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AN IOT- BASED AUTO CONTROLLED SYSTEM FOR ELECTRICAL APPLIANCES BASED ON HUMAN MOVEMENT IN SMART ROOMS

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Abstract

The ever-growing demand for larger integration density, higher bandwidth, and lower power Over the past few years, due to the increase in consumption of daily usage resources, there has been rapid growth in demand for energy. Energy is derived from fossil fuels and as time passes fossil fuels deplete. So, we are in immediate need of an energy conservation system. For the implementation of this system, the Internet of Things (IoT) provides the solution to perform the tasks. This paper presents a cost-efficient, and energy-efficient Internet of Things (IoT) based system where different devices can be connected over the Internet resulting in conserving energy. Also, this paper proposes an additional feature of saving time by turning manual work into automatic, that is to automate the user attendance system. The proposed prototype of "IoT Based Electricity Conservation and Biometric Attendance System" focuses on integrating the above two functionalities and can be accomplished using a PIR sensor and fingerprint sensor. If the PIR detects any motion, it sends a signal to NodeMCU which in turn triggers the relay to turn on the lights and turn off if no motion is detected. The fingerprint sensor scans the biometric of the person and marks attendance for that day.

Keywords-PIR sensor, NodeMCU, Energy conservation, Fingerprint sensor, Automation, Internet of Things, Cost-effective, Time conserving, Energy efficient.

I. INTRODUCTION

Using IoT (Internet of Things), devices with different functionalities can be connected over the Internet. In this project, two different features need to be integrated so the concept of IoT is used. The modules of this project are Energy Conservation System and Biometric Attendance System. Energy conservation involves turning on/off the lights if there are people in the near surroundings. In [1], to detect the presence of people PIR sensor is used. A PIR sensor is a type of IR sensor that monitors variations in the temperature radiated by nearby objects to detect motion. When motion is detected the PIR sensor outputs a high signal on its output pin which acts as an input to NodeMCU. NodeMCU is a microcontroller that is featured with Wi-Fi capabilities, analog pins, digital pins, and serial communication protocols. The logic signal from the PIR sensor can be read by NodeMCU which in turn sends a signal to the relay [1]. Then the relay supplies the volt to the connected devices which can be a bulb, a tube light, a fan, or any other electrical device. Thus, the control of the light intensity is accomplished through NodeMCU [2].

The second part of this project is to maintain an automated biometric attendance system through a fingerprint scanner. In [3], the fingerprint scanner used here is an optical fingerprint scanner which is quick and produces accurate results. This provides a good 2D image and a high resolution of the exact picture. This scanner uses an LED (Light Emitting Diode) light to illuminate the finger. The fingerprint image is scanned and developed by the sensor by identifying the light and dark regions produced by the fingerprint ridges and deduced by [3]. When a person touches their finger on the glass plate, which has a rough surface, the scanning process begins. Initially, when a new user comes in, they have to register their fingerprint through the website and their biometrics will be saved along with the user's information. Once registration is done, the device can recognize the fingerprint through already saved templates and mark the attendance of the users accordingly. Further, the user logs can be exported to excel and can be considered for further use [4].

Following are the sections that make up the remainder of the paper. The next section of the paper, section II narrates related works and problem statements. Section III presents process flow, a conceptual model that includes a flow chart, connection, and implementation. The results & discussion and conclusion are given in section IV which closes the paper by suggesting future research directions.

II. RELATED WORKS

Some of the previous works related to this paper are listed in this section. It has been recognized that IoT technologies play a crucial role in energy conservation in a variety of domains, including industry, transportation, health, and smart cities.

R. Yasodharan et.al stated that their IoT project will help the staff present in the classroom to allow them to control the classroom using an Android application. The overall system design is mainly based on Arduino Mega 2560. The Android application is developed using Blynk software or Blynk android application. We can supervise the state of sensors connected to the Arduino board and we can control the modules by simply enabling some options in the Android application on our smartphone [5].

In their paper, Isanka Diddeniya, Niroshan Gunawardana, Kaveendra Maduwantha, Kaveenga Koswattage, Mahadurage Viduni Randima, and Vasanthapriyan proposed a cost-effective energy-efficient Internet of Things (IoT) based device controlling system that can be used with minimum user interaction, in the case of operating any electrical device. The proposed prototype of "IoT Based Energy Efficient Smart Classroom" is implemented to reduce the wastage of electricity in a lecture hall at the Sabaragamuwa University of Sri Lanka. The system controls the operations of electrical devices (such as ON/OFF) by identifying the presence of humans in a specific area [6].

In the year 2021, Mohd Wafi Nasrudin, Nur Asyikin Nordin, Iszaidy Ismail, Mohd Ilman Jais, Amir Nazren Abdul Rahim, and Wan Azani Mustafa proposed that electricity-saving can be achieved through the efficient use of energy such as turning off lights and electrical appliances when not in use. Therefore, this work proposed the smart classroom for electricity-saving with an integrated IoT System to prevent wasting electricity in the classroom. The main objective of this work is to control the lighting systems and fans by using the IoT application and sensor system. Blynk application software is used to display the status of the classroom[7].

Tripti Jain et-al present light on simple, easier, and portable methods for student attendance in which IoT is used. The student's attendance is recorded using a fingerprint-based biometric scanner and then data is secured safely over cloud

storage. The system averts the proxy attendance, time will also be saved, thereby the reliability of students' attendance information is also maximized. The student's data are loaded securely over the cloud and can be easily fetched according to the need [8].

III. PROBLEM STATEMENT

There has been an increase in the use of energy in India since 2000, with coal, oil, and solid biomass accounting for 80% of the demand. Economic development, a growing population, and technological advancements are all contributing factors to increased energy consumption. Due to the fact that most of these resources are mostly non-renewable resources, they get depleted over time. It would be difficult for living things to live if all resources ran out. So, we should start conserving the remaining resources for future needs. Also, we need to start working on time management. Effective time management helps us to achieve our goals faster and increase productivity.

IV. CONCEPTUAL MODEL

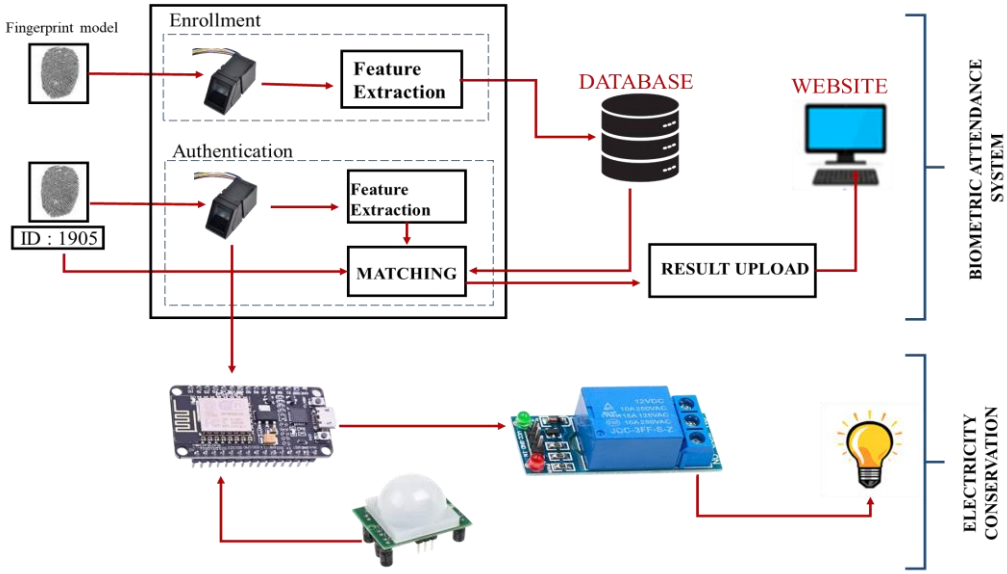

Fig.1. represents the complete architecture diagram of this project.

This involves two different modules namely,

A. CONSERVATION OF ELECTRICITY
B. FINGERPRINT-BASED BIOMETRIC ATTENDANCE SYSTEM

Getting focused on the first module 'Conservation of Electricity' is done using a PIR sensor. PIR sensors detect motion, usually used to determine whether a human has entered or left their range. Besides being small, inexpensive, and low-power, they are also easy to use and do not wear out. IR motion sensors are also known as PIR, passive infrared sensors, or pyroelectric sensors. By utilizing all these advantages, students' presence in the classroom is identified and lights are turned on and off accordingly. The second module 'Fingerprint Based Biometric Attendance System' involves a website to register their fingerprint and get details of their logging in and off timing. After registration, the students enter the classroom by making attendance with their fingerprints. Their login time will be noted on the website. Soon after the class ends, students are asked

to authenticate themselves with their fingerprints to calculate their log-off timing.

V. ARCHITECTURAL FRAMEWORK

This paper proposes two functionalities that are integrated into the Internet of Things. As a result of both of these functionalities, a reduction in manual work is achieved, which in turn saves energy. An IoT-based classroom electricity-saving system that saves more electricity than manual switching off appliances in a classroom will demonstrate the benefits of an IoT-based system in today's world, especially for saving electricity. As an added feature, a biometric attendance system has been integrated, which helps teachers manage the present and absent status of users with less effort. To implement this paper, we will be using a NodeMCU Microcontroller, PIR (Passive Infrared Sensor) and a Relay Control for conserving electricity, and Optical Fingerprint Sensor Module along with an OLED display for Biometric Attendance System.

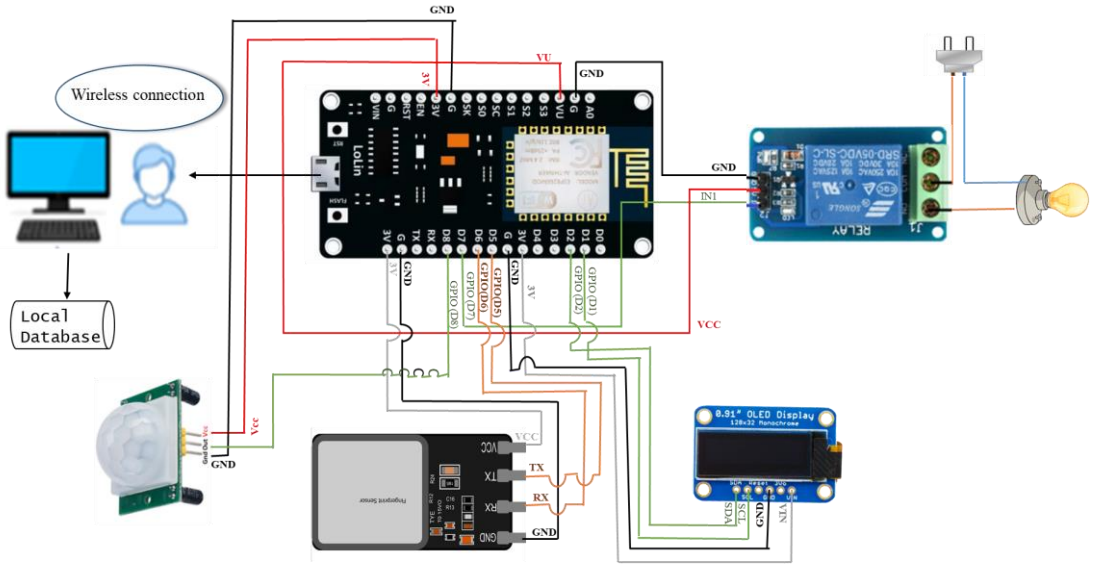

Fig.2. Circuit Diagram

Fig.2 apparently indicates the circuit diagram of this project where NodeMCU acts like a bridge for two features that are been discussed in detail in the following chapters.

Focusing on the explanation of the modules done in this project, this project is divided into two modules,

V.1. CONSERVATION OF ELECTRICITY

V.2. FINGERPRINT-BASED BIOMETRIC ATTENDANCE SYSTEM

Stepping toward the next part of the explanation,

V.1. CONSERVATION OF ELECTRICITY

1) Connections:

The pins (Output, Input, and Ground) of the PIR sensor and the pins (Output, Input, and Ground) of the Relay Module are connected to the NodeMCU ESP8266.

2) Implementation:

We have taken a classroom of size 6m by 6m, having 2 fluorescent tube lights. The next consideration was based on the Fresnel zone, thus the sensors were placed above the fan and the lamp so that the clearance is met, such that the sensors can detect every motion in the classroom to switch the fan or lamp automatically. The sensor will be able to detect body heat ranging from 0°C - 50

°C which is the average range comfortable enough for the system to detect the presence of users or an empty classroom.

After the data has been recorded by the PIR sensor, it will be sent to the microcontroller. The microcontroller has been programmed to do the following:

Table I: Procedure for Microcontroller

Steps	**Instructions**
Step: 1	Data is collected through the infrared radiation emitted by hot bodies.
Step: 2	An electrical signal is generated when the sensor detects infrared radiation. An internal PIR sensor has two halves, one of which is positive and the other negative.
Step: 3	Thus, one half detects a hot body's motion and the other half creates a signal.
Step: 4	Output signals are generated by the difference between the two signals.

Primarily, this sensor consists of Fresnel lenses which are bifurcated to detect the infrared radiation produced by the motion of a hot body over a wide range or specific area.

For the implementation of the design, the following software was used:

i) Windows operating system (windows 10)

ii) Arduino IDE (Integrated Development Environment).

The Pseudo Code for energy conservation using a PIR sensor has been mentioned in short. The concept mentioning pseudo code in this paper is to figure out some points like easy to understand even for non-programmers and can be quickly and easily converted into an actual programming language due to similarity to a programming language. It doesn't matter if there are errors in the syntax-it is usually still obvious what is intended.

3) Hardware Specification:

i) Specification of NodeMCU

In addition to its ability to act as a standalone system, ESP32 can be used as a slave device to a host MCU, reducing communication stack overhead on the main application processor. Through its SPI / SDIO as well as I2C / UART interfaces, the ESP32 can interface with other systems for Wi-Fi and Bluetooth functionality.

There is 128 KB of RAM and 4MB of Flash memory on the NodeMCU for storing data and programs. The device's high processing power along with its Wi-Fi and Bluetooth capabilities make it ideal for Internet of Things projects.

TABLE II. Hardware specification of NodeMCU

DESCRIPTION	SPECIFICATION
Microcontroller	ESP-8266 32-bit
Node MCU Model	Clone LoLin
Node MCU Size	58mm x 32mm
Pin Spacing	1.1" (27.94mm)
Clock Speed	80 MHz
USB to Serial	CH340G
USB Connector	Micro USB
Operating Voltage	3.3V
Input Voltage	4.5V-10V
Flash Memory/ SRAM	4MB/64KB
Digital I/O Pins	11
Analog In Pins	1
ADC Range	0-3.3V
UART/ SPI/ I2C	1/1/1
Wi-Fi Built-In	802.11 b/g/n

b) Specification of PIR Sensor

TABLE III. Hardware specification of PIR sensor

DESCRIPTION	SPECIFICATION
Model	PIR HC-SR501
Operating Voltage(VDC)	4.5~ 20
Average Current Consumption(mA)	0.06
Distance Measuring Range(CM)	300 ~ 700
Output Type	(High/ Low-level Signal)3.3V TTL output

V.2) FINGERPRINT-BASED BIOMETRIC ATTENDANCE SYSTEM

There are many types of biometric systems. This research paper is aimed at implementing a system that is capable of identifying students in institutes and marking their attendance. As a result, fingerprint recognition is used to mark the attendance of the students. This system provides flexibility in optimizing the attendance of the students, rather than identifying one by one the absentee's details manually.

i) Flow Chart:

Considering oneself as a new user, the user

has to register their fingerprint through the fingerprint sensor module and the registered data will be stored in the institution or an organization's database.

A new feature of this website extends the functionality of the fingerprint tracking system by allowing the administrator or supervisor to remove a user's fingerprint if he or she leaves the institution or leaves the campus.

Managing people's daily records is a difficult task for most organizations and maintaining their records is not an easy job. This biometric attendance system reduces the manual workload and effectively manages time. Based on the fingerprint stored in the institution's database, this track mainly involves extracting minutiae points from model fingerprint images and matching them with the stored fingerprints.

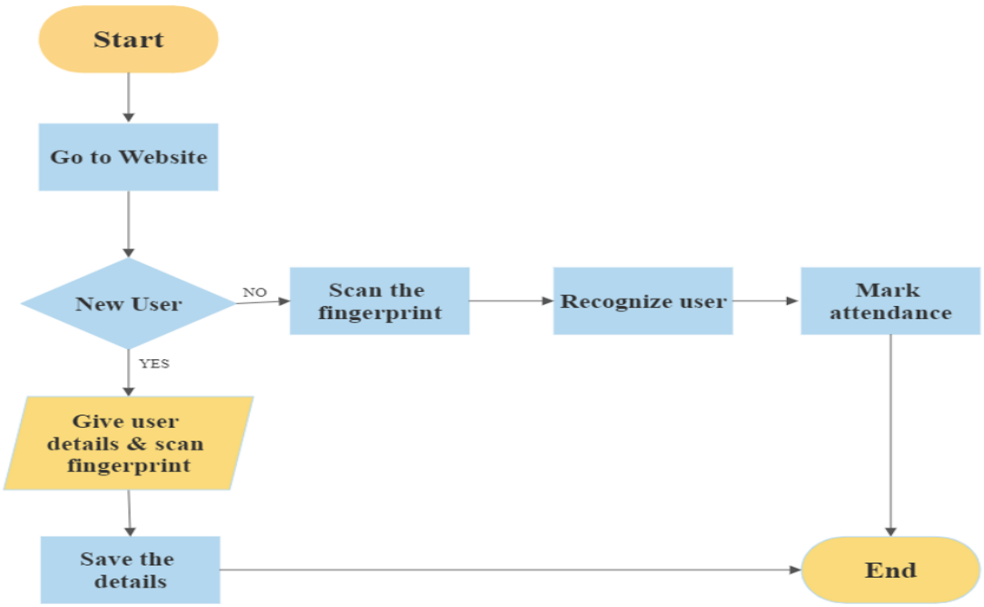

Fig.3. Flow chart of attendance monitoring website

ii) Connections:

The pins (Receiver, Transmitter, Voltage, Gnd) of the Optical Fingerprint sensor module along with the OLED display are connected to the NodeMCU ESP8266. The organic light-emitting diode (OLED), also called organic electroluminescent diodes (OLDs), is a light-emitting device in which emissive electroluminescent layers are organic compounds that emit light when a current flows through them. It consists of an organic layer that is sandwiched between two electrodes, with at least one electrode being transparent. OLEDs are used to create digital displays on televisions, computer monitors, smartphones, and portable systems such as handheld game consoles. Developing white OLED devices for use in solid-state lighting applications is a major area of research.

The fingerprint sensor is connected to the PC through Wi-Fi and the information is stored in Database for further retrieval and usage.

Implementation of the design was carried out using the following software:

A) Windows operating system (windows 10)
B) Arduino IDE.

The Hardware specifications are mentioned below,

iii) HARDWARE SPECIFICATION:

a) SPECIFICATION OF FINGERPRINT SENSOR MODULE:

TABLE IV. Hardware specification of a fingerprint sensor module

DESCRIPTION	SPECIFICATION
Model	AS608
Resolution	500dpi
Supply Voltage	3.3V
Peak Current	<60mA
Window area(mm)	15.3 x 18.2

4) Implementation:

Initially, users are asked to register for their fingerprint through the website. The fingerprint sensor and PC are connected via Wi-Fi and the sensor gets transmitted & received through NodeMCU. Databases are used for maintaining the user's attendance record.

Immediately after the registration and authentication process is complete, time in is recorded while the user enters the classroom by using fingerprint-based biometric attendance, and time out is recorded on exit. You can export all these user logs (Name, serial number, fingerprint ID, Time In, Time Out, and Date logs) in Excel.

A. Energy Conservation System

VI. RESULTS & DISCUSSIONS

By implementing the energy conservation and biometric attendance system, we were able to achieve the objectives of this project that is to conserve energy and to save human time by turning manual work into automatic.

Here are the snapshots of this project module taken during the system execution. Each snapshot specifies different features that are implemented in this project.

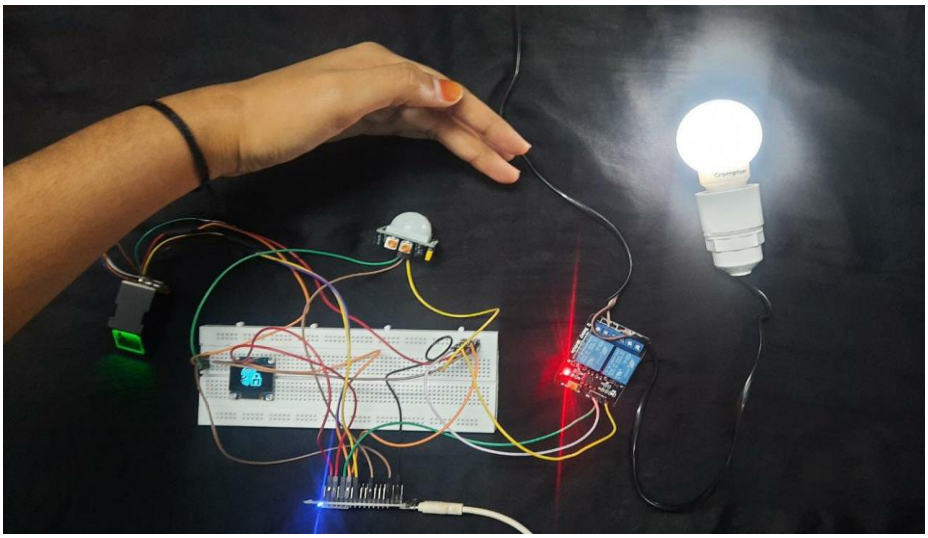

Fig.4. Implementation of energy conservation system

Based on the specified objective, energy conservation has been accomplished cost-effectively with the help of a PIR sensor as shown in Fig.4. This figure demonstrates energy conservation through motion detection. When the user enters the room, the motion detection load is operated. So, the user need not consider turning on/off the appliances.

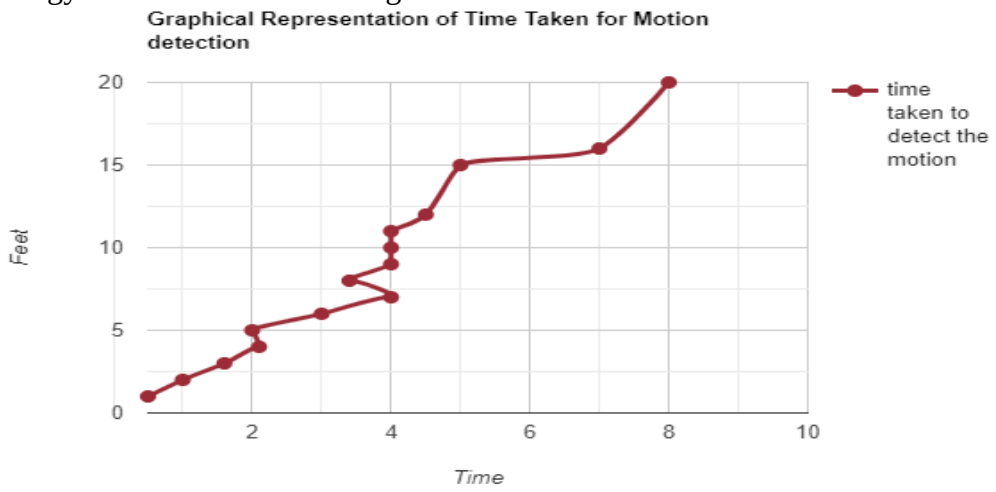

Fig.5. Graphical representation of Time Taken for Motion Detection

The linear representation of the graph shown in Fig.5 demonstrates the relation between time and distance (in feet). The PIR sensor used in this project covers a distance of 20 feet and the average time taken to cover this distance is 6 seconds.

A detailed description of the graph involves the x-axis which represents the time taken to detect and the y-axis which represents the number of feet covered by the PIR sensor. This graph does not produce an exact linear report but can be produced by sensitivity adjustments.

The sensitivity adjustment can be done by using the screw in the PIR sensor, turning them anti-clockwise up to which the desired sensitivity is being achieved.

B. Biometric Attendance System

Getting focused on the second functionality, the main goal of saving time has been fulfilled with the help of the registration website and AS608 Fingerprint Sensor Module.

The process proceeds in this manner, initially, the user is asked to register and authorized themselves with their fingerprint and with additional information like email ID and roll number.

Along with registration addition operations like updating and deletion can be done on the same website so that any changes in the existing user's details can be performed and any user dropping out from the institution or organization can be permanently deleted. Fig.6 illustrates the above-mentioned statement.

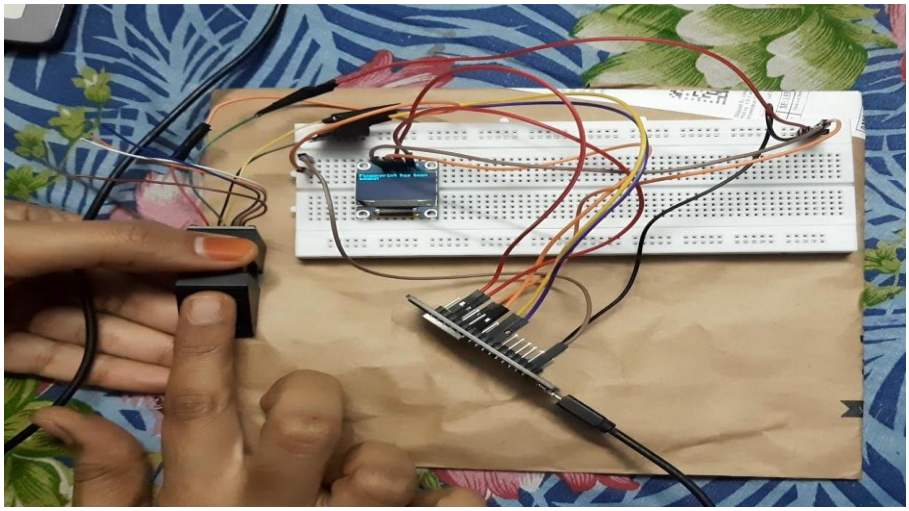

Fig.6. Registering your fingerprint for the first time through the website

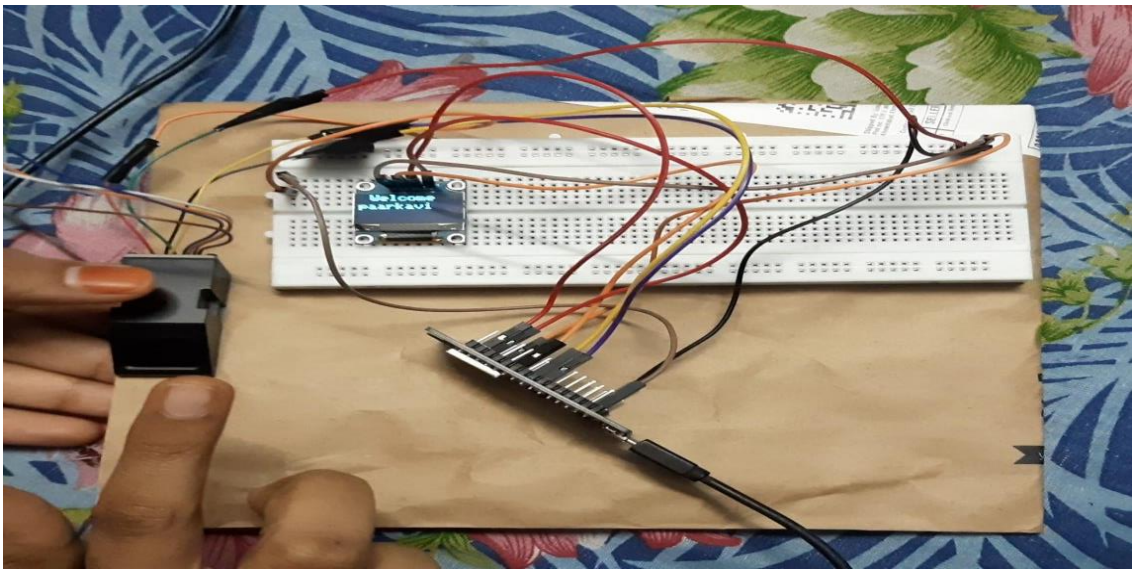

Fig.7. Welcome message displayed on the LED after it recognizes the user

Fig.7 manifests a welcome message for new users and gives them an identity. Once the user has been registered successfully each user gets an authorized fingerprint ID that helps the module to differentiate each user.

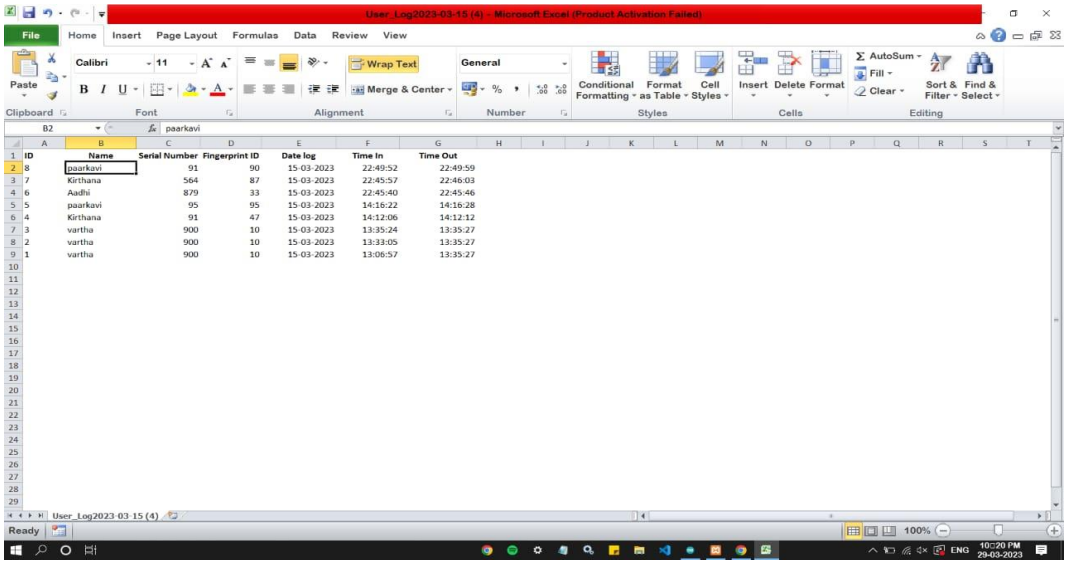

Fig.8.Attendance report downloaded as Excel

Once the attendance record has been completed, the one who handles the session can get all these records in the form of an Excel sheet which can be downloaded from the website. The snapshot of the downloaded Excel has been presented in Fig.8. And the Excel sheet that is generated through the website includes the fields like user name, fingerprint ID, roll number, date, log-in time, and logout time.

VII.FUTURE WORK

We have developed this system using a breadboard, which is a board for prototyping. In the upcoming future, we have planned to develop the system as a real-time working product using PCP (Primary Cross Connection Point). PCPs are control panels for all cables that go on to the data processor from the exchange. The main lines from the exchange terminate here. The PCP is responsible for controlling all cables leading to the DP.

Also, this system can be further enhanced by incorporating a sensor to measure room temperature and light intensity so that fans can be switched on if the temperature is high and lights can be turned on only when the surroundings are dark. As a result, we will be able to save even more energy than usual.

VIII. CONCLUSION

This paper presents an IoT-based energy conservation system that uses passive infrared radio sensors to turn off lights in classrooms when users aren't present and a Biometric attendance system using Fingerprint sensors to maintain users' attendance reports. The electricity conservation system was placed in a range (6 feet surround) and connected to the light that covers that particular area. Biometric Attendance system reduces the workload of staff through automation. The cumulative of these systems comes with the advantage of saving energy, time, and cost.

REFERENCES

[1] Cynthia Twumasi, Koffi Agbeblewu Dotche, Francois Sekyere, Energy saving system using a PIR sensor for classroom monitoring, IEEE, 2017

[2] Talal H Noor, El-Sayed Atlam, Abdulqader M. Almars, Ayman Noor, Amer S.Malki, IoT Based Energy Conservation Smart Classroom System, Intelligent Automation and Soft Computing, Volume 35 Issue 3, 2023

[3] M. A. Meor Said, M.H. Misran, M. A Othman, M M Ismail, Biometric Attendance, International Symposium on Technology

Management and Emerging Technologies (ISMET 2014), May 24, 2014

[4] Aswinth Raj, IoT-Based Biometric Attendance System using Arduino and Thingsboard, May 2019

[5] Yasodharan R, Bennaiah D, Hari Krishnan V, Karthick S, Prince Roy, IoT Based Classroom Automation Using Arduino, International Journal of Trend in Scientific Research and Development, Volume 2 Issue 2, February 2018

[6] Isanka Diddeniya, Niroshan Gunawardana, Kaveendra Maduwantha, Kaveenga Koswattage, Mahadurage Viduni Randima, Vasanthapriyan, IoT based Energy efficient smart classroom, International Journal of Multidisciplinary Engineering Science Studies, Volume 6 Issue 12, December 2020

[7] Mohd Wafi Nasrudin, Nur Asyikin Noordin, Iszaidy Ismail, Mohd Ilman Jais, Amir Nazren Abdul Rahim, Wan Azani Mustafa, Smart Classroom for Electricity saving with Integrated IoT system, Journal of Physics: Conference Series, Volume 2107, October 2021

[8] Tripti Jain, Urvashi Tomar, Umang Arora, Swati Jain, IoT-based Biometric Attendance System, International Journal of Electrical Engineering and Technology, Volume 11 Issue 2, May 2020

[9] D Sathiyaraj, Jeevanantham M, Dayalan S, Hariharan M, Suraj Punj, Classroom Automation Based IoT, Journal for Multidisciplinary Research Volume 11 Issue 4, 2021

[10] Shyamli u. Kamane, Akshay S. Bhoyar, Shubham V. Kusange, Swati M. Gajbe, Stuti S.Patil, Smart Classroom Automation System using Arduino and IoT, International Journal of Research and Analytical Reviews, Volume 7 Issue 1, March 2020

[11] Vishal Kolambkar, Tejas Patil, Sagar Anute, Prof. Rasika Shintre, Smart Classroom Automation Based on IoT, International Research Journal of Engineering and Technology Volume 7 Issue 3, March 2020

[12] S.A.I.P. Diddeniya, H.D.C.N. Gunawardana, K.Maduwantha, K.R.Koswattage, IoT Based Energy Efficient Smart Classroom, Journal of Multidisciplinary Engineering Science Studies, Volume 6 Issue 12, December 2020

[13] Kaustav Mani Pathak, Priyanka Jain, Swati Yadav, Veena Mittal, Prateek Jain, An IoT-based Mechanism for Automatic Classroom Electricity Saving, IEEE, October 2019

[14] Ganesh Kakade, Prathamesh Shivpuje, Sanket Awale, Shubham Rawale, IoT Based Classroom Automation System, International Research Journal of Engineering and Technology (IRJET), Volume 6 Issue 12, December 2019

[15] Sebastian Chennattu, Aditya Kelkar, Aaron Anthony, Sushma Nagdeote, Portable Biometric Attendance System using IoT, IEEE, November 2019

[16] Sri Madhu, Kavya Kanagotagi, Devansh, IoT-based Automatic Attendance Management System, International Conference on Current Trends in Computer, Electrical, electronics and Communication (ICCTCEEC-2017)

[17] K C Arun, Mubashir Ali, Ayesha Siddique, Muhammad A Asim, Zaka Ullah, Energy Efficient Classroom Automation using IoT, June 2017

[18] Mohammad Kamrul Hasan, Musse Mohamud Ahmed, Bishwajeet Pandey, Hardik Gohel, Shayla Islam, Izzul Fitrie Khalid, IoT-Based Smart Electricity Monitoring Control System Using Usage Data, Wireless Communications and Mobile Computing, Volume 2021, October 2021

[19] Prabesh Paudel, Sangkyoon Kim, Soonyoung Park, A Context-Aware Architecture for Energy Saving in Smart Classroom Environments, IEEE International Conference On Consumer Electronics, 2019

[20] Fawaz Alassery ,A Smart Classroom of Wireless Sensor Networks for Students Time Attendance System, IEEE Integrated STEM Education Conference (ISEC),2019.