A Design of Smart IoT-Based College Room Using Arduino

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Abstract. Electrical appliances and local switches can be controlled distantly by utilizing the Internet of Things (IoTs) communication protocols. Those devices can be accessed and operated through mobile phones. A smart college room is one of the applications in smart campus which worked by means of Wi-Fi existence for distant observing of electrical devices or switches in the particular room. Hence, this paper describes the project’s design and development based on IoTs by implementation of Arduino. The project applies Arduino MEGA 2560 board in conjunction with ATmega2560 chip. The main controller (ATmega2560) is used to connect the board with Wi-Fi module as well as to control DC motor, servo motor and LED in the project. The inputs need to be controlled in the room are lights, fan, sliding door and curtain. Since internet is the sub-core to this project, it helps the project system to acknowledge what user has decided in their mobile phones. For instance, when user wants to turn light in the room, he can simply do it by touching the respective button in the mobile phones. The project is purposely designed for preventing electricity wastage among students which usually happens in colleges. Besides, it promotes accident-free environment while operating the electrical appliances or switches in the room.

1. Introduction
Living in this world today, it can be seen that technology has become essential and necessary to many lives. To date, there are lots of systems as well as applications are transformed tremendously from being conservative to technology-improvised. Having Internet of Things (IoTs) recently has made the technology development evolves swiftly[1]. It is now being a platform which is very common to many people around the world. IoTs can be explained as a medium in connecting gadgets or any devices such as mobile phones, internet televisions and sensors to the internet. All the devices are connected together allowing different forms of communication between things and people and vice versa. Among the applications affected by the IoTs growth in technology, smart room is one in the list. The existence of smart room has led to many purposes. Some of the reasons are for helping elderly and handicapped patients [2], for monitoring air quality [3], for detecting occupancy status [4], for observing energy power consumption [5], for curbing light wastage [6] and many more. Back in few years ago, Bluetooth was the popular technology to execute home automation [7]. Thus by having IoTs around, it has advanced
substantially in the last recent years as it enhanced and improved the world of communication and information technology.

This project can solve lots of problems that usually happen in college, for instance, electricity wastage amongst students, electricity-related accidents, electrical short circuit situation and many more. These problems can cause danger to the students as well as tarnish the institute’s reputation. Hence, the project is proposed to control electrical usage in college room plus to improve its facilities in offering maximum comfort to the students. The main interest for this project is to design and implement a college room automation system which is able to control and automate most of the electrical appliances in the room by using IoTs via mobile phones. The proposed system has excellent flexibility to communicate its distributed sensors to home automation server by using Wi-Fi technology.

For this project, the design and development of the smart college room is constructed based on Arduino MEGA board. The board has ATmega2560 that acts as main controller which will interact with Wi-Fi serial transceiver module. This will help the communication between the board and the mobile phones provided that internet connection is good throughout the process. The interaction occurs for the user to monitor the electrical appliances in the particular room. This system operates completely on wireless network since Wi-Fi module (ESP8266) is used to do such task. It allows internet access to the whole system by assigning an internet protocol (IP) address when connected to the network.

When user checks the usage of electrical appliances he has in the room via his mobile phones by implementing Blynk App, he also can decide to turn on or off the electrical appliances instantly. Through his mobile phones, he is now capable in observing the electrical status of his room remotely on condition that the internet is accessible during the practice. Instead of conventional method, the switching operation and equipment in the room can be done by touching on mobile phone’s screen. Furthermore, risk in handling electrical appliances can be reduced compared to the usual method.

2. Methodology
The development of this project is partitioned into two main parts which are hardware construction and software elements. In the hardware construction, the circuit for the whole system is fabricated in PCB lab and its prototype model of the project is developed. However, for software details, the entire working system is programmed by means of Arduino IDE (programming software).

2.1 Hardware architecture
Arduino MEGA has been chosen to be the main controller board for this project. The microcontroller on the board used is ATmega2560 which acts as a core controller. It will run the system according to the program set in the software development. This board is purposely designated for more complicated projects. By having 54 of digital input/output(I/O) pins and 16 of analog inputs pins, this is actually sufficient for all the inputs needed in the project.

For the board, it includes everything required to sustain the microcontroller by just connecting it to a personal computer with a USB cable. Else it can be powered up by using AC-to-DC adapter or battery. The board is also fitted with most of shields offered in the market that are suitable with UNO. As for the program codes, Arduino has its own software applications named integrated development environment (IDE). The software serves completely for any C or C++ programming languages. Figure 1 shows the Arduino MEGA board with ATmega2560 controller on the board.
Figure 1. The Arduino MEGA board utilizing ATmega2560 as the microcontroller.

For Wi-Fi serial transceiver module, ESP8266 is chosen to allow microcontroller in the Arduino MEGA board to access any Wi-Fi network. This module has an on-board processing and storage feature that enables it to be incorporated with sensors and other application-specific devices through its I/O with minimal up-front growth and minimal runtime loading. This module supports Bluetooth and Automatic Power Save Delivery (APSD) for Voice over Internet Protocol (VoIP) applications as well. It consists of self-calibrated radio frequency permitting it to operate under all conditions with no requirement of external radio frequency parts. Since the module is a low cost type yet simple [8]–[11], the module is a common choice for other researchers too. It does not have a voltage regulator circuit on board, but it can handle current of 300mA or more with only limitation voltage at 3.3V. Hence, when using Arduino, an external 3.3V voltage regulator needs to be applied. Figure 2 portrays the Wi-Fi module used; ESP8266.

Figure 2. The Wi-Fi Serial Transceiver Module ESP8266.

Other than two main components mentioned in figure 1 and figure 2 above, another important feature that is used for this project is Blynk Application. Blynk apps is a medium to control Arduino, Raspberry Pi, or any platform used for designing electronics projects regardless of its operating system; iOS or Android provided that it has internet accessibility at anytime and anywhere. The apps is a digital dashboard where user can simply drag and drop widgets to build a proper graphic interface for their own project [12], [13]. Figure 3 exhibits the home page in Blynk apps for the project. In this project, the inputs that need to be controlled are lights, curtain and sliding door.
Figure 3. Home page in Blynk apps for the project.

Figure 4 shows the block diagram for the smart college room based on IoT by using Arduino while figure 5 displays the hardware architecture of the whole project. The hardware design involves one main component which is the connection between Arduino MEGA with Wi-Fi module of ESP8266. This allows Wi-Fi connection to be accessed by Arduino MEGA. Thus, Arduino MEGA can perform any task by activating selected input from user in his mobile phone. For instance, if a user wants to open up the sliding door, user only needs to slide to the most right in Blynk apps. Input from Blynk apps will notify Arduino to give command to servo motor to rotate, hence sliding door will open up. Similar case will apply for lights and fan to turn on or off and sliding curtain to open or close.

Figure 4. Block diagram of the smart college room.
2.2 Software development
For the software of the project, it is based on flowchart drawn in figure 6. When the system starts, user will be directed to the main page in Blynk apps designated for the project. User will be given four options to choose. The first option is whether to switch on or off the light, second is the option for turning on or off the fan, third is for opening or closing the sliding door and the fourth option is for opening or closing the room curtain. With one touch, user is able to control his electricity usage in the room as long as the internet connectivity for his mobile phone as well as Wi-Fi network in the college is perfectly fine. Figure 7 shows the pseudo codes of the complete project. The entire program codes are then set by referring to figure 6 and figure 7 in Arduino IDE.

START

switch (input)
{
    case (1): if LIGHT pressed
               LIGHT ON or OFF
    case (2): if FAN pressed
              FAN ON or OFF
    case (3): if SLIDING DOOR slide
              DOOR OPEN or SHUT
    case (4): if CURTAIN slide
              CURTAIN OPEN or SHUT

END input

Figure 6. Flowchart of the smart college room.

Figure 7. Pseudo code for the project based on the flow chart.

2.3 Schematic diagram
The project hardware architecture diagram is portrayed in Figure 8 whereas Figure 9 shows the schematic diagram of the connection between Arduino MEGA with Wi-Fi module (ESP8266) as well as DC motor and servo motors by using Fritzing software. Due to limited components in the Fritzing software, Wi-Fi
module is not present in the software. Therefore, it was replaced to another input connector available which has the same pins like Wi-Fi module has. In Figure 10, it describes the program codes used for connecting ESP8266 with Blynk apps in mobile phone. To start Blynk apps, user needs to have a unique identifier which is called Auth Token. Auth Token will connect the hardware to the mobile phone. When a new project is created, the token will be automatically generated for the project. The token will recognize promptly the hardware part and perform as a proof that the hardware acknowledges whatever user sets in the mobile phone. User needs to download Blynk library (in the official Blynk website) so that it can be called upon running the program in Arduino IDE.

![Project hardware architecture diagram](image1)

**Figure 8.** Project hardware architecture diagram.

![Schematic diagram for connection between Arduino UNO board with GSM module and LM35](image2)

**Figure 9.** Schematic diagram for connection between Arduino UNO board with GSM module and LM35.

```c
#define BLYNK_PRINT Serial
#include <ESP8266_I.h>
#include <BlynkSimpleShieldEsp8266.h>

char auth[] = "ac8e8101b4d642a847b2f0b84e3b7f";
char ssid[] = "maan";
char pass[] = "1234567890"

#define ESPSerial Serial1
#define ESP8266_BAUD 115200

ESP8266 wifi&Serial1;
void setup()
{
  Serial.begin(9600);
  delay(10);
  Serial.begin(ESP8266_BAUD);
  delay(10);
  Blynk.begin(auth, wifi, ssid, pass);
}

void loop()
{
  Blynk.run();
}
```

**Figure 10.** The program code for connecting ESP8266 with Blynk apps.

3. Result and discussion

Few tests were carried out to examine the performance of the system. The tests consist of turning on and off the lights, turning on and off the fan, opening and shutting the sliding door as well as curtain. Figure
11, Figure 12, Figure 13 and Figure 14 show all the observed result respectively. As soon as the program starts, user is only required to monitor his electrical appliances on his mobile phone. When he insists to turn on or off lights in his room, he only needs to press once at the button LIGHT in Blynk apps on his mobile phone. Similar steps are needed for turning on or off the fan. For sliding door and curtain to be opened, user needs to slide the slider option in the Blynk apps. If user slides to the most right, it will trigger motor to rotate clockwise and eventually open the sliding door or curtain while sliding to the most left will cause the motor to rotate counterclockwise hence shutting the door or curtain off.

**Figure 11.** When lights are set ON.

**Figure 12.** When fan is pressed ON.

**Figure 13.** When sliding door is set to open (slide to the most right).

**Figure 14.** When the curtain is adjusted to open (slide to the most right).

Table 1 displays the analysis of results obtained after testing the software development together with the hardware construction. When “LIGHT” button is pressed on the mobile phone in Blynk apps, the designated light will turn on instantly. Whenever user wants to turn the off the light, he just needs to touch again the “LIGHT” button on the Blynk apps. Similar steps are needed to turn on or off the fan in the college room. User only needs to slightly touch the “FAN” button on the Blynk apps. But for sliding door and curtain to be open or shut, user needs to slide the slider on the Blynk apps to the most right and left respectively.

| Case | Input via Blynk | Output |
|------|-----------------|--------|
| 1    | Press button on at “LIGHT” section to turn on/off the LED | Lights will turn on/off |
| 2    | Press button on at “FAN” section to turn on/off the fan | Fan will turn on/off |
| 3    | For “SLIDING DOOR” section, user needs to slide the slider to the right(open) | Sliding door will open/shut |
4. Conclusion
In conclusion, this project is designed to enhance the conventional method of conducting electrical appliances in the college room to become one-touch solution for all. It is considered as an automatic system since user can monitor and control the electricity in his college room through mobile phone remotely, provided that the internet connection is available for both parties. This system employs IoTs technology which enables everything to be controlled and organized by means of internet accessibility. Upon completing the project, it is believed that a lot of improvements can be offered pertaining to electricity saving, college facility, user safety issue and current technology involvement. Furthermore, the designed system is inexpensive due to minimal usage of components throughout the project.

References
[1] Coelho S, Rozario R, Sharma R, and Mehra M 2018. An IOT Based Smart Cubicle System for Effective Power Usage and Employee Monitoring in Offices, 2018 Int. Conf. Smart City Emerg. Technol. ICSCET 2018, pp. 1–6.
[2] Nath P and Pati U C 2018. Low-Cost Android App Based Voice Operated Room Automation System, 2018 3rd Int. Conf. Converg. Technol., pp. 1–4
[3] Spachos P, Lin J, Bannazadeh H, and Leon-garcia A 2015. Smart Room Monitoring through Wireless Sensor Networks in Software Defined Infrastructures, pp. 216–218.
[4] Tran L D, Stojcevski A, Pham T C, De Souza-daw T, Nguyen N T, and Nguyen V Q, 2016. A Smart Meeting Room Scheduling and Management System with Utilization Control and Ad-hoc Support Based on Real-Time Occupancy Detection, pp. 186–191.
[5] Arya A K, 2018. Smart Energy Controller for Energy management using IOT with Demand Response, 2018 IEEE 8th Power India Int. Conf., pp. 1–6.
[6] Coelho S, Rozario R, Sharma R, and Mehra M, 2018. An Iot Based Smart Cubicle System For Effective Power Usage, Int. Conf. Smart City Emerg. Technol., pp. 1–6.
[7] Verna M, Sigh S, and B Kaur, An Overview of Bluetooth Study, 2015. Int. J. Curr. Eng. Technol., vol. 5, no. 3, pp. 1588–1592.
[8] Mesquita L A J, Guimaraes D, Pereira C, Santos F. 2018. Assessing the ESP8266 WiFi Module for The Internet of Things.
[9] Srivastava P, Bajaj M, and Rana A S 2018. Overview of ESP8266 Wi-FI Module Based Smart Irrigation System using IoT.
[10] Thati Y V N J, Kumari P V, 2017. Controlling of Home Appliances Through Internet, Int. Conf. Energy, Commun. Data Anal. Soft Comuting.
[11] Singh P and Saikia S, Arduino-Based Smart Irrigation Using Water Flow Sensor, Soil Moisture Sensor, Temperature Sensor and ESP8266 WiFi Module.
[12] Todica M 2016. Controlling Arduino board with smartphone and Blynk via internet.
[13] Doshi H S 2017. Internet Of Things (Iot): Integration Of Blynk For Domestic Usability, Vishwakarma J. Eng. Res., vol. 1, no. 4, pp. 149–150.
Acknowledgements
We would like to thank all the lab assistants in Faculty of Electrical Engineering Universiti Teknologi MARA Terengganu Branch, Malaysia for their help and support in completing this project. Their constructive comments have assisted us much and bettered the project significantly in so many ways.