AUTOMATED CLASSROOM MONITORING WITH IOT AND VIRTUINO APP

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ABSTRACT— *Internet of Things(IoT) with the concept of integrating connectivity, sensors, data analysis and decision making in an underlying framework has ease many real world problems. Classrooms are learning spaces which are found in educational institutions of all kinds, from preschools to universities. In educational institutions much of the time is wasted while entering the classroom in queue, picking up their own materials, sit up and down while answering to questions and it makes very much difficult for teachers to handle huge number of students without any technology. On an average, a student spends about 1025 hours each year just for following instructions given to him/her. Connected devices and emerging trending technologies will help teachers to focus on student's learning needs rather than wasting time for managing large group procedures because of which they cannot give enough time for developing some extra qualities in students. Connected devices would definitely help teachers to transform classroom experience. This paper consists of some practical scenarios of about how I.O.T can be implemented for a better classroom experience and how teachers can focus on student's skills and which will help to save the time of both.*

The attendance system that we currently use now is recorded by signing our signature on a piece of paper, which makes tracking and processing troublesome. It will need to be digitalized by using various sensors and module on it. Besides, the current conventional classroom system does not implement any energy saving system, which contributed to the high cost in paying electrical bills. Thus, in this paper, an IoT based Smart Classroom System is presented. This system consists of two features; the autonomous attendance system as well as an energy saving technology implementation. As for the autonomous attendance system, the attendances that were taken from student card will be digitalized and send to the server to be processed, and then the attendance records are able to be viewed via web or Virtuino app. Meanwhile, through the energy saving technology, students or lecturer does not purposely need to switch off the air conditioning, fans and lights each time they leave the class anymore. Overall, the whole system will increase efficiency in terms of attendance

recording and processing and save huge amount of cost spend in electricity bill.

You can monitor all the data from your smart phone by using Virtuino app. Then a twit can be send to students parents mobile automatically if the student is absent from class. With the incorporation of IoT devices and computational algorithms such as machine learning and data analysis, it can ease the monitoring task and increase efficiency in terms of attendance recording and processing and save huge amount of cost spend in electricity bill.

Keywords— Autonomous Attendance Recording; Energy Saving System; Radio Frequency Identification (RFID); Smart Attendance System; Internet Of Things (IoT); Short Message Service(SMS).

I. WHY IOT

We are living in Internet age where every physical object may be connected to each other for sharing information purpose. IoT has emerged as a new network paradigm, which allows various physical entities in the world to connect with each other. The observed or generated information of these entities have a great potential to provide useful knowledge across different service domains, such as building management, energy-saving systems, surveillance services, smart homes, smart cities, etc. IoT was first proposed in 1999 by Kevin Ashton, who is the co-founder of Auto-ID centre at the Massachusetts Institute of Technology (MIT) [9]. One foundational technology of IoT is the Radio-Frequency IDentification(RFID) technology, which allows microchips transmit the identification number of the objects to a reader through wireless communication. Through RFID technology, the physical objects can be identified, tracked, and monitored automatically. Nowadays, RFID technology has been widely adopted in logistics, pharmaceutical production, retailing, and supply chain management [10, 11]. Another foundational technology of IoT is Wireless Sensor Networks (WSNs), which adopt interconnected intelligent sensors to periodically sense the monitored environment and send the information to the sink (or base station), at which the gathered/collected information can be further processed for end-user queries [12]. The applications include disaster control, environment and habitat monitoring, battlefield surveillance, traffic control, and health care applications [13]. Additionally, many other technologies and devices such as Near Field Communication

(NFC) [14], short-range wireless communication (i.e., ZigBee [15] and Bluetooth [16]), universal mobile accessibility (i.e.,Wi-Fi hotspots [17], and cellular networks [18]), social networking [19] and cloud computing [20] support internet of things to compose a extensive network infrastructure.

II. RELATED WORK

A number of related works exist in literature, specifically to the area of attendance monitoring problem. The following paragraphs describe the related work proposed by the various authors.

Authors [1] proposed an idea of integrating the ubiquitous computing systems into classroom for managing the student's attendance using RFID technology. In this work, RFID technology manages student's attendance throughout the working school day. A real time intelligent system is developed in addition with RFID hardware to record student's attendance at class rooms and laboratories in a school/university environment.

Authors [2] proposed an idea of Face recognition based Attendance Monitoring and Management System. The Raspberry pi module is used for face disclosure and affirmation. The camera is connected to the Raspberry pi module for face capturing. The understudy database is assembled. The database consolidates name of the understudies and there pictures. This raspberry pi module will be presented at the front side of class to take the attendance. Camera will capture the face of each student and this picture is compared with database set. If matches occurred then corresponding student attendance is marked. Latter, the list of attendance will be displayed in the webpage through IOT (Ethernet, Wi-Fi).

Authors [3] proposed an idea of "Fully Automated Attendance Record System using Template Matching Technique". In this work, authors designed a system that will automatically arrange the record and calculate the average attendance of each student. Main objective of this Attendance Record System is to replace the manual model

of attendance record keeping. The proposed work describes an efficient image processing algorithm that reads the scanned hard copy accurately and further calculates the absence or presence accordingly.

Authors [4] proposed a system which takes attendance electronically with the help of a fingerprint sensor. This system will capture the fingerprint of each student and all captured records are saved on a computer server. Fingerprint sensors and LCD screens are placed at the main entrance of each class room. Here, student has to place finger on the fingerprint sensor. Captured finger print compared with already stored data set. If a match found then student attendance is updated in the database and he/she attendance is notified through LCD screen.

Authors [5] introduced a new approach for automatic attendance management system with computer vision algorithms. The proposed system works on real time face detection algorithms. They are integrated on existing Learning Management System (LMS).

Proposed system will automatically detect and update the student's attendance.

Authors [6] developed an RFID technology for student''s attendance system. Radio Frequency Identification is a wireless objects identification technique. This technique is very popular technique and is used for the identification of physical objects. This technique works on radio frequencies and it is much more advantageous, safe, secure and easy with lower overhead compared to other conventional technique.

Authors [7] described a method for Student's Attendance System. This system works on face recognition technology using Principal Component Analysis (PCA) algorithm. The proposed system will record the attendance of the students in class room environment automatically and update the database accordingly. This system also allows the facilities to access the information of the students.

Authors [8] developed a technique for staff attendance, E Attendance System (EAS) works on existing technology by

using smartphone. This system is capable to record the attendance of staff using their smartphone device with Bluetooth feature. But authors not explained anything about student's attendance.

III. IOT BASED PROPOSED SYSTEM

Most educational institutions' authorities are bother about the student irregular attendance. In today's world accurate attendance of students have a great importance. Truancies can affect student overall academic performance. The normal method of attendance tracking by calling names or signing on paper is very time consuming and insecure, hence inefficient. Our new Time and attendance that also called RFID attendance system using IoT, IRsensor, RFID tag is one of the solutions to address this problem. This system can be used to take attendance for student in school, college, and university. It also used to take attendance for Teacher, Staff and other Employee. Its ability to uniquely identify each person based on their RFID [21] tag type of ID card make the process of taking the attendance easier, faster and secure as compared to conventional method.

Students only need to place their ID card on the reader and their attendance will be taken immediately. With real time clock capability of the system, attendance taken will be more accurate since the time for the attendance taken will be recorded.

A. Project Work Flow

This automated classroom monitoring system is divided into two main parts; the first is the RFID attendance system and second is the WSN Energy Saving System. The RFID attendance system can be divided into the prototype design and the web design part. The prototype design will grab out the RFID number from a RFID card to be sent to the server through Ethernet and save the information in the database. A web page is designed to visualize the information of the student as well as attendance statistical. As for the WSN Energy Saving System, it is dealing with detecting any human movement in the classroom and the system will automatically switch "ON" or "OFF" the electrical appliances that are in the classroom depending on the situation.

B. *RFID Attendance System*

Figure 1 shows the flowchart for the process of RFID attendance system. The RFID attendance system can be divided into two parts; one is hardware, the other one is software. The hardware part consists of several low cost development shields and modules such Arduino Mega IC, RTC module, RFID reader, Ethernet module and etc. While the software part consists of MySQL database, server connection, webpage and etc.

In order to record student's attendance, students are required to tag their matric card onto the RFID attendance system, specifically to the RFID reader. After that, RTC module will record the time the student tagged their matric card and at the same time buzzer will be sounded two times (to indicate that the student successfully tagged their matric card into the attendance system). Then the time and RFID number of that student will be sent to server through Ethernet module.
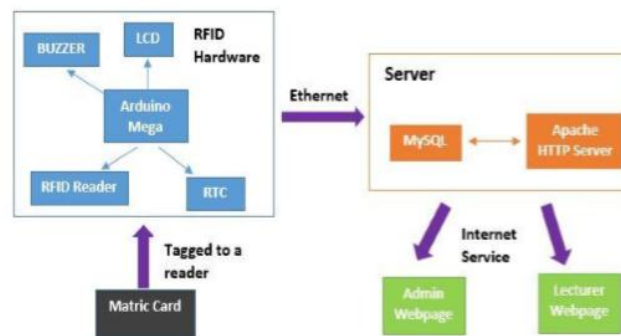

Figure 1: Process of RFID attendance system

The server will check the availability and validity of the student whether he or she is in the correct class, before the data is successfully saved in the MySQL database. If the attendance is successfully taken after checking all the information, a string of a welcome message together with the student name ('Welcome <name of the student>') will be displayed on the LCD display. Through this, the student can know that their attendance is successfully taken.

Figure 2 shows the proposed interface of ASTU attendance system website. User need to log in first in order to able to access the contents of the website. Initially, only two level of users will be provided; one for the administrator or lecturer, the second one for the parents and students. A username and password

will be provided in order to access the website.
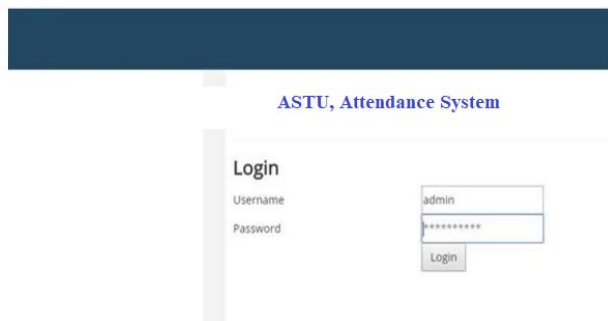
Figure 2: Design of the Website

The administrator is able to create a user account, register subject to time table, student registration and attendance table in the server. They can have direct access to all the settings and configurations of the server and database system. Whenever a modification of the system is needed, admin can log in with their account to do their work. Besides, admin also can create a new ID and password to access the website, able to register any new student with Name, RFID number and Matric Number, able to register the subjects taken by the students, able to register any new subjects with necessary info like ID, Name, Day, Time Start and End, Class ID and Name of lecturer and create an attendance table in the database from selecting the subject and

day of the subject. Meanwhile, lecturer can log into their account to check their student attendance data and details. The system will automatically calculate all the necessary attendance information without the lecturer to do it manually. Lecturer also could re-check the status of student attendance, and are able to change the status of attendance in case of medical leave. After that by using internet network attendance can see in real time by teacher, student and even parent, so that student presences can be monitored from anywhere in real time.

C. WSN Energy Saving System

Figure 3 shows the flowchart for the process of WSN Energy Saving System. The WSN Energy Saving System were divided into two mechanisms: the human movement detection and off-working hour mechanism. In the design, there will be two nodes with the Arduino Pro Mini as their microcontroller (MCU), they are called PIR node and relay node. PIR node will be dealing with detecting human movement in the class while relay node serves to switch "ON" or "OFF" the electrical appliance depending on the PIR

node's signal. The PIR node will be connected to a PIR sensor and a nRF24L01 wireless communication module while the relay node will be connected to 1 channel relay, a RTC mode and a nRF24L01.
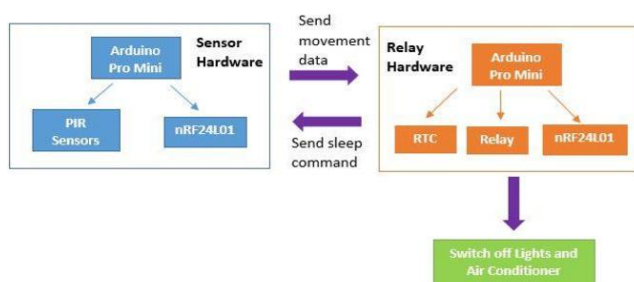

Figure 3: Process of WSN energy saving system

For human movement detection, whenever there is no human movement in the classroom, the PIR sensor will trigger the MCU in the PIR node to wait for a period of a time; during the waiting period, if there is still no human movement detected, then the nRF24L01 will send a trigger message to relay node to indicate that there was no human in the classroom. The relay node will receive the message and automatically switch "OFF" the electrical appliance in the room by controlling the input-output (IO) of 1 channel relay. Vice versa, if there is a

constant human movement detected in a period of time, thus it confirms there are human in the class. The nRF24L01 will send a message to the relay node to switch "ON" the lights or other electrical appliance. As for off-working hour's mechanism, the RTC module becomes the most important tool in order to determine whether the current time is falls on the weekend or it is after 6pm in the weekdays (last class of the day). Whenever the current time on the RTC falls in these off-working hours period, a signal will be sent to relay node in order to activate the sleep mode function. Note that, the sleep times are different from the one on weekdays and weekends. Before the relay node goes to sleep mode, it will send a RF signal to the PIR node to ask it to activate the sleep function; all of the electrical appliances connected to PIR node will be switched "OFF". At 8.00am of the next day, both of the nodes will wake up automatically and resume its routine operation.

IV. ARCHITECTURE OF THE SYSTEM

The IOT based Smart Classroom has the following components –

Barcode:

In this technology, students carry barcodes printed on their student cards, which at the time of presenting barcodes read using barcode reader, this presence is fast enough and does not cost a fortune, but this system has a drawback where barcodes can be easily duplicated by printed using a regular printer.

Figure 4: Type of an RFID tags.

Magnetic Stripe:

The use of magnetic strips can eliminate the deficiencies of barcodes, because in this technology magnetic card is required as an ID for each student, in the duplication of the magnetic card cannot be done easily because it requires a magnetic card reader and magnetic card writer, which because of the price quite expensive so it cannot be easily owned by students.

Arduino Pro/UNO/Mega:

The Arduino UNO is ATmega328 based microcontroller board. It is one of the most popular prototyping boards. The board comes with built-in arduino boot loader. It has 14 GPIO pins, 6 PWM pins, 6 Analog inputs and on board UART, SPI and TWI interface an on-board resonator, a reset button, and holes for mounting pin headers. While programming the board, it can be connected to the PC using USB port and the board can runs on USB power. The Arduino UNO has 32 Kb Flash memory, 1 Kb EEPROM and 2 Kb SRAM. The board can be connected to different Arduino Shields for connectivity with Ethernet, Bluetooth, Wi-Fi, Zigbee or Cellular network and it can be connected to most of the IoT platforms.

RFID Reader:

The RFID reader is a module with RFID reader and antenna. It is small in size and integrates with any sort of hardware design. It is used to read the data stored in the RFID tags.

Pin Number	Pin Name	Pin Function
1	Ground	Ground
2	GPIO1	General purpose IO, Serial Tx1
3	GPIO2	General purpose IO
4	CH_PD	Active High Chip Enable
5	GPIO0	General purpose IO, Launch Serial Programming Mode if Low while Reset or Power ON
6	RESET	Active Low External Reset Signal
7	GPIO3	General purpose IO, Serial Rx
8	VCC	Power Supply

Figure 5: ESP-01 pin configuration

ESP8266 Wi-Fi Modem:

The ESP8266 Wi-Fi Module is used to connect the Arduino board with a Wi-Fi router, so that it can access the cloud. It is a self-contained SOC with integrated TCP/IP protocol stack that can access to a Wi-Fi network. The ESP8266 is capable of either hosting an application or off-loading all Wi-Fi networking functions from another application processor. Each ESP8266 module comes pre-programmed with an AT command set firmware. The module comes available in two models - ESP-01 and ESP-12. ESP-12 has 16 pins available for interfacing while ESP-01 has only 8 pins available for use.

In this paper we are using the ESP-01 model. The ESP-01 model has the following pin configuration –

The RESET and VCC pins of the module are connected to the 3.3 V DC from Arduino while Ground pin is connected to the common ground. The TX and RX pins of the module are connected to the 9 and 10 pins of the Arduino UNO.

LCD Display:

The LCD display is used for displaying the data. It consists of 16 pins: three pins are connected to the power supply, and the remaining pins are connected to the port 2 of the microcontroller.

LCD	Arduino UNO
RS	13
RW	GRND
E	12
D7, D6, D5, D4	3, 4, 5, 6 respectively

Figure 6: LCD pin configuration
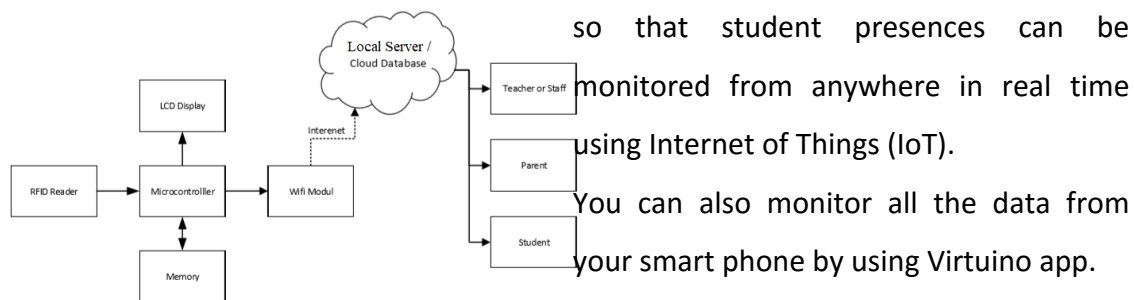
**Figure 7:Diagram of classroom attendance monitoring system.**

Figure 7. Show that the process of attendance is done by using RFID technology, in this system each student has an RFID Tag to do presence, student put RFID Tag near RFID Reader, then ID result from RFID reader will be sent to microcontroller and compare it with the student data stored in memory, memory serves to store the data of the student's name of the course, if the data ID is a lecture participant then the student's name will be displayed on the LCD Display as well if the student data is not listed it will be informed through LCD Display that the student unregistered, using Wi-Fi module microcontroller can send student attendance data to Local Server/Cloud database by using internet network, data already accommodated in Local Server/cloud database can be seen in real time by teacher, student and even parent,

so that student presences can be monitored from anywhere in real time using Internet of Things (IoT).

You can also monitor all the data from your smart phone by using Virtuino app.

V. RESULTS AND DISCUSSION

A. Smart RFID Attendance System

To display the results of presence data the user must login first, the user is divided into two kinds of login as a teacher or administration, and login as a student or parent, attendance data that has been stored in the server/cloud database can be displayed through two types of users, i.e in one output display for teachers and administration, where in this view attendance data from students are grouped by subject and class, while in other output display for students and parents, it only displays data from students who login only, the name of the students displayed depending on the user's students and parents, so that each student and parents can only see their own presence data only.
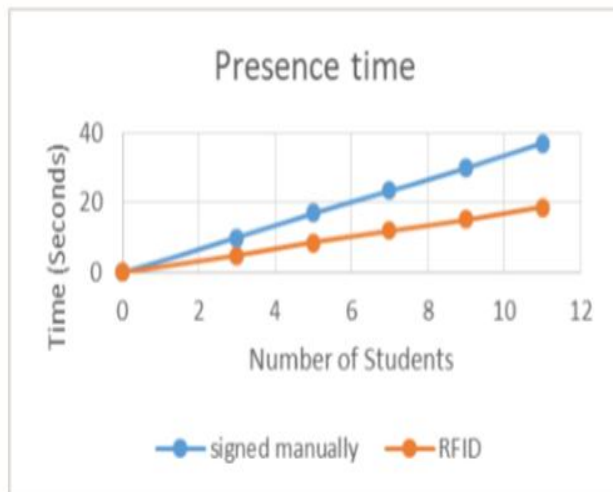
Figure 8: Comparison of time attendance.

In Figure 8, it shows the comparison between the listing attendance manually and using RFID. The figure represents that using RFID, listing the attendance of 11 students took only 20 s, whereas the manual method takes twice as long which is 40 s.

B. WSN based Energy Saving System

The system is implemented in Arduino connected with PIR sensor and communicate using nRF24L01 RF module. When there is a continuous no human movement in 4 seconds waiting time, then the PIR node will send a message to the relay node to switch "OFF" the electrical appliance. However, when there are human movements during those periods, PIR node will tell the relay node to switch "ON" electrical appliances.

1) No human movement

When there is no movement, the Arduino will keep on counting for 4 more seconds (refers to Figure 16), if still no human movement, then it will send a message to the relay node to switch "OFF" the lights.

```
humanCount : 0    noHumanCount : 1
humanCount : 0    noHumanCount : 2
humanCount : 0    noHumanCount : 3
humanCount : 0    noHumanCount : 4

STATUS:
Confirmation that no human movement in the class!!
Sent order of 2
```

Figure 9: Web Page of the Attendance Table Info for Admins

2) Human movement

When there is no movement, the Arduino will keep on counting for 4 more seconds (refers to Figure 17), if there is a sudden human movement detected, then it will tell the relay node to switch "ON" the lights as shown in Figure 18.

```
humanCount : 0    noHumanCount : 1
humanCount : 0    noHumanCount : 2
humanCount : 1    noHumanCount : 0
Motion detected!

humanCount : 2    noHumanCount : 0
humanCount : 3    noHumanCount : 0
humanCount : 4    noHumanCount : 0

STATUS:
Confirmation that human movement is present in the class!!
Sent order of 5
```

Figure 10: Case Results of Human Movement in Class

Figure 11: Picture of the prototype of Human Movement present

VI. FUTURE SCOPE

Automated Class room monitoring system can help higher education in many ways. There is no doubt that an automated Class room monitoring will help save time and money by eliminating plenty of manual processes involved in attendance and leave entry and calculating hours attended. With Automated Class room monitoring system, teachers can more accurately and quickly track student's time in the classroom. Here are the top ten advantages of implementing automated Class room monitoring solution:

i. Reduce paperwork and save time and mone with RFID-based attendance management system.

ii. Eliminate duplicate data entry and errors in time and attendance entries.

iii. Improve visibility to track and manage student attendance & absenteeism across multiple campuses.

iv. Real-time status tracking of leave requests.

v. Automatic calculation of leave and reward points accrued.

vi. Easy attendance recording using RFID & NFC-based attendance system.

vii. Track the attendance of teachers and staff, assign work and manage allocation.

viii. Keep the parents informed about the student's performance via Email & SMS alerts.

ix. Auto-generate various types of reports of class or student attendance.

x. Increased security and confidentiality with role-based permissions to users.

VII. APPLICATIONS

Single RFID ID cards issued to the student can be used for multiple purposes for identification, authentication & attendance/tracking at:

i. Attendance of faculty, officials and non-teaching staff and Leave management.

ii. Campus entrance gate.

iii. Hostel.

iv. Class room.

v. Labs.

vi. Computer Centre.

vii. Examination hall, etc.

VIII. CONCLUSION

From the results we found that, the IoT based smart classroom monitoring system that consist of the smart RFID attendance system and WSN energy saving technology will be successful and can be worked out inside of any classroom. Further development in the design of the system will be needed to enable full system to be ready to be implemented in every classroom throughout the university. With the introduction of the WSN energy saving system, we hope that the energy consumption spent in classroom for fan, air conditioned and lights will be significantly reduced in terms of energy used as well as the energy bills. So that it could channel more fund in research and other facilities. This smart attendance system will benefit not only for students, but for lecturers especially in reducing their daily workout. When their work is reduced, they can concentrate more on their research and bringing knowledge to every student.

There are lots of aspect for improvement needed in this proposed paper, especially for the web interface for the administrator, lecturers, students and parents. The interface should be clear, concise and attractive. For the RFID attendance system and WSN energy saving prototype, the system currently is running in sequential order, it should be improved to be run in parallel sequence so that it would not be depending on every code block in running the system.

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