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Energy smart saving classroom with IoT based

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Abstract. A smart lecture room system is an approach to a complete solution for both building managers and users from a classical lecture room. This project is made to control the access of the lecture room automatically using a magnetic door lock. The system is controlled by the smartphone-based application with Wi-Fi connection. The access control system comes with energy-saving capability which is control the power supply. The system is also equipped with a security attribute as it embedded with motion detectors. This system is for detecting intruders who have no permission to enter the lecture room and make it more secure. Therefore, this device can be applied for general used to improve the current smart lecture room system.

1. Introduction

The university has more than 100 lecture rooms to be managed and monitored. Unmanaged and low-security lecture rooms could lead to electrical wastage and damage or loss of important electrical appliances due to many unregistered users. The university has resourced to contractors to manage the lecture rooms. Universiti Tun Hussein Onn Malaysia (UTHM) decided to go for an implementation of a smart saving lecture room management system. This implementation could reduce the cost of labor especially the cost to hire a third-party contractor and also minimizing the cost of keys, padlock, and storage keys space for various types of conventional lock sets for each different type of door in UTHM lecture rooms. The implementation also can reduce the workforce and manpower in locking and unlocking the lecture rooms door in the university. Energy saving smart classroom is proposed to save cost on hiring contractors, better monitoring and data logging of the room usage, a better-controlled usage to registered users or academic schedule arranged by the university and to save amount of cost spend in electricity bill.

The intelligent door locking system based on the Internet of Things is one of the innovations in high security technology. This system consists of two features which are energy saving technology implementation and security system. The purpose of this project is to simplify locking and unlocking

activities and to improve the reliability of the door locking system.[1].Therefore, the objectives of this project are:

1. To customize an IoT based lecture room solution uniquely for UTHM main campus.
2. To develop door lock system of lectures room.
3. To develop indoor and outdoor lighting control system.

2. Literature Review

2.1. Internet of Things (IoT)

The Internet of Things is a network that combines information and energy mechanisms to track very large collections of different objects. The evolution of the Internet of Things makes it clear that morphogenesis is the most enigmatic biological capability of life systems. The operating facilities for the so-called software Internet of Things come from the physical world cell automation network, where the all-encompassing structure of the holographic universe emerges. The Internet also links information sources to individuals. There will be another aspect to the field of information and communication systems and accessibility for anything, in addition to connectivity at all times and elsewhere. The Internet of Things (IoT) consists of smart devices, such as mobile phones, computers, alarms and appliances, and industrial machines that are always connected to the Internet. The IoT scale will involve thousands of linked devices, all of which could provide information and many can take action on the basis of the information received. With the Internet of Things in Technology, it's easier to solve problems than any computer, and the Internet of People is a super brain to solve time-critical problems [2]. In order to keep them up-to-date with the status of their data, a modern network architecture and protocol network interacts with other network devices. The Internet feature of the computer in the security mechanism is a single security process that communicates and updates its status to nearby devices. If a security violation occurs on a single device, an alert against a compromised device will flood the network, ensure that other devices are still in search of an attack, and protect them from node attacks.

2.2. A survey of Wi-Fi Technology in Control Remote Devices

Wireless Internet networks do not have a physical link between the transmitter and the receiver using the Radio Frequency (RF) Radio Wave Transmission Technology (RF)-Associated Electromagnetic Spectrum Frequency. When an antenna has an RF current, an electromagnetic field is produced that can spread over space. The Access Point (AP) is the basis of any wireless network. The main task of the access point is to receive a wireless signal from a computer and to "stun" it. Computers and tablets should be equipped with wireless network adapters for connecting to the access point and entering the wireless network. [3]. Wireless Network provides cost-effective solutions, including remote control and monitoring, for a variety of applications. A variety of remote monitoring, monitoring and control systems, including remote control systems, anti-theft vehicle control systems and smart door locking systems, are also being developed using Internet Wi-Fi technology. The remote control system has been designed to monitor remote uses. The Intelligent Control System consists of three main components: the server, the hardware interface module and the application package. The router and hardware interface module communicate via secure Wi-Fi technology. Users can use the same technology to sign up to the Web. If the server is connected to the Internet, remote users can access web-based applications on the Internet using a compatible web browser. Appropriate web-based asp.net technology can be accessed from a network via an IP server (internet IP) from any local PC on the same LAN or remotely from any internet connected PC or mobile device. The network infrastructure linking devices and controller modules to hardware is chosen as WiFi technology. Wi-Fi is chosen to improve network security and increase device efficiency and scalability by using a secure Wi-Fi connection. Even if the user needs to add new hardware interface modules, a repeat or controlled wireless LAN solution will solve this problem perfectly. The main functions of the server

are the management, control and monitoring of confused system components, allowing hardware interface modules to perform assigned tasks (by actuators) and to notify servers of events.

2.3. Smartphone

IBM and BellSouth launched the first joint smartphone in 1994. In addition to the mobile phone features, Simon included a calendar, an address book, a global clock, a calculator, a note pad, an email and games. Instead of normal buttons and one MB of RAM and one computer memory each, the touch screen could also be extended via an external slot. Hybrid technology, which integrates a mobile phone with a personal digital assistant (PDA), has been launched in the next decade or so. Most of these devices are running Windows Palm OS or CE Pocket PC. Some of the devices have a stylus to choose objects on the screen. Applications from third parties may be downloaded or incorporated with a Mac.

Mobile production started in 2007 and Nokia introduced the N95, with most of the standard smartphone features. Autofocus sensor A5-megapixel (MP) and flash and Wi-Fi networking, GPS connectivity. That year, Apple launched its first iPhone. It includes the Apple iOS and iPod Touch operating systems, which allow developers to develop software for both devices. Two major technologies have stepped up the smartphone market in 2008. Initially, Apple released its second iPhone and SDK debut in the Apple App Store. It lets developers build iPhone apps that allow users to download and install without a Mac connection. Apple has also made a separate iphone model. The iPhone was the first device to be developed. The way people listened to and bought music has changed with the iPod Touch. Apple has used the knowledge gained from the design and development of the iPod Touch user interface and put it on the iPhone. Apple has found that the delivery of content to a device is just as important as the output of a working device. The only way to load your music is via iTunes on an iPod. From the point of view of both the user and the developer, Apple is running a closed control system for iPhone applications. Apple also acknowledges all applications that comply with the App Store and reserves the right to reject unauthorized applications.

Android is an open-source platform that provides all system services to users. Google released the second version of Android OS. Google wanted to encourage developers to access the full core operating system by enabling third-party applications. It's all seen as an unlimited Android app. Google also included open-source SDK and mobile applications such as Gmail, Calendar, Maps and the Chrome Web browser. Android is an OS and an application development software platform. A wide range of applications, including web browsing and e-mail for daily business, are included in mobile apps [4].

2.4. Blynk Software

Blynk Software is used to integrate the system with all of the lecture room appliances, this integration is called the Internet of Things or IoT. By having this system, any person that is is responsible for the lecture room can control the access of the lecture room by controlling the door lock and monitoring via the detection of motion sensors. Blynk is a smartphone-based software application that is able to control and monitor Arduino, Raspberry Pi and any other microcontroller via the internet. A variety of widgets are available in the software interface to help syncing with the hardware used. The software works both on iOS and Android. The Blynk Graphical User Interface (GUI) allows the user to design their own user interface according to necessities. The icon provided can be assigned to their respective hardware by assigning the connected hardware pins. Only dark and light themes are available at this time. The names of the pins can be changed according to needs. The user needs the authentication token to enable the connection between the microprocessor and the software.

2.5. Smart classroom

Classroom administration, lecturer rooms, laboratories, and open spaces and in every institutions the effective use of such tools is challenging challenges. With IoT evolving, the management of these resources can be automated. Methods to automatically record activities and monitor resource usage inside classrooms in real-time are usually intricate [5]. Through applying smart technologies in real-

world space the Smart Classroom initiative connects the classroom with the in terms of teacher experience, gap between tele-education and traditional classroom activities and these two currently separate educational practices are seamlessly integrated.

3. Methodology

Development of this project start with monitoring four lecture rooms in Blok G3 as shown in Figure 1. Solution of each room is identical, involving switching On or Off the electrical compliance. Three major parts are divided which are alternating current (AC) with high power control and circuitry, direct current (DC) with low power control and WiFi unit, also networking and user interface. As for the Part 1, this project needs the block diagram of the whole project, schematic for the AC and high power control and the circuitry, the networking mesh and IP address also computer dashboard and user interface. Next development part for DC and low power control and WiFi unit for each room is needed. This is includes a unit WiFi module with micro-controller and DC power supply. Each WiFi module would be configured as part of the networking via TCP/IP agreed with PTM (Pusat Teknologi Maklumat). The customized coding would be written to the micro-controller. Next, a specific outputs are assigned to switch on DC relays where they are electrically isolated to AC power compliance which are lamp, electromagnetic controller doors (EM lock), air conditioners and alarm/buzzers. A customized web page also would be developed to remotely control each WiFi unit.

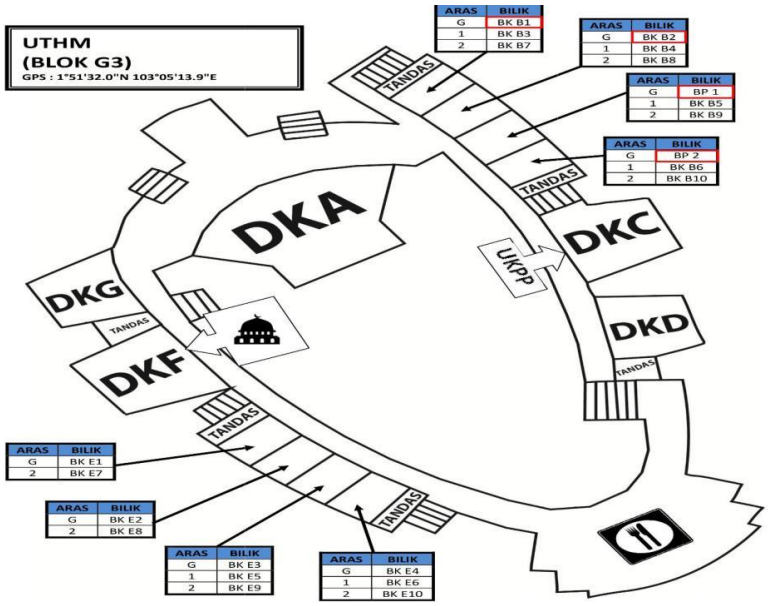

Figure 1 Lecture Room Layout Plan (BK B1, BK B2, BP 1, BP 2.

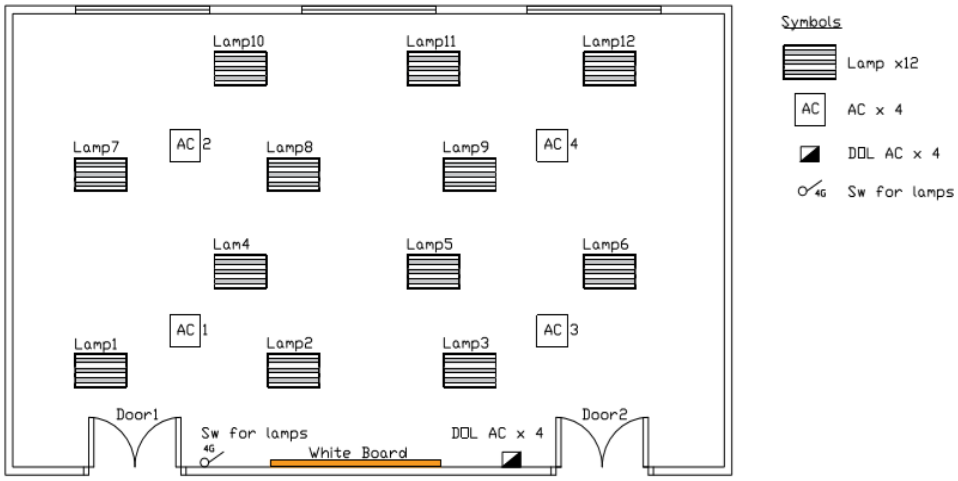

Figure 2(a) Existing Layout

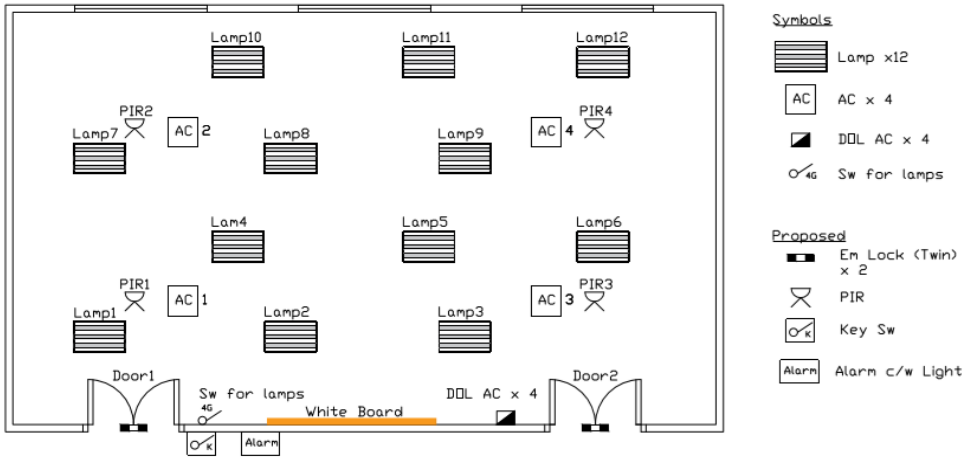

Figure 2(b) Proposed Layout

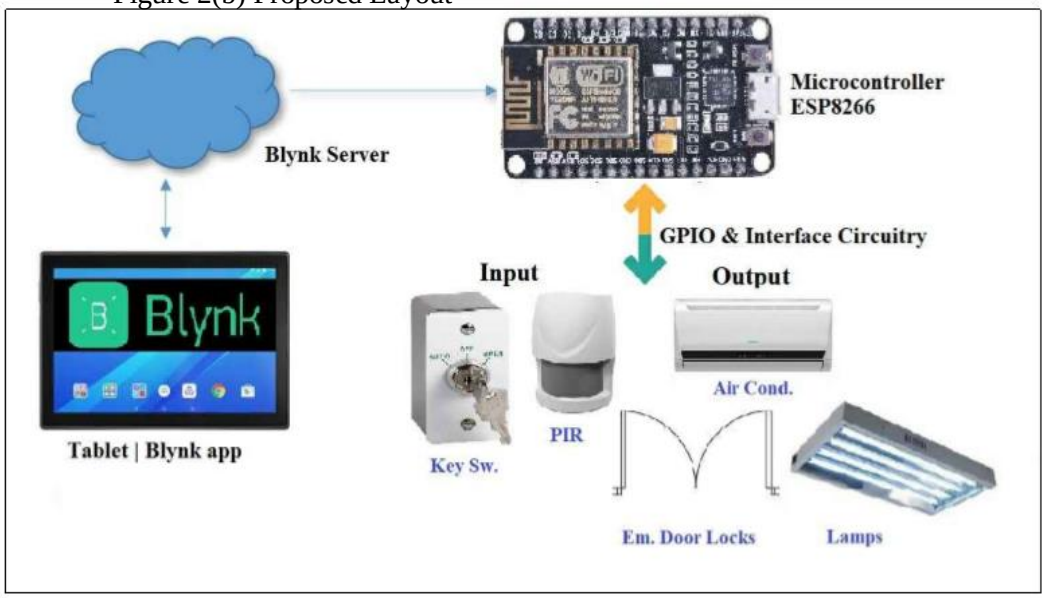

Figure 3 Block Diagram

As shown in the Figure 3, the Blynk application is used to control the door lock, motion sensor and electric power. The motion sensor is used to detect any intruder when the class is in auto mode and it will notify the users automatically.

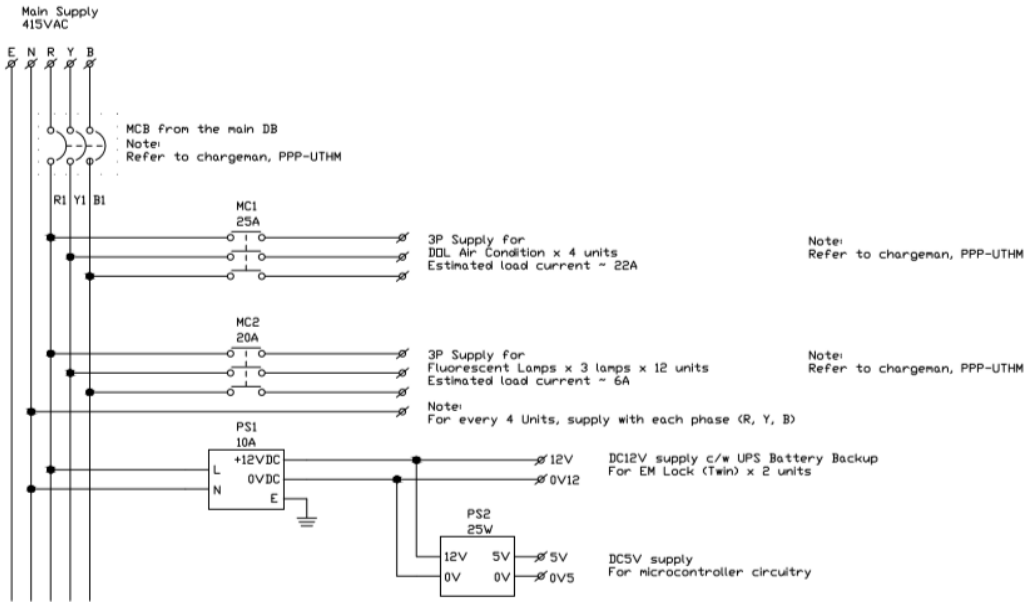

Figure 4(a) Schematic 1

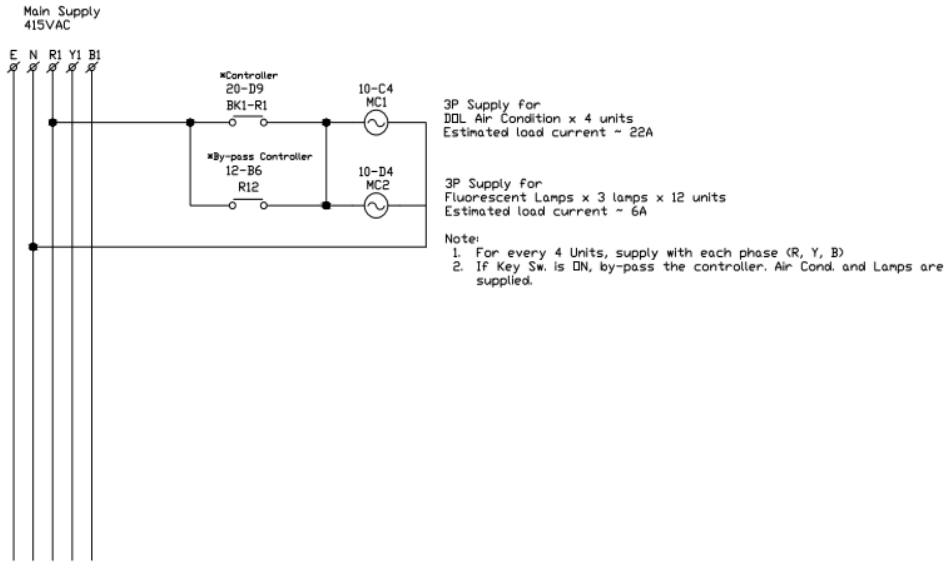

Figure 4(b) Schematic 2

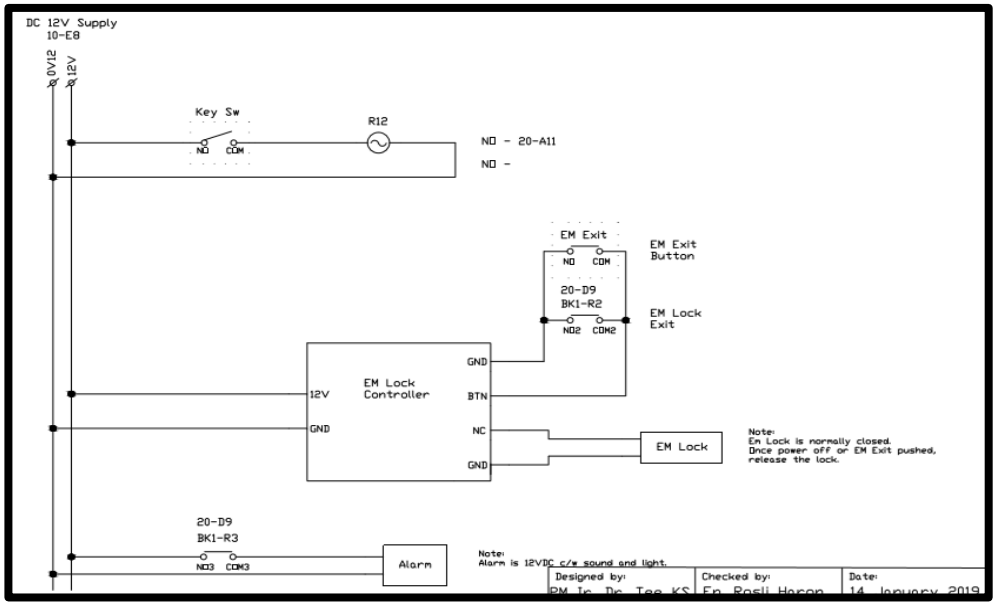

Figure 4(c) Schematic 3

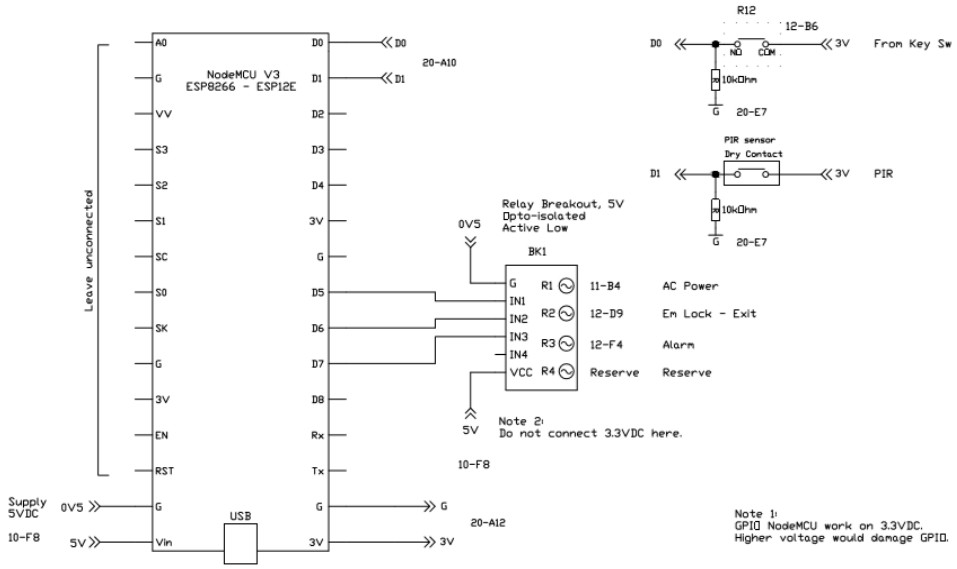

Figure 4(d) Schematic 4

4. Result

4.1. Pre-Installation

This pre-installation process started with site visit to lecture rooms which are BK1 (FPTV), BK2 (FKMP), BP1 (FKEE), and BP2 (FSKTM) in Blok G3. Currently, the doors are locked and unlocked manually by the PTjs. SSID and Password for all rooms were assigned to Pusat Teknologi Maklumat (PTM) experts. They changed the AP 5.0Ghz to support AP 2.4Ghz as shown in Figure 5. As for Pusat Pembangunan dan Penyenggaraan (PPP) experts were assigned to coordinate working schedule of contractor, the room's owner and the researchers.

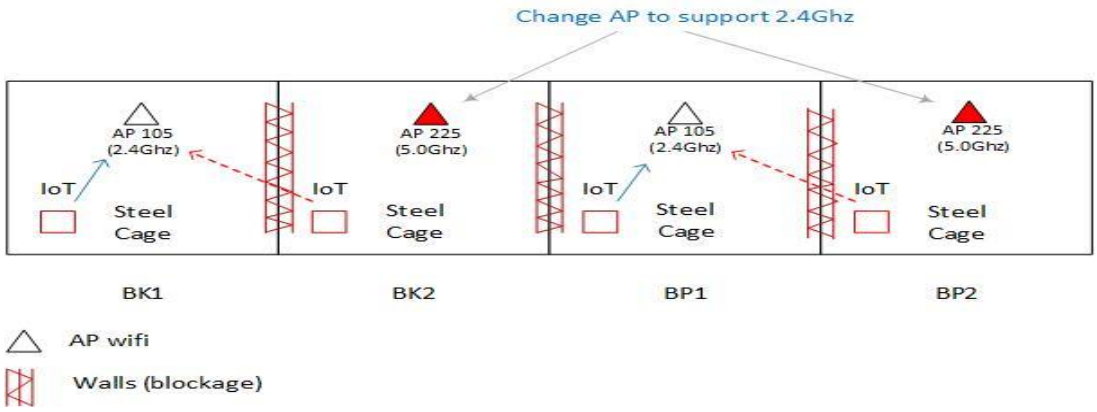

Figure 5 Diagram of AP for the four rooms

The team project also made Google Account and Blynk Account to start the coding and customize the based board for the smart classroom. Blynk Graphical User Interface (GUI) is developed to control and monitor the lecture room. There are two modes available for the system. The auto or simply called bypass mode will pass the electric power to the micro-controller and the Passive-Infrared sensor will be activated for security and intrusion detection. The manual mode will reconnect the electric power and unlock the door lock for the class sessions.

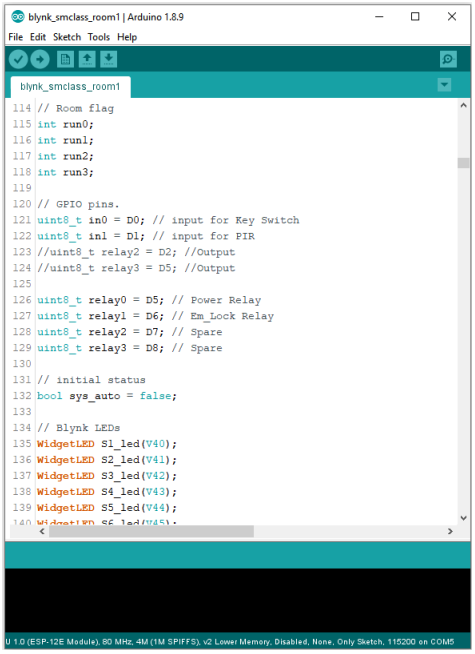

Figure 6 Coding process

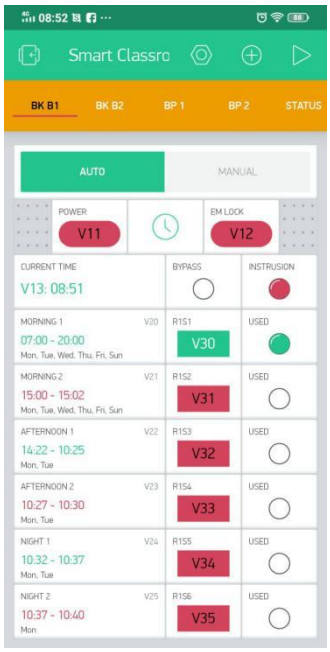

Figure 7 Blynk - GUI

4.2. Coding and Debugging

After the pre-installation finished, the project continue with coding and debugging the based board for all the rooms to test the performance of Blynk Apps until the connection success.

4.3. Function Test

This function test is to analyze the performance of the application for both mode Bypass Mode and Internet Mode which is auto and manual operation. These two modes were powered 12V batter. The Internet Mode has been tested for six slots as shown in Table 1.

Table 1. Function test result.

No	Function	Checked	Comments
1	Auto|Manual → Segmented Sw	Y	Read by NodeMCU
2	When Manual		
	Button| Power and Em_Lock – ON	Y	Outputs ON. Regardless of scheduler.
	Button| Power and Em_Lock – OFF	Y	Outputs OFF. Regardless of scheduler.
3	Turn to Auto when Button| Power and Em_Lock – OFF	Y	If no scheduler is active, outputs stay O FF
	Turn to Auto when Button| Power and Em_Lock – ON	Y	If either one of the scheduler is active, outputs switched to ON. Scheduler wor ks.
4	RTC Current time and today (Sunday – Saturday) Note: Current time => hour and minute	Y	Read and matched with internet time. Displayed on blynk. Used to compare with scheduler inputs, Slot 1 – Slot 6.
5	Auto Mode | Scheduler – Time Input – Slot 1 Weekday Start Time Stop Time Selection Button – ON or OFF Note: If weekday is not selected, Blynk reflected as everyday.	Y	Scheduler active. Used LED turn ON when all parameters matched. Weekday = today, current time is within range (Start to Stop), and Selection Button is ON. Scheduler deactivated if either one of the criterion not met.
6	Auto Mode | Scheduler – Time Input – Slot 2 – Slot 6	Y	Working as Slot 1.

For the result in Bypass Mode, the key switch is ON and the electric power is bypassed by the micro-controller also the Em-Lock released and the door is not locked. This mode also allows electric power flow to the air conditioner and lights. In case there is electric power failure, Bypass Mode remain stay.

If the key switch is cut on purpose, the doors would be em-locked. For Internet Mode, the key switch is OFF and the electric power is controlled by the micro-controller and GUI and all doors are em-locked.. The mode also remain stay if there is electric power failure. The result is satisfying as there is no error in the working principle of both modes.

4.4. In-Room Test

This project also did in-room test for trial. Researchers leave the set up for two weeks using router outside Level 6 at FKEE, Blok QA. Data has been collected from Blynk connectivity screenshot and visual inspection of Nodemcu and LEDs. From the observation, Blynk Apps keeps connect and disconnect to Nodemcu from time to time. Disconnection is short and resume also the operation of Nodemcu appear to be normal.

4.5. Installation

Project team started to install the system to all targeted lecture rooms with helps of the expert from PTM and PPP. All needs were successfully installed.

Figure 8 Installation process

4.6. On-Site Tests

After the installation, researcher did on-site test for Wi-Fi connection. This trial is for a week and data collection of Blynk connectivity and visual inspection of Nodemcu and LEDs were collected. To logging data from the router, researchers did request PTM for the access WiFI for each room and re-study logic error at key switch and remove all logic for bypass state. From observation, Blynk keeps connect and disconnect to Nodemcu from time to time. The disconnection is long especially BP2 and others room appear to be in normal operation. Blynk does disconnect and re-connect to Nodemcus often but manual observations indicate tolerable short-time of disconnection and normal operation is expected to work. Researchers also done trial run for this smart saving classroom before it official use. The trial runs project is schedule during semester break from 28 October 2019 until 31 October 2019.

This trial run project is set on Internet Mode and the scheduler test from 8.00 am to 5.00 pm. The observation has been done in manual inspection.

5. Conclusion

In conclusion, this project is able to achieve all the objectives stated for this project. The relay breakout was functioning well for changing the state of the door lock and breaking the battery connection. The repeatable testing help to improve and monitor the result to see the progressed of this system and obtained accurate result. As to integrate with IoT, this project is able to function properly. A manual switching method can be made by a management party. A notification in the Blynk application helps the owner management to detect intruders inside the lecture room. The system works really well with a good internet connection.

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