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Smart Building Lighting System

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Abstract. In a building, lighting contributes 20-60% of the total consumption of electrical energy usage. To turn on and off the lamp with the switch manually sometimes people forget to turn it off when leaving the room. This resulted in the inefficiency of energy and cost, where the lamps work not based on need. To overcome this problem designed a lighting control system using internet of things concept so that the lights can be controlled and monitored remotely. This control system is designed using Arduino Mega 2560 as a microcontroller, relays as connectors and electric breakers voltage lamp and motion sensor as a switch that turns off the lights when there is no person in the room and indicator of the activity in the room. In addition, outdoor lights are lit in accordance with a predetermined schedule for more efficient power usage. With lighting control system is expected to reduce consumption of electrical energy usage so more efficient.

1. Introduction

Nowadays, the most popular development of Internet technology is the Internet of Thing. The Internet of things is a global concept that enables information services in an easy way both physical and virtual based on current technological developments [1]. Internet of things can be applied to various things in the environment, among the buildings, the largest contributor to electricity use in many countries is in buildings. More than half of the energy used in buildings lies in electricity consumption and one-third is for lighting [2].

There are still many-storied buildings that have not implemented the lighting control and monitoring system. This resulted in the inefficiency of energy and cost, where the lamps work not based on need. Based on this, the issue of energy saving in lighting facilities is of great importance to research [3]. For example, another paper describes a different intelligent control system research project for the development of intelligent remote-controlled street lighting systems based on enhanced technology [4].

Smart Building is a concept that combines architectural design, interior design, and mechanical-electrical in order to provide the speed of movement / mobility and ease of control from any direction and anytime in the case of automation where all activities that occur in a building or building can occur in the absence of human interference inside it.

In this research is designed a lighting control system on the building using the concept of an internet of things. This control system uses motion sensors as a switch. In addition, this system uses the application and web server so that users can manage and control in real-time from a distance.

2. Methods

The project of this smart parking system is build by some system, starting from hardware architecture, software architecture and system.

2.1. Hardware architecture

Figure 1 shows the design and schematic of the control system circuit. The components used in this circuit are: Arduino Mega 2560, ESP 8266 (wifi module), two PIR sensors, six pushbuttons, 4 - channel relay module, six pushbutton, six 10k ohm resistors, and three pieces 1k ohm resistor.

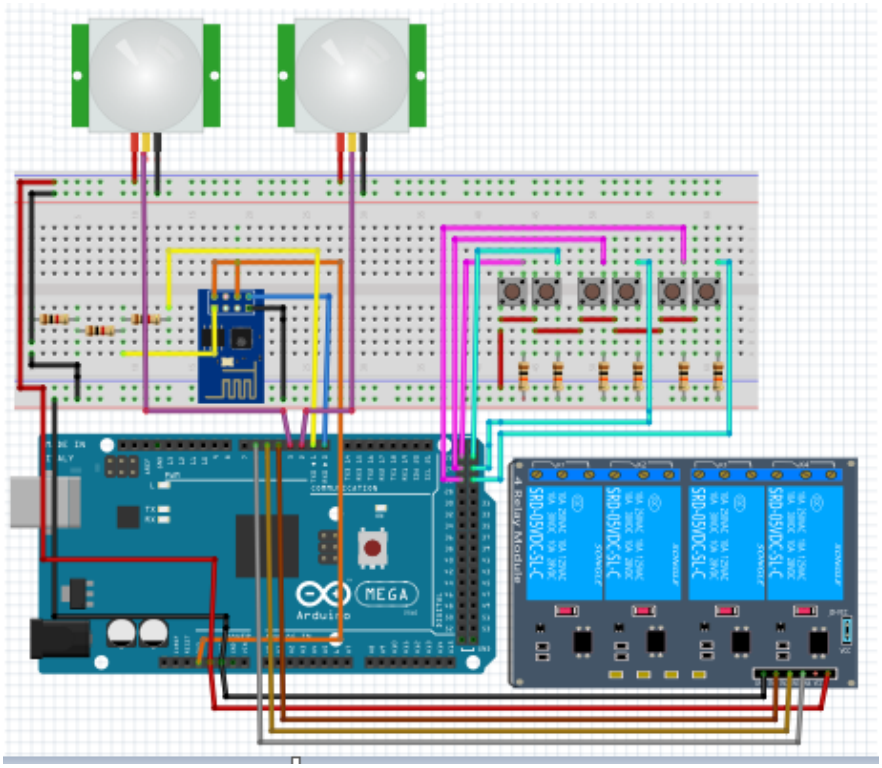

Figure 1. Schematic installation.

2.1.1. Arduino Mega 2560. Arduino Mega 2560 microcontroller is a microcontroller that uses ATmega2560 chip on the board [5]. Arduino Mega 2560 has 54 digital I / O pins (15 pins of which are PWM), 16 pin analog input, 4 pin UART (serial port hardware). The Arduino Mega 2560 is equipped with a 16 MHz oscillator, a USB port, DC power jack, ICSP header, and reset button. This board is very complete, it already has everything needed for a microcontroller.

Figure 2. Arduino Mega 2560.

2.1.2. ESP8266. ESP8266 is a wifi module that serves as a microcontroller enhancement such as Arduino to connect directly to wifi and create TCP / IP connections. This module requires about 3.3v power with three modes of wifi namely Station, Access Point and Both (tools). This module is also equipped with processor, memory, and GPIO where the number of pins depends on the type of ESP8266 we use. This module can stand alone without using any microcontroller because it already has equipment like the microcontroller [6]. The default firmware used by this device uses AT Command.

Figure 3. ESP8266.

2.1.3. PIR sensor (HC-SR501). Passive infrared sensor (PIR sensor) is an electronic sensor used for motion detection from a distance of about 20 feet, this sensor has an adjustable delay time of about 2 - 4 seconds. This sensor is most often used in motion detectors in a room [7]. In this system control, PIR sensor is used as an indicator of activity in the room and also as a switch that turns off the lights when there is no activity in the room.

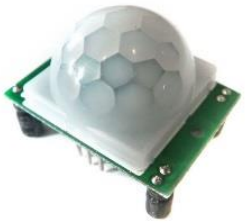

Figure 4. PIR sensor.

2.1.4. Relay module. The relay is electrically operated and is an electromechanical component consisting of two main parts namely Electromagnet. Relays use the Electromagnetic Principle to drive the switch contacts so that a small electric current can perform higher electrical voltages. In this control system, relay serves as a connector and breaker voltage of the lamp.

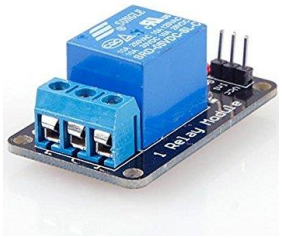

Figure 5. Relay module.

2.1.5. Push button. Push button switch is a simple device that functions to connect or disconnect the flow of electric current with unlock press system. Unlock system here means the switch will work as a connecting device or circuit breaker when the button is pressed, and when the button is not pressed, then the switch will return under normal conditions. In this control system, pushbutton serves as a switch that serves to turn off and turn on the lights.

Figure 6. Push button.

2.2. Software architecture
Software that is used in this research is Arduino IDE, application and web server cayenne.

2.2.1. Arduino IDE. Arduino IDE is software for writing and uploading programs into Arduino and some other microcontrollers. Arduino IDE uses its own programming language that resembles the C language.

2.2.2. Apps and web server cayenne. Cayenne is an application and web server to create project internet of things. Cayenne has features for monitoring and controlling the objects connected to it. Using Cayenne is very easy to use because it is only with visual drag and drop. Use of Cayenne on this project as monitor and control the lights remotely manually and scheduled.

Figure 7. Logo Cayenne.

2.3. System architecture

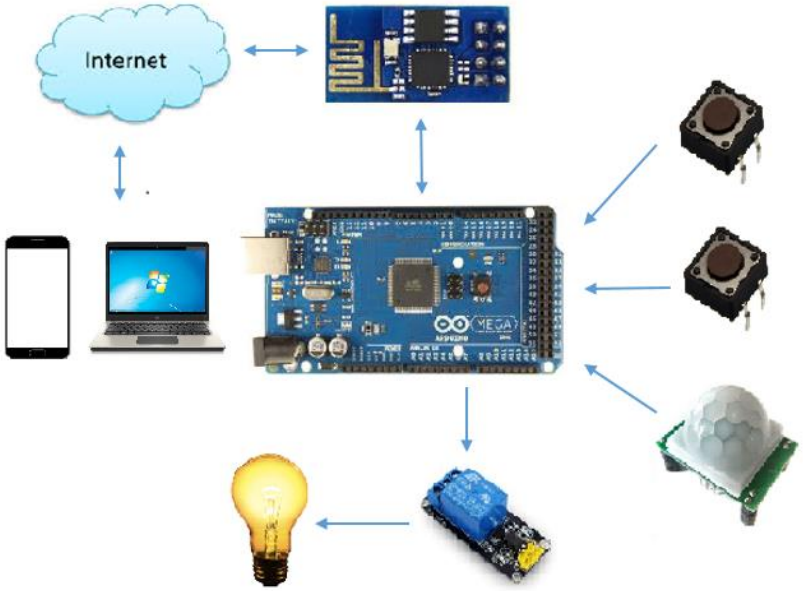

Figure 8. Architecture of smart lighting system.

As shown in Figure 8, the picture explains the architecture of intelligent control building lighting system. This system is divided into two parts hardware and software. In the hardware, the section used a smartphone / personal computer, ESP 8266 wifi module, Arduino Mega 2560, Pushbutton, Motion Sensor (HC-SR501), Relay Module, Lamp, and other supporting components. On software using Arduino IDE, Cayenne Application for smartphone and web server cayenne for a personal computer.

In this control system, pushbutton and sensor function as a giver input digital signal I / O on Arduino. Then Arduino will receive a digital signal so that the relay will set the lights to turn on or off. At the same time, Arduino Mega 2560 will transfer information to app or web server cayenne by using wifi module so it can monitor in real time.

Using the Cayenne app and web server not only as monitoring but also as a remote control so that can turn on and off the lights with automatic or manual. This control system uses a motion sensor that serves as an indicator of activity in the room and as a switch to turns off lights automatically when there is no activity in the room.

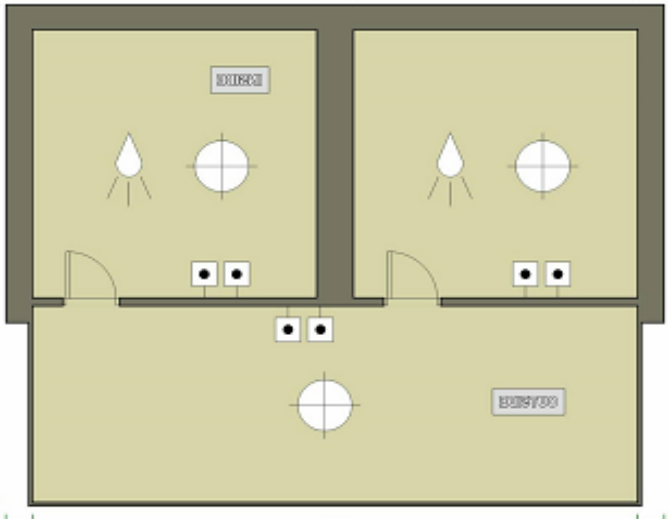

Figure 9. Architecture of smart lighting system.

As shown in Figure 9, the picture describes the design of miniature smart building lighting system. In each room, there is one ON switch and one OFF switch, one lamp and one motion sensor. Outside the room, there is one lamp and two switches to turn off and turn on the light manually.

3. Results and discussion

The result of this project is a building prototype by using a lighting control system connected to the application and web server cayenne so that it can be controlled and viewed remotely in real-time.

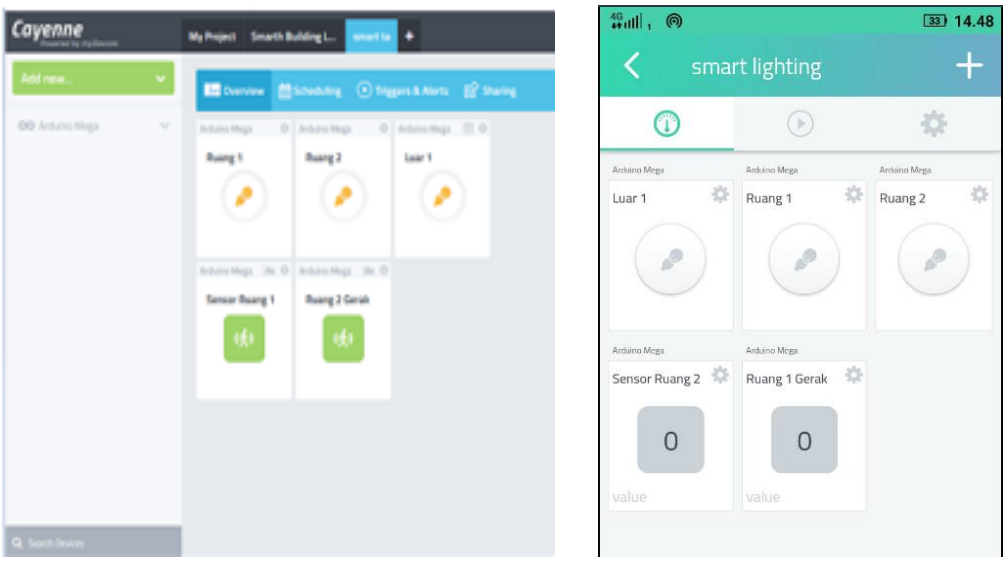

Figure 10. Display on the web dashboard and Cayenne apps.

Based on the prototype can be seen in figure 10, the light will light up when pushbutton ON is pressed so that the relay will be in high position and when pushbutton OFF at press lamp will go off. The lights can also be switched on or off via the internet by pressing the light icon on the web server or mobile application. When there is activity in the room PIR sensor will provide information through ESP8266 which can be seen on the web server and mobile application in the form of motion icon. This sensor also serves as an automatic switch that turns off the lights when there is no activity in the room.

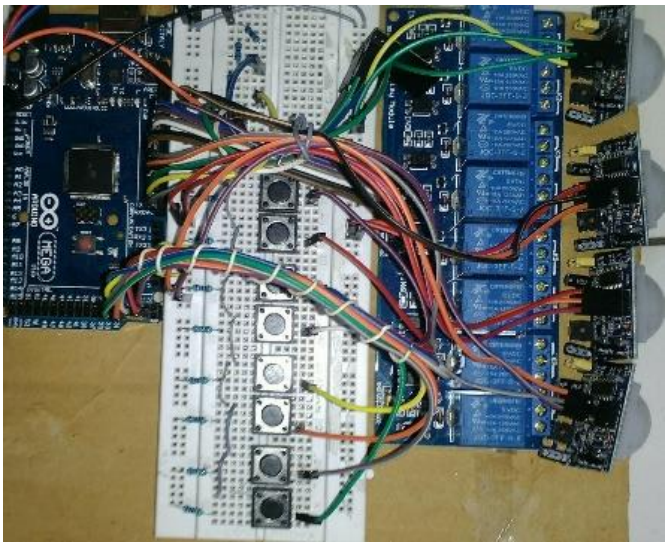

Figure 11. Hardware system.

In figure 11. Showed the hardware for lighting control system in buildings. This prototype has several that is the mismatch between the goals with the results achieved. These constraints include:

- In the planning of this project, the prototype consists of 2 floors each floor has 2 rooms and 1 lamp outside. Due to a hardware error so it is not in accordance with the planning.
- There is still a delay time exchange of information between hardware and web server or application.
- Sometimes hardware is not connected to the Internet network because ESP8266 is not stable
- The sensor used has a problem with sensitivity.

4. Conclusions

The smart lighting system in building in this project isn't too much developing as a whole. Although the project is still many shortcomings, the system has been made in accordance with the purpose of the smart lighting system. The purpose is to monitor and control the lights automatically or manually on the building through the web server and applications using the concept of an internet of things so that it can connect on personal computer or smartphone to efficiently energy and cost.

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