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Automated Attendance Monitoring System Using IoT

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***Abstract*—Most of the process is automated to reduce human intervention and manual mistakes in this busy world. It will be easy if we can automate some complex, sensitive activities of day to day life. This paper discusses a smart attendance system that automatically monitors and manages the attendance of students in an educational institution. Further, this system makes automated analysis and prepares a detailed report weekly, monthly and annually. The whole system is developed with an Arduino microcontroller and RFID readers. Also, GSM and Wi-Fi communication modules are used to make convenient communication depend on the availability of the network. A microchip (microSD) is placed to store data in case of communication failure and those stored data will be uploaded bulk when the communication channel is restored. This system will reduce a lot of manual work of educators and education administrators of an education institution**

Keywords—Attendance, IoT, Microcontroller, Arduino, Automation

I. INTRODUCTION

Higher education is the most valuable service for a community. The students who are following higher education are young and joyful in their institutions. Attendance is the most concerned issue in almost all the higher education institutes. Maintaining attendance is a very difficult and complex task and higher education institutions are struggling always to make it better.

IT and other associative technologies are growing faster in this technological era. There are many new emerging technologies being introduced every day. The Internet of Things (IoT) is one of them, which is growing faster and mostly invaded everywhere in the world. The recent development in mobile communication technologies and Personnel Area Network (PAN) technologies are highly improved through 4G, 5G, Near Field Communication (NFC), Radio-Frequency Identification (RFID), ZigBee and Bluetooth. The current 4G and 5G cellular technology have increased the strength and availability of the Internet also, the 4G broadband and fiber optic connectivity is providing higher bandwidth facilities nowadays. The scientist says that the RFID will be ubiquitous in 20 years.RFID is one of the techniques to identify the unique data in the devices within a short distance using radio waves. NFC is one of the subsets of the RFID family. The data is stored in the RFID card as eight sets of hexadecimal number which will give 2^{128} unique identifications. Usually, the RFID technique is coupled with RFID card and receiver.

Therefore, it's easy and efficient to use these technologies together by applying IoT concepts to implement an automated and low-cost solution to enhance the attendance recording and monitoring activity in higher educational institutions. Hopefully, each difficulty and loopholes can be covered through this method. This paper proposes an IoT base automated attendance monitoring system that also produces detailed categorized and analyzed report. This system immensely reduces the physical burden of the teaching and administrative staff of the higher educational institutions in attendance monitoring.

II. BACKGROUND

Always there are difficulties in handling attendance manually in educational institutions. This kind of activity needs a lot of physical works to be done. Also, it will be an added burden to the teachers and academic administrators. For example, it's very complex to ensure the attendance of a class where hundreds of students are studying. Further, it consumes a considerable amount of time as well. Table I describe approximately the time taken to mark attendance manually in a school with regards to the number of students.

TABLE I: NUMBER OF STUDENTS AND AVERAGE TIME

Number of students	Average Time (Minutes)
10-30	4.5
30-50	11.25
50-70	15
70-90	17.5
90-110	19
110-130	20

As shown in Table I, around 10 -15 minutes are used to mark manual attendance for every session. The time taken for this purpose can be utilized to increase the student contact hours, such as additional explanation on concepts, exercises, etc. if there is a way to automate it. The productivity of teaching can be increased by introducing an automated system and also teachers can only focus on teaching. Also, the student punctuality can be maintained and the teacher's teaching time can be improved by at least an hour for a month.

III. RELATED WORKS

There are many systems proposed in the past to sort out this problem in an efficient manner. The researchers used many different PAN technologies, hardware mechanisms, and application-based approaches. Some of them used RFID and window-based applications for this purpose [1] and some of them used hardware chips with keypads connected to displays [2]. However, these systems are not user-friendly and sometimes more complex too. Smartphones also used for this purpose but, it seems there are chances to make fraudulent access in the

system [3]. There are some works done using iBeacons and Java programming applications [4]. This is a good model but looks expensive. Many types of the research proposed video and image-based automated monitoring [5] [6] [7] where it's not economically feasible and depend on location of the camera, the posture of the student and sometime it may fail when there are two or more students with similar facial features. However, some more works are studied and analysed to come up with an efficient, accurate and low-cost solution.

Research related to Hypertext Transfer Protocol (HTTP), HTTP/1, HTTP/2 experimental analyzing is done by Beckett, Sezer in 2017. The research objective is to understand HTTP/2 deployment to protect the information from Distributed Denial-of-Service (DDoS) attacks. Due to HTTP/2 allowing multiple requests per packet, HTTP/2 is the binary framing layer that can be categorized under the application layer and it encapsulates the messages in binary format. Therefore, this technique can be used to increase security while making the packet transmission [8]. Therefore, we planned to use this HTTP/2 technique to transfer the packets to the server.

Amendola et al. discussed how to integrate IoT and RFID in the field of medical monitoring. They have used the RFID and Near-Field Communication (NFC) technology to acquire the patients' activity details in every minute. These RFID tags are passive and cheaper and that enable object tracking into reality [9]. The above research is done with Ultra High-Frequency RFID for the benefit of long-distance reading; however, the reader is expensive compared to High-Frequency RFID readers. In this project, the low-frequency reader is good enough to use and we can avoid any unwanted tagging when a person is crossing the device with an RFID card somewhere away, not for tagging with our receiver.

Chen and others investigated how we can use the RFID in attendance and also identify the arrival of the vehicle to pick up the kids. Additionally, GSM message service is used to send messages to parents. They put the tag in parent's vehicle in the traffic system and when the reader comes in a range of RFID tag, it will send a message to the speaker to announce that, this kid's parents are here to pick him [10]. Here, the reader can sense the RFIDs in the long distance too. This type of long-distance RFID is not necessary for our project where it is a simple attendance monitoring in real-time with a physical presence. So, we have chosen passive RFID for additional reliability.

Kadlec and others are used RFID technology to improve the productiveness of inventory management based on hospital laundry management applications to detect and identify the objects. When a person taps the RFID card with the RFID reader, it senses the information from the card, and it will start process according to that information. i.e., the RFID reader produces the electromagnetic field, and when we tap the card, it will generate the power from the electromagnetic field and send the information in a certain frequency. The reader received the information from that card during that time, [11].

Research of "Prototype of Group Heart Rate Monitoring with NODEMCU ESP8266" is done by Skraba and others in 2017. In this research, they mainly focused on the heart rate monitoring system, and they justified why they are using the ESP8266 v12E Wi-Fi module than other communication tools. Further, this study describes the client-server architecture and communication between the ESP8266, client, and server.

In the proposed model, we used ESP8266 v12F to improve the Wi-Fi communication coverage because this v12F has an optimized Wi-Fi antenna than v12E[12].

Yoppy and others did research on Received Signal Strength Indicator (RSSI) comparison of ESP8266 Modules in 2018. In this research, they measured the signal strength of each version of the ESP8266 Wi-Fi module. According to the obtained results, the meandered PCB antenna module has -84.51dB RSSI at 40 meters distance between the sender and receiver. The meandered inverted-F PCB antenna got -90.94 dB RSSI with the same environment [13]. Therefore, we decided to use the ESP8266 v12F Wi-Fi module to overcome this issue in our project.

Finally, an RFID receiver and an RFID card (Student ID card) can be used with Arduino Microcontroller with the Wi-Fi module. The GSM module is used as an alternative communication setup to cover communication failure of Wi-Fi [14].

IV. Methodology

The proposed model is designed with microcontroller and personal area networking solutions. The IoT components which are used to design this module are shown in Fig. 1.

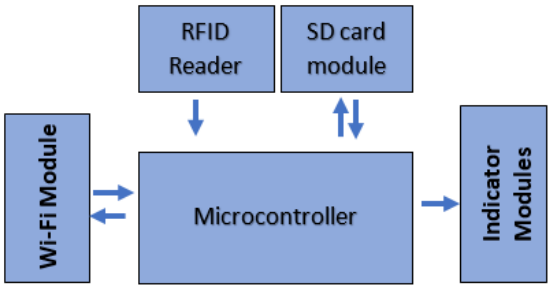

Fig. 1: System Architecture

V. Component Selection

Arduino microcontroller has been used as a microcontroller for this proposed module. As per the past products and success rate, the Arduino Uno is selected for this model. The RFID card is planned to use to build an ID card, and an RFID receiver module is connected with the microcontroller to ensure the students' attendance. The Wi-Fi module is selected as a primary data transmission method, and the GSM module also been used as plan B. Further a microSD card also used to store the data read when there is no communication available for real-time transactions. Several indicators are used in this system; LEDs used to indicate power and Internet connectivity. Further, another LED display also used with the system in the early testing, but due to the cost, an 8 Ω buzzer is replaced to indicate the acceptance of the card. A thanking voice is providing through the speaker for each successful tagging of the RFID card. The voice MP3 is converted into 8-bit 8KHz Pulse Code

Modulation (PCM) audio. Then the PCM file was encoded and the data is used in the Arduino tone function.

VI. Implementation

The data will be received through the RFID receiver by taping the RFID card in the inductive coupling method[15]. Each RFID is having a unique hexadecimal number, which is assigned to each student individually as a unique ID. The name is mapped from the database when the student taps their ID card.

The student database is designed in such a way that the parallel attendance reader system can be used for attendance monitoring at the different entrance of an institution and never produce any redundant data in the cloud storage. The unique data will be mapped and verified by the microcontroller and stored into a temporary storage card (MicroSD) to avoid the loss in case of communication failure. Also, it has been planned to use a simple solar panel for backup power. However, the mapped and processed data will be sent to an online database, and there, it will be stored as records. The stored data can be monitored and processed anytime without mapping or deleting it. Further, the integrated online application will do the top-level processing in report making and also it will help in producing warning messages in case of poor attendance.

VII. Data Transfer Mechanism

The Wi-Fi module is the primary data transfer device. The selected ESP8266 Wi-Fi module can be work as a Wi-Fi station, Wi-Fi access point, and both simultaneously [16]. There is a stern problem in Wi-Fi modules to assign the Service Set IDentifier (SSID) and password if we need to change another access point for connectivity. Once we set the SSID and password in our system programmitaically, then we need to change it manually whenever we try to replace another Access Point. We need to modify the code when we change the Internet providing Access Point. This is an annoying task, and this problem is managed by the Wi-Fi module's mode changing facility and the availability of Electrically Erasable Programmable Read-Only Memory (EEPROM) in the ESP8266 module. The Wi-Fi module is set to work as a Wi-Fi station and when there is no matching SSID, which is saved in EEPROM. The Wi-Fi module is assigned with SSID and IP addresses to deliver web pages to all connected devices. The new SSID and password of the Wi-Fi router can be assigned through a web page, which is provided by the ESP8266 module [17] by connecting the Wi-Fi module's network through a smartphone or a laptop.

The unique data read from an RFID card is send to the cloud database in real-time. The HTTP request and GET method is used to send the data from the Arduino to the webserver [18]. Wi-Fi module is used to send the data to the cloud database in two methods; one is storing the read data into the microSD card locally in the system when there is no connectivity. After connectivity established, the data will be automatically sent to the cloud database. This method is applicable in the peak time of student entrances or in poor internet coverage situations. The other method is instantly sending the data in real-time to the cloud soon after tagging the RFID card. The data transfer mechanism of the system is shown in Fig. 2.

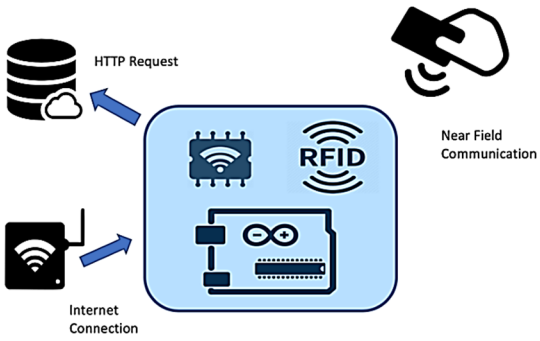

Fig 2: Data Transfer Mechanism

There is another type also tested in this system. The Google sheet is used to store the read data rather than using a cloud database. A third-party Application Programming Interface (API) is used to send the data to the google sheet. However, this method is not suitable because there are many dependencies and time delay that makes a barrier to being a reliable and consistent system.

SIM module also tested for data transfer. The SIM900A module used for GPRS connection to use HTTP protocol for the purpose of sending the data into the cloud. As the GPRS data transfer rate is low, the time delay in the data transfer is a drawback in this method. This is not applicable for real-time data transfer for each tagging of RFID card. More than 40 seconds is taken for each data transfer through this method. For example, if there is a queue of 100 students to tag the RFID card, then it takes an hour to complete. It can be simply replaced with the 3G modules available, but the cost of the system will be higher; therefore, the Wi-Fi module is used as a primary data transfer method.

VIII. Results and Discussions

Finally, the prototype is developed and set up to transfer instance RFID readings to a webserver via the Internet as well as Google sheet. The designed prototype is fixed with the casing and the student details are printed in the RFID card (as an ID card). The MicroSD card can store around one-year records for many parallel batches of students. TABLE II and TABLE III show the difference between the data transfer delay using the cloud database and Google sheet.

Date & Time	Card Data
27/08/2019 16:16:33	936a8d32
27/08/2019 16:17:39	936a8d32
27/08/2019 16:17:50	936a8d32
27/08/2019 16:18:07	936a8d32
27/08/2019 16:18:19	936a8d32
27/08/2019 16:18:29	936a8d32
27/08/2019 16:18:40	936a8d32

TABLE II: GOOGLE SHEET DATA

Student ID No	Student Name	School	Date	Time
91a79233	Lithusan Sadachcharnathan	Udk	2019-09-11	13:05:29
91a79233	Lithusan Sadachcharnathan	Udk	2019-09-11	13:05:31
91a79233	Lithusan Sadachcharnathan	Udk	2019-09-11	13:05:35
91a79233	Lithusan Sadachcharnathan	Udk	2019-09-11	13:05:37
91a79233	Lithusan Sadachcharnathan	Udk	2019-09-11	13:05:39
91a79233	Lithusan Sadachcharnathan	Udk	2019-09-11	13:05:41

TABLE III: Cloud Database Data

IX. CONCLUSION

Finally, we proposed an efficient and low-cost system with an easy maintenance mechanism. The proposed system will reduce the time taken to manual attendance in educational institutions. Further, this system helps teachers to increase their efficiency in teaching, learning, and lesson preparation activities by offering more time that is used for attendance marking earlier. Therefore, the productivity and performance of teachers and students can be improved through this system. The system makes educational administrators convenient by reducing a lot of complex physical works. Also, this system indirectly helps in increasing the student's punctuality too.

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