithium ion coin cell

4. Software Tool:

4.1 Android studio:

Androidcomes with its Software Development Kit (Android SDK). The SDK provides the developers the API (Application Programming Interface), libraries and developer tools necessary to build, test and debug applications. The IDE used for the development of this Application is Android Studio developed by Google.

Figure 4.1 Android studio

It is the official integrated development environment (IDE) for Android Platform Development. Android Studio software which is available in this link (https://developer.android.com/studio/index.html)

Android applications are developed in JAVA hence, JDK (JAVA Development Kit) is another requirement for the compilation of the code for the application. (http://www.oracle.com/technetwork/java/javase/downloads /index.html)

SQLite is a software library that provides a relational database management system. The lite in SQLite means light weight in terms of setup, database administration, and required resource. SQLite has the following noticeable features: self-contained, server less, zero configuration, transactional. Server less: Normally, an RDBMS such as MySQL, PostgreSQL, etc., requires a separate server process to operate. The applications that want to access the database server use TCP/IP protocol to send and receive requests. This is called client/server architecture. SQLite database is integrated with the application that accesses the database. The applications interact with the SQLite database read and write directly from the database files stored on disk.

5. METHODOLOGY:

Every authorized student will be given with a unique BLE module incorporated in the uniform using wearable Technology.

At the transmitting side, BLE module continuously sends the data to the receiver like device name, MAC Address, UUID, RSSI, Heart rate.

At the Receiving side, the Android mobile scans for the active BLE modules which are advertising the signals is stored in android database i.e., SQLite data base. In the background, the dynamic BLE MAC Address is matched with the static student's data in the same data base and absentees list given at the output. So that faculty can take down the list of absentees in an efficient manner.

The static student's attendance can be managed such as adding the student's data, view the total students of the class, updating the individual student data for correcting and deleting the individual student data.

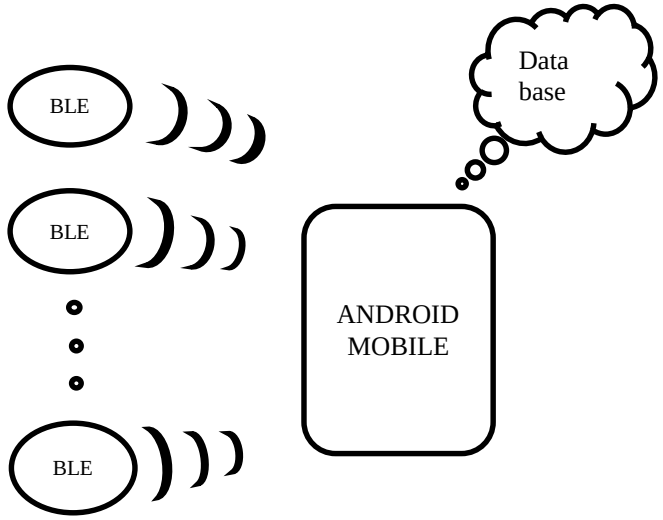

Figure 5.1 Block diagram

5.1 Algorithm:

Step 1: Install Attendance Marker Application in your Mobile.
Step 2: Open the Application.
Step 3: Press " GO " button in the application for Scanning the Students in the class.
Step 4: Wait for the Progress bar to fill i.e., Scan for Active BLE devices or students.
Step 5: After the Progress bar is filled, you will be taken back to Previous Activity.
Step 6: Press " View Absentees " button to view the list of Absentees of the class.
Step 7: Press " Static Database " button to manage the Static the student data of the particular class.
Step 8: Enter the particular students name, MAC id and roll number in the fields and Press " Add " button to add the particular student data.
Step 9: Press " View " button to view the total students of the particular class.
Step 10: Enter the Students data such as name, MAC id and roll number in the fields and Press " Update " button to update the data of the Particular roll number associated student's data.
Step 11: Enter the roll number and Press " Delete " button to delete the Particular roll number associated student's data.
Step 12: Press " Click " button for viewing the General instructions in the Application itself.

5.2 FLOW CHART:

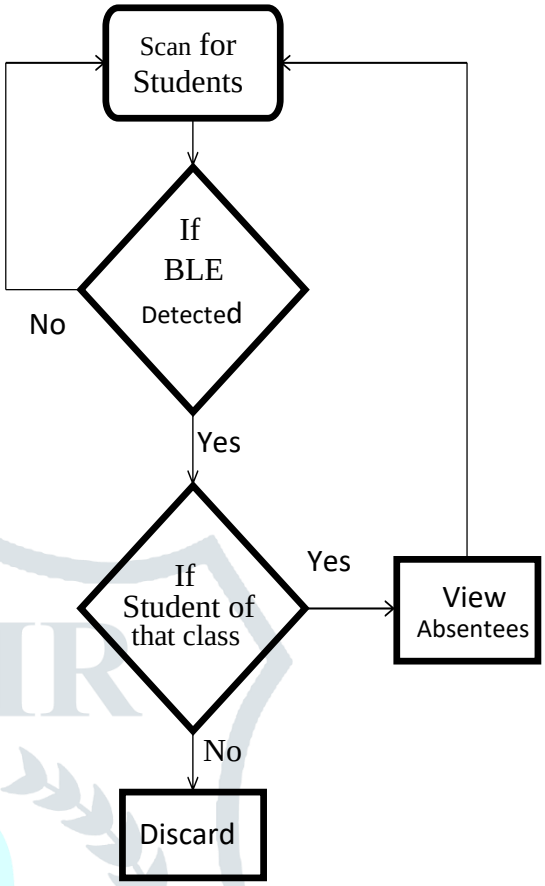

Figure 5.2 Flow chart

6. Results obtained:

- Application looks like:

Figure 6.1 Application Icon

- When the Application is opened, it asks us to enable the Bluetooth if it isn't enabled.

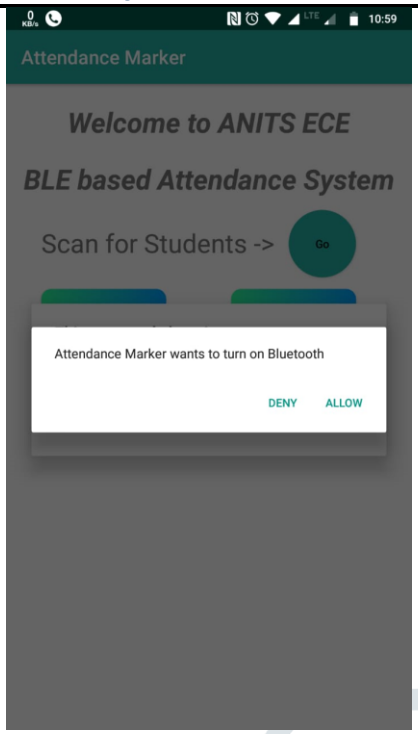

Figure 6.2 Pop up for enabling Bluetooth

- It also asks for location Access to be enabled.

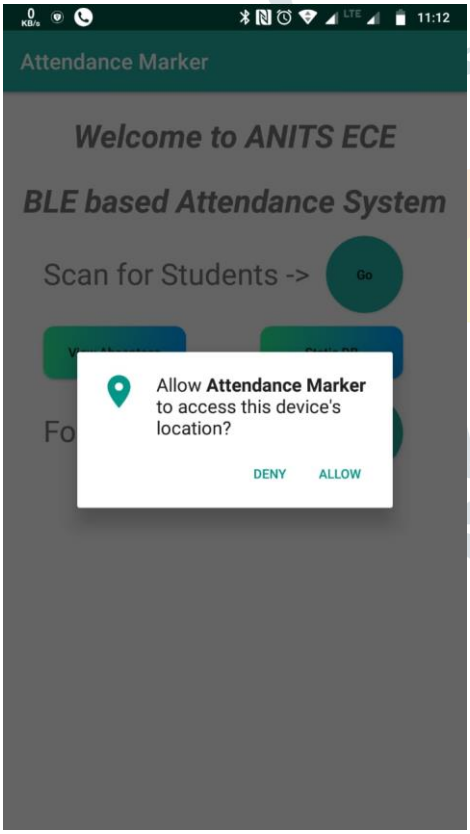

Figure 6.3 Pop for enabling location access

- Main Screen looks like

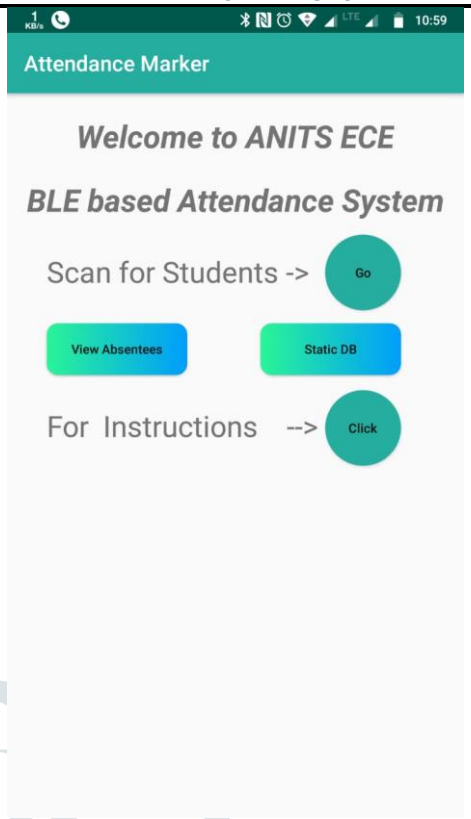

Figure 6.4 Main screen when App opened

- After clicking "GO " button it scans for Active BLE devices or students

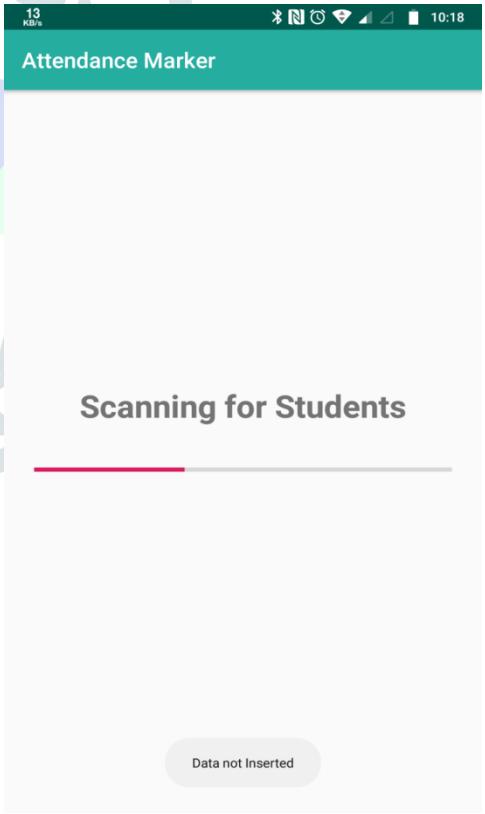

Figure 6.5 Scanning for students

- Adding Students's data into Static table in the database

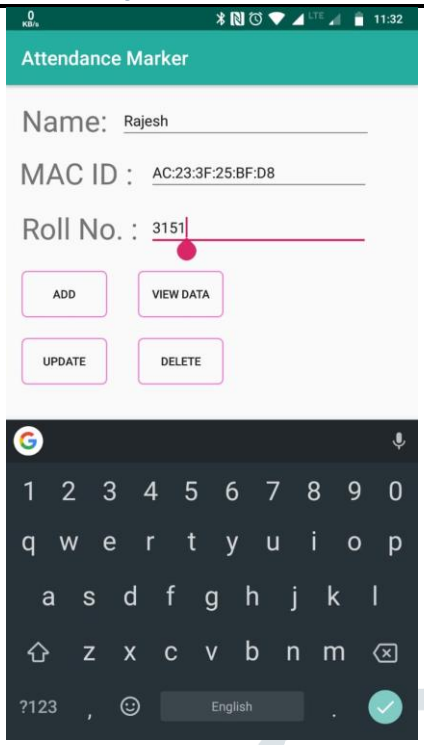

Figure 6.6 Entering user data into the table

- After pressing "view" button

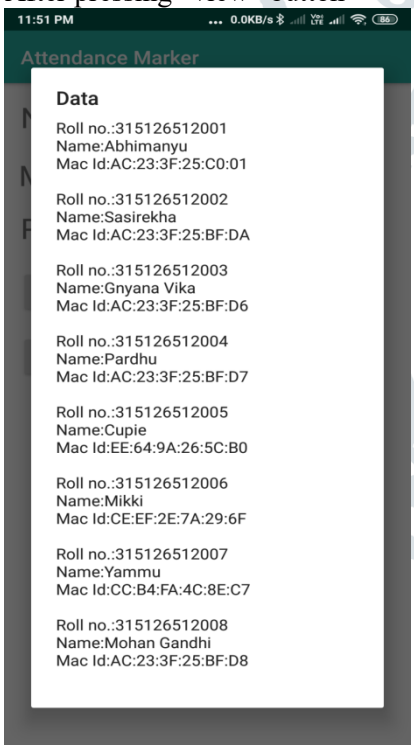

Figure 6.7 Viewing data in the static table

- The final result the list of absentees after pressing "View Absentees" button

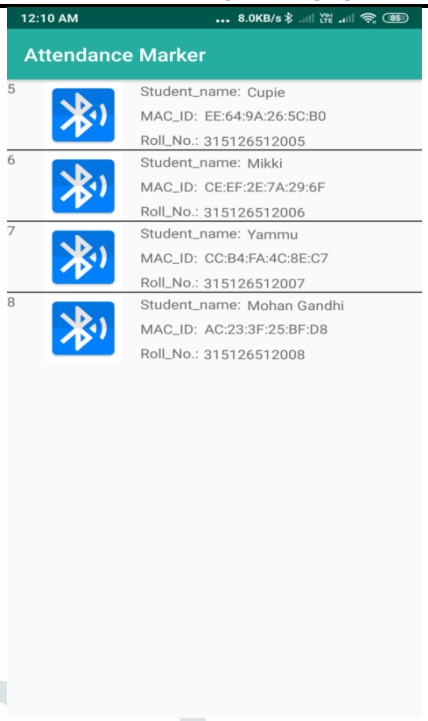

Figure 6.8 The list of Absentees after populting

- After pressing "Click" button

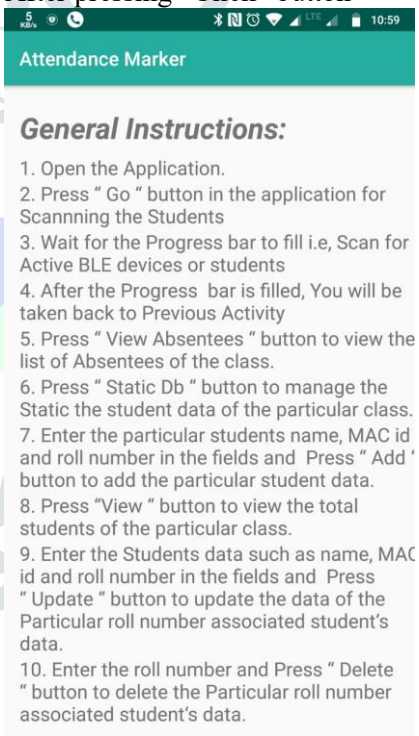

Figure 6.9 General instructions

7. Conclusion:

This work is done with the help of NRF51822 BLE module, Android studio and Android mobile. It's Aim is to detect the students with in the classroom and mark's their Attendance. It displays the students roll numbers who were not present in the classroom i.e, Absentees. Thus it automatically mark the attendance of the students with in the classroom. We have Observed that this technology can give a Scanning range of approximately 20 meters which is advantageous compared to RFID. It can be extended for implementation in the Schools, organization etc.. It can also be implemented to find books in the Library.

In the world of Automation, This Automatic Attendance management system is the future scope for taking Attendance in schools, colleges, educational institutions and organizations. This technology can replace almost all the RFID based technologies such as large godown inventory management, Automatic Boom barrier motion etc.. which are of more costlier than BLE based technologies.

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