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Radio Frequency Identification based Attendance Management System

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ABSTRACT

Over the years, Radio frequency identification is an emerging technology that has wide applications in various sectors directly or indirectly useful to mankind.

RFID uses electromagnetic fields to automatically identify and track tags attached to objects.The tags have a memory to store information. Passive tags are battery-less the possess energy from interrogating radio waves and active tags have inbuilt power source (such as battery) that may operate hundreds of meters from the RFID reader.

As a result of the challenges of the manual method of taking attendance in schools and colleges, an automated attendance system needs to be adopted. These challenges include difficulty in maintaining / keeping the attendance list over a long period of time, unnecessary wastage of time during writing or signing, improper documentation, students / employees forgetting to write or sign the attendance paper, lecturers forgetting the attendance list in the classroom, students writing or signing illegally for an absentee among others, employees buddy punching for another who is not present.

This paper implements RFID based attendance management system which many functionalities like registering students / employee, recording their attendance, generating weekly or monthly statistical reports for administrators. This system will eradicate the deficiencies associated with the manual attendance system with an automated system implemented through RFID technology.

Keywords Radio Frequency Identification, Attendance, RFID

I. INTRODUCTION

RFID, stands for Radio Frequency Identification, is an automatic identification technology used for retrieving from or storing data on to RFID Tags without any physical contact.

RFID chips or tags generally don't need a battery as they draw power from whatever happens to be reading them run of the mill credit cards and wrist bands are classified as passive. They consist of a tiny antenna, embedded CPU to process radio waves and a small amount of data storage (a few KB of data) in order to keep power consumption low enough to be able to be powered by a reader. In today world people don't need more than a few KB of storage for the RFID to be useful tool. For example, some cars have RFID tags so that they can be recovered if someone tries to steal it, casino have RFID in their chips to prevent people from committing fraud, Paperless ticketing for events, unlocking hotel rooms, travelling on monorail, buying merchants at an amusement park.

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Industries, Organizations and Educational institutions are concerned about students / employee's irregular attendance. The existing attendance system is manual, and it is taken on paper and it consumes lot of time. Traditionally an "Attendance system" uses attendance registers to note down the attendance. The main limitation of traditional attendance system is wrong attendance can be entered. For example, in an industry, there are chances that an employee can enter incorrect login logout time (intentionally or non-intentionally). They may arrive at the office at 11 am and can enter 8 am. In colleges one student can give proxy attendance of another student. Probability of this is very less but it does happen. In order to avoid these problems, we have implemented automated attendance system using RFID technology.

Thus, it is a RFID based attendance management system. In this system each user, student or employee will be given a RFID card. The Reader is placed at doors or entry gate of company, office or schools. The card is then placed on the RFID reader. Then the RFID reader, reads the unique identification number of RFID card and the time at which the employees / student has checked in. And in the same manner while leaving employee / student must show the card. So, the exit time will be noted.

II. EVOLUTION OF RADIO FREQUENCY IDENTIFICATION

The success of RFID technology centers on the advent of radio technology.

1. *World War II* – The first use of RFID was used in World War II. British tracked and identified aircrafts making the first RFID system.

2. *First RFID Tag* – Mario W Cardullo received the first US patent for an active RFID Tag.

3. *UHF (Ultra-)* – In the mid 1990's the first UHF reader was invented with a 20-foot read range and faster data transfer.

4. *Wal Mart* – Wal-Mart spent up to $500,000,000 on their initial RFID programs.

5. *Cost per Tag* – On average an RFID tag costs 7-15 cents and companies received around a 200% ROI.

6. *RFID Market* – The RFID market is projected to grow to 24.5 billion USD.

7. *Price Drop* -- The price is predicted to drop down to 5 cents per RFID tag.

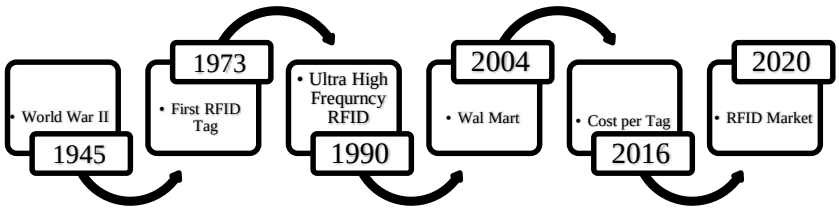

Fig. 1. Evolution of Radio Frequency Identification Technology

Fig. 2.

RELATED WORKS

[2] RFID based e-monitoring system for municipal solid waste management.

Indian has a population of an astounding 140 crores and Urban India alone generates 188,500 tons per day (68.8 million tons per year). In a conventional approach a number of pickup trucks visit each locality

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and collect the MSW and then transfer these MSW in a pre-specified location, but all the above jobs are not properly monitored. Such as:

1) *Dumping the MSW in unspecified location (near residential area) create health issues.*
2) *Negligence in collection of wastes by Municipal laborer's as per schedule. (In long term landfills leak and pollute groundwater and the surrounding environment).*

As a result, day by day MSW produced in India is increasing and getting circulated within India rather than recycling / disposing it.

The authors M.L. Ali, M. Alam and M.A.N.R Rahaman have proposed a solution to this problem. Using RFID technology with PIC micro-controller and presents the development of an electronic monitoring (e-monitoring) system to overcome the above problem. Therefore, the municipal authority in charge can monitor the Sewage Waste collecting status through an application and can generate many reports / graphs based on the requirements. This can help in improving the performance of their service.

[3] An internet-based RFID library management system.

Library is one of the main sources of education. A typical Library in India has over thousands of books of different categories and subcategories managed by a librarian. Some of the concerning issues in library management are:

1) *Locating the misplaced / mis-shelved books.*
2) *Manual work of sorting of books. (categories and subcategory wise)*

As a result, this would create a difficult conundrum to the librarian. The authors A. Pravin Remold, R. Joshi Rani developed a solution that would reduce the manual work and overcome those problems stated above by using RFID technology. A RFID is a wireless non-contact system which uses radio-frequency (RF) waves Technology in order to transfer data from a tag attached to an object.

In this research paper the authors have used RFID reader Motorola MC9090 for the entire process which is carried inside the library. This reader is a compatible reader that can read any kind of tag of frequencies like Low, High & Ultra High. Every user and every book are provided with a RFID Tag which has a dedicated, unique EPC (Electronic Product Code) which is made in relation to the database for the further details. Internet concepts are put forward with the help of Internet of Things architectural layer.

[4] Design and Implementation of Hospital Management System.

[4]World health Organization (WHO) has defined hospital as an integral part of social and medical organization that provides the complete curative and preventive health care and treatment to people. Therefore, the hospital is one of the most complex of administrative organizations. The purpose of their research paper was to solve the issues regarding the hospital's management system. Such as:

1) *Redundancy in term of data storage (as data is stored in terms of heaps of file or worse on paper).*
2) *Wastage of time in retrieving data especially in finding a past health records.*
3) *Inaccurate reports*

Here the authors have developed a simple system of using MYsql as a backend for retrieving of data. They used a local server to deploy this project.

[5] RFID-Based Attendance Management System

Here in this paper the authors have presented a successful development of a low-cost attendance and tracking management system. The authors clam that the system would be more cost effective if ESP8266 module is used instead of MRF24WB0MA WIFI module which is 3 times expensive. The ESP8266 module is a low-cost WIFI with full TCP/IP stack and capability. It can be used as the host controller for RFID reader. Therefore, the size of the reader can be greatly reduced, making it easy to install and thus helping to reduce manufacturing cost.

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SYSTEM ARCHITECTURE

The system architecture diagram is shown in Fig. 2

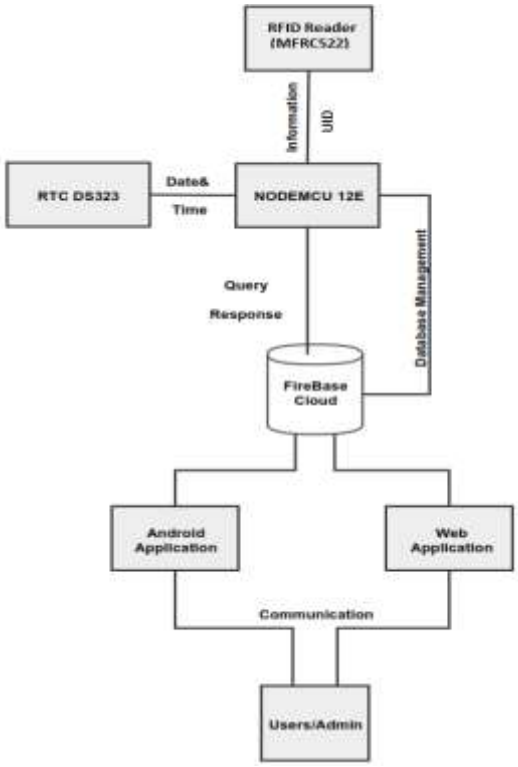

Fig. 3. Complete System Architecture

The design of the attendance management system using fingerprint based biometric system comprises of the following modules:

A. NodeMCU ESP8266 ESP - E12

NodeMCU is an open source IoT platform which includes firmware which runs on the ESP826 module and hardware which is based on the ESP-12 module.

In this project, NodeMCU acts as a base station which serially collects the data from the RFID Reader (MFRC522) module and computations are carried out. This data will be uploaded to cloud database. As NodeMCU is connected to internet any information going out or incoming must pass through NodeMCU.

B. RTC Time Module – DS3231

RTC stands for Real Time Clock which is computer clock (most often in the form of an integrated circuit) that keeps track of the current time. The clock operates in either the 24-hour or 12-hour format with an AM/PM indicator. Operating Temperature Ranges 0°C to +70°C which uses 3.3 v. It is compatible with most of the microcontrollers on the market. It has an integrated temperature compensated crystal oscillator and crystal.

We have used DS3231 module which is a low-cost and provides extremely accurate time and date which is used to track the student's records.

C. Mifare MFRC522 RFID Reader

Mifare RC522 is a RFID card reader which works on non-contact 13.56mhz communication. It is low cost and low power consumption compact size reader. It is compatible with 14443A. It consumes DC 3.3V, has an Operating Current 13-26mA, Idle Current 10-13mA. Supported cards include Mifare1 S50, Mifare1 S70, Mifare UltraLight, Mifare Pro, Mifare Desfire. Card reading distance is about 0 – 30mm.

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We have used this product as it commercially available, easily portable and low cost. This is used to read and extract the UID and data from the RFID cards given to the user during the registration.

D. RFID Tag (Passive)

A Passive RFID Tag is an RFID Tag / Card which doesn't come with a battery. The power is supplied to the tag by the reader. When the RFID Tag / Card encounters the RFID, Reader emitting radio waves. The coiled antenna with in the Tag / Card forms a magnetic field and current gets induced inside it. As these only store a little information (Data + UID). It doesn't require a lot of current to run it. The antenna then sends the Data and UID to the Reader.

E. Cloud Database

[1] Firebase is a mobile and web application development platform developed by Firebase, Inc. in 2011, then acquired by Google in 2014.We have used Firebase Real-Time Database and Firebase Storage for our backend storage as it would provide faster processing, uploading and retrieving services.

Here when a user places his / her RFID Tag / Card on the reader the reader sends the data to the Realtime database. The data is then retrieved from either android or web application or both.

F. Android App (User Interface)

An Android Application is used to act as an interface for the user. The user must go through a registration procedure via the Android Application. Once registered the user should use the credentials given during the registration process to authenticate himself in the app. After the authentication he / she will give given access to their attendance stats.

G. Web Application (User Interface)

A Web Application (Website) is used to act as an interface for the user. The user must go through a registration procedure via the Web Application. Once registered the user should use the credentials given during the registration process to authenticate himself. After the authentication he / she will give given access to their attendance stats.

The working of the entire system is depicted in the flow chat in fig 3.

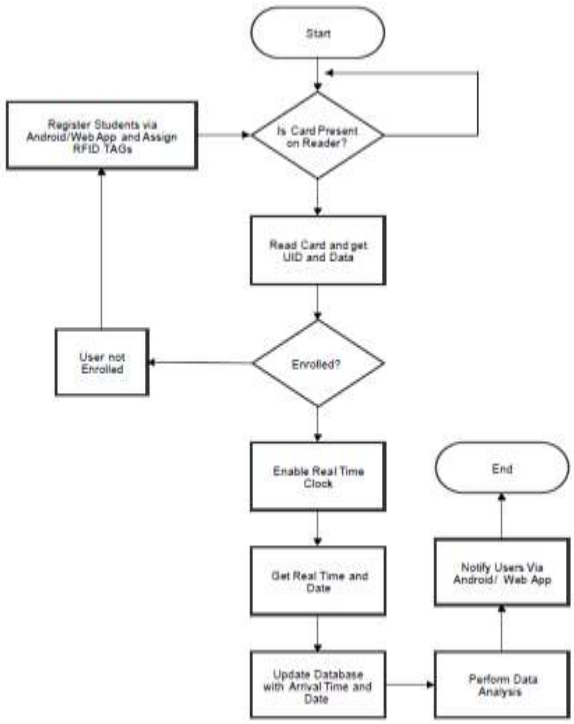

Fig. 4. Flow chart of Complete System

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RFID TECHNOLOGY

A RFID system in general can be categorized into:

1) Short or long read range

2) Low or high-power consumption level

3) Large or small hardware size, etc.

The difference among them is the technical parameters of the system (Carrier Frequency, type of RFID tags, etc.).

A RFID tag consists of a microchip that can store a unique Identification number(UID) in its memory. RFID tags are designed specific to its applications and environment.

TABLE I. TYPE OF TAGS

Features	**Types of Tags**		
	Passive	***Active***	***Semi-Active***
Read Range	Short (up to 10 m)	Long (up to 100 m)	Long (up to 100 m)
Lifespan	Up to 20 years	Between 5-10 years	Up to 10 years
Battery	No	Yes	Yes
Cost	Cheap	Very Expensive	Expensive
Availability	Only in field of Reader	Continuous	Only in field of Reader
Storage	128 bytes read/write	128 bytes read/write	128 bytes read/write

As depicted in the table passive tags have no dedicated power source as well as the ability to initiate communication. Instead, they operate when they come in contact with energy of the electromagnetic field of the reader's antenna. Current gets induced in the coils present in the tags. Passive tags are cheaper to manufacture and they have longer lifetime than active or semi-active ones.

Currently there are 3 different standard protocols for RFID systems defining the communication range, read rate and anti-collision algorithm, modulation scheme and physical parameters such as tag sizes.

TABLE II. STANDARDIZATIONS OF RFID CONTACTLESS CARD

Standard	***Card Type***	***Estimated range***
ISO10536	Close Coupling	0-1cm
ISO14443	Proximity Coupling	0-10cm
ISO15693	Vicinity Coupling	0-1m

ISO10536 is has the shortest range among the three as depicted in the table. It also has a relatively higher manufacture cost. As for the ISO14443 and ISO15693 protocols, the main advantage is that it can provide very high data rate which can be up to 848Kbits/s. These tags require high power to activate the tag and yet, the max read range there is only 10cm. ISO15693 provides a lower data rate than the first one (20Kbits/s). Therefore, it doesn't require high power to activate the tag, and the read range can be up to 1m.

ANTI-COLLISION ALGORITHM FOR ISO15693

To get a better understanding, let us consider an example. Suppose there are 4 Tags which are in range of the RFID Reader. IDs of the RFID are E000000000000254, E00000000000017C, E00000000000037C, E00000000000028C. For simplicity let us consider them as 0x254, 0x17C, 0x37C and 0x28C.

www.ijetmas.com May 2018, Volume 6, Issue 5, ISSN 2349-4476

In the first Round, the reader will send a request to the Tag which will have a mask value and mask length of 0 (indicating that the RFID reader wants to scan the least significant bit). Each tag in the readers range will find a match and give response to one of these 16 slots. This process is illustrated in the below Table 3.

TABLE III. FIRST ROUND SCANNING

0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10(A)*	*11(B)*	*12(C)*	*13(D)*	*14(E)*	*15(F)*
	-	-	-	0x254	-	-	-	-	-	-	-	0x17C 0x37C 0x28C	-	-	-

Round 1, Mask Value = 0, Mask Length = 0

As depicted in the table above, the first row is the number of slots and their representation in Hex-Decimal written within the brackets. The second row represents IDs of the tags responding to each slot. As depicted in the above table slot 4 has only one tag so the reader can receive the complete ID of that tag. Therefore, tag one is completely received. But there are 3 tags on slot 12(c) which means that collision has happened at this slot. After the scanning of all the 16 slots the reader will initiate the second round.

In the second Round, the mask is recalculated.

New mask value = old mask value + collision slot number

As in the First-round collision detected was at slot 12(C) and old mask value is 0. So, the new mask value is 0 and the new mask value is incremented by 4 bits indicating that the reader wants to scan the next two least significant bits of the tag ID. New mask value is C. The process of matching is shown in Table 4.

TABLE IV. FIRST ROUND SCANNING

0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10(A)*	*11(B)*	*12(C)*	*13(D)*	*14(E)*	*15(F)*
-	-	-	-	-	-	-	0x17C 0x37C	0x28C	-	-	-	-	-	-	-

Round 1, Mask Value = C, Mask Length = 4

As depicted in the table above there are two tags (0x17C and 0x37C) in slot 7 and only one tag (0x28C) in slot 8. So, the tag in slot is recognized and slot 7 is marked as collision. Then the reader will progress to the third round.

The Third round is similar to the second round, where the new mask is calculated.

New mask value = old mask value + collision slot number

The old mask value is C and the collision slot number is 7. The new Mask Length is incremented by 8 bits (indicating that the 3 significant bits will be scanned).

The process of matching is shown in Table 5.

TABLE V. FIRST ROUND SCANNING

0	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10(A)*	*11(B)*	*12(C)*	*13(D)*	*14(E)*	*15(F)*
-	0x17C	0x37C	-	-	-	-	-	-	-	-	-	-	-	-	-

Round 1, Mask Value = 7C, Mask Length = 8

In this round, tag ID 0x17C is in slot 1 and 0x37X=C is in slot 2.Since there are no collisions detected in this round, the anti-collision sequence ends here and these two tags are successfully recognized.

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RESULT AND SCREENSHOTS

The outcome of this project is a portable fingerprint-based attendance recording & monitoring system.

The features of this system are:

1) *Portable and Easy to use.*
2) *Efficient & Effective way to record Attendance using Firebase Realtime Database.*
3) *Processes the data in the attendance database to determine specific requirements such as percentage of attendance, number of hours and date worked.*
4) *Real Time Android Application for user.*
5) *Real Time Web Application for user.*

As soon as the user opens the Andoid Application he / she will be faced with the login page (fig. 6) where the user must enter their username and password. The crediential (username and password) are aquired through the registration page (fig. 7).

Once the user is logged in he / she will be directed to the main / home page where they have two options “View Attendance” and “View Profile”. Profile page (fig. 8) will display entire details of the user. Attendance page (fig. 9) will have entire attendance stats of the user.

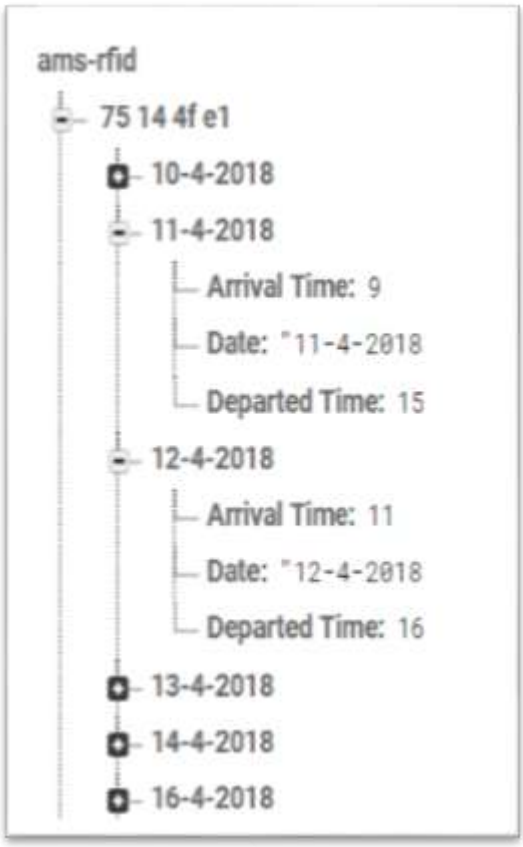

Fig. 5. Firebase Real-Time User Database

Fig. 6. Firebase Real-Time Attendance (Date, Arrival Time and Departed Time) Database

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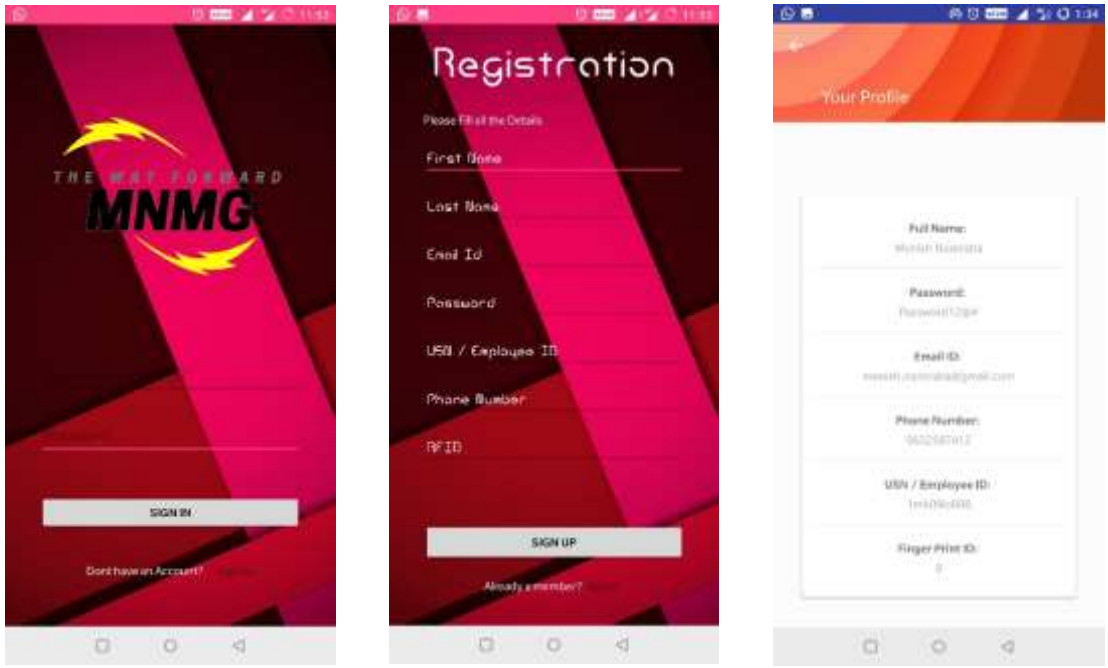
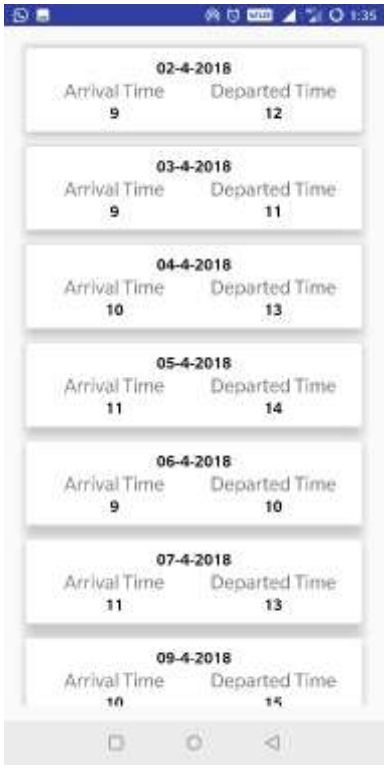


Fig. 7. Left Screenshot is Login Activity

Fig. 8. Mid Screenshot is Register Activity

Fig. 9. Right Screenshot is Profile Activity



Screenshot is Attendance Stats Activity

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We take this opportunity to thank all our lecturers who have directly or indirectly helped our project. Last but not the least we express our thanks to our friends for their cooperation and support.

CONCLUSION

This paper presents the successful implementation of a low-cost attendance management system. It is based on the use of RFID technology combined with the use of Firebase Real-Time Database for storage. Some advantages of this system are fast, fully automated, flexible, reliable, accurate, does not required physical site of contact, reducing paper-based work, saving the time of attendance call, authentic attendance, no proxy attendance, students would have a reason to go to class. Student's Attendance weight-age is also calculated in order to confirm their eligibility to sit in exam.

The functionalities of the system can be further enhanced through the following recommendation:

1) Portability:

The module could be remotely connected to a PC wirelessly (through the use of Bluetooth, Wi-Fi, WLAN) so the administrator can have access to the attendance data without physically interfacing the Module with PC.

2) SMS Feature:

The Module can be interfaced with a GSM Module to send SMS to the Security Personnel anytime an unregistered finger tries to sign-in or out or to parent notifying him/her of his/her child's attendance records.

3) Location Feature in App:

The Android Application can be enhanced to detect the location of the user. So, the Admin can have general idea so as to where the person may be.

4) High Frequency Tags:

The usage of High Frequency (HF) active RFID tags against passive Low frequency (LF) RFID tags for better performance and flexibility of users.

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