ASEAN Journal of Engineering and Technology, 3 (1): 41-45, 2023
e-ISSN: 2710-5471

DOI: 10.26666/rmp.ajet.2023.1.7

The Development of Automatic Light Controlling Management

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Received: 15 March 2023; Revised: 20 April 2023; Accepted: 15 May 2023; Published: 30 June 2023

Abstract: Automatic Light Controlling Management is an intelligent network based on a lighting control solution that incorporates communication between various system inputs and outputs. This lighting system allows users to manage energy consumption supported by visual aid on an online dashboard. The primary purpose of this project is to utilize electricity without disregarding the user's safety. Automatic Light Controlling Management is designed to function during dark or night by controlling the turning on and off the light based on human movement. Microcontroller ESP32 is used to control the operation of the light based on sensor status and transmit the operation data to the online monitoring dashboard. The Light Depending Resistor (LDR) and Microwave Sensor are chosen to detect the dark situation and the movement in the respective area. The Internet of Things middleware Node-RED has been used to design this system for the online monitoring dashboard. Based on the result, this system will detect movement around 1 to 3 meters to turn on the light and will be turned off when the user is out of this range. Along with turning on and off the light, the online monitoring system will promptly state the operation of the light system. In this project, two modes can be applied: manual operation mode and automatic operation mode.

Keywords: *Light, Management, Dashboard, Energy*

1. Introduction

Rapidly depleting energy resources and increasing greenhouse gas emissions have made energy-saving approaches in interior lighting extremely significant for every country around the world [1]. Nowadays, saving energy is very important due to cost and the environment. There are various ways to save energy, such as giving awareness about saving energy. The Automatic Light Controlling Management system was developed to manage the lighting system and approach energy saving. Automatic Light Controlling Management is a microcontroller based on automatically turning on and off the light in dark areas. The control circuit is designed using microcontroller NodeMCU ESP32 for this project which is programmed using assembly language. In this project, two modes can be applied: manual operation mode and automatic operation mode. In automatic operating mode, the system is designed to turn on and off based on the presence of human movement. The notification will appear on the online dashboard to show the presence of human movement. The light will turn on when the movement is detected at a certain distance. This system was appropriate for the walk-away area, where rarely been used. It is to make sure not to waste the energy consumption to allow the light to turn on even if no human uses it. The project is also helpful for many applications and suitable places not only in walk-away areas, but it can also be used for street lighting, dark places, and strategic places for pedestrians.

2. Literature Review

One energy consumption that can be considered in the city comes from the lighting system. A study by [2] said that 10 to 38% of the energy bill comes from the street lighting system in a typical worldwide city. The existing lighting system consists of an electrical wiring circuit connecting lights with a power source. This system is manually operated from the physical location; the system's monitoring can only

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be done locally. Thus, this system was not monitored in real-time via an online platform. Research conducted by [1] shows that managing the lighting system in daylight is the best approach to energy-saving and efficiency. The development of the internet of things (IoT) recently allows emerging technology to connect various electronic devices. With the aid of IoT devices, the system can transmit and receive data using the internet as a medium to communicate with the world [3]. The data transmitted by the sensor can be monitored and analyzed to determine the power consumption of the light system. The research done by [4] shows they use the sensor to detect the surrounding of the streetlight to let the light turn on and off if necessary. Also, the purpose of their project is to save energy consumption for sustainability.

Internet of Things (IoT)

The IoT plays a significant role in designing the online monitoring system. Based on the designed system by [4], they used the switches as their devices which connected to the internet and automatically operated. As they used a microcontroller as a new heart of the system, it can communicate with mobile phones as a smart device to remotely control the system. The IoT technology also offers an online monitoring system using the web page or desktop. It can be realized using the IoT platform of web-enabled services.

Microcontroller ESP32

ESP32 is designed to be used as a microcontroller to receive and manipulate the internet of things application data. As its one of the powerful microcontrollers that can be used in internet of things technology, it is equipped with WIFI and Bluetooth Low Energy (BLE) that can be used in internet of things applications. The extra feature of this microcontroller is it has low-power chips, which are only in the wake-up state whenever the data arrive periodically. This low duty cycle will be resulting low power consumption of this microcontroller [5].

Light Sensor

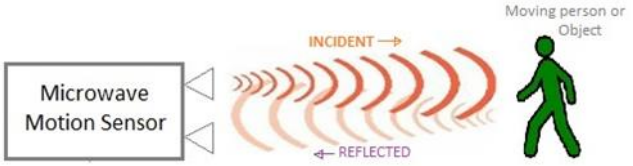
[6] in their project shows that they use the light sensor to indicate the darkness of the surrounding area. The light sensor will detect the darkness before turning it on or off. In the [7] project, they used Light Depending Resistor (LDR) to detect the darkness in the test area. The purpose of darkness detection was to ensure the system only operated in appropriate dark conditions. The light sensor can accordingly convert ambient light energy into an electrical signal. This electrical signal in the form of electrons can be transmitted to the microcontroller to be manipulated as the light data signal.

Microwave Sensor

A Microwave sensor is an electronic device that detects motion and can be used to control luminaires. The microwave sensor can generate the Radio Frequency (RF) field between transmitter and receiver, creating an invisible volumetric detection zone. Research conducted by [8] explained that two cases of microwave sensors were evaluated in their project; one was the object moving towards the sensor, and the other was moving away from the sensor. The result of their research was measured by the Doppler shift value, positive or negative.

Figure 1: Depict the microwave motion sensor operation.

Node-RED



Node-RED is one of the internets of things middleware that uses Flow-Based Programming (FBP) as the medium to control the application of the system. Node-RED is a free, open-source programming tool that allows the connection of any physical input and output devices, cloud-based systems, databases, and Application Programming Interface (API). With Node-RED, the developer can perform their programming by graphical flows and nodes. Each node in Node-RED represents the function, such as the data; it does something with that data and then passes it to the next node in the flow to perform the data processing. Node-RED can be used well with Raspberry Pi and the personal computer that serves as a local host for prototype environment applications. Node-RED can also serve as an internet of things gate away by handling the transmitted and received data from hardware and displaying it in its browser-based User Interface UI (dashboard). Another advantage of using Node-RED as the internet of things middleware, the Node-RED design can work either in Hyper Text Transfer Protocol (HTTP) or Message Queue Telemetry Transport (MQTT) as a lightweight protocol.

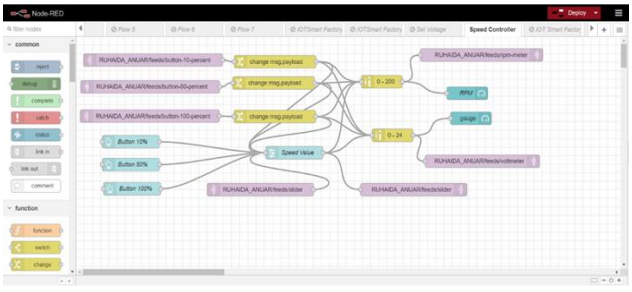


Figure 2: The Node-RED flows to perform applications in the Internet of Things System

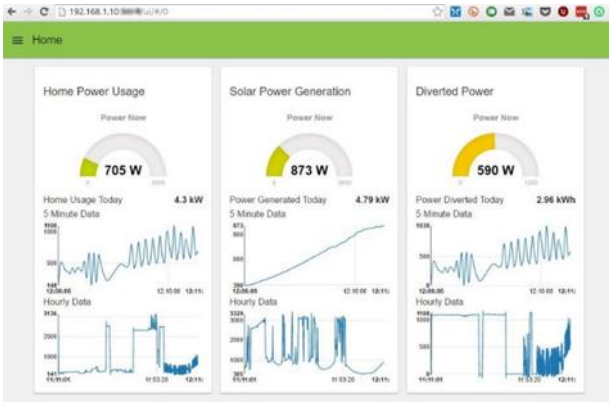


Figure 3: The Node-RED browser-based User Interface

3. Methodology

Automatic Light Controlling Management is a microcontroller based on automatically turning on and off the light in dark areas. In this project, two modes can be applied: manual operation mode and automatic operation mode. Based on the block diagram in Figure 4, the project uses ESP32 as the microcontroller. The LDR will serve as the light sensor to indicate the darkness to operate the system.

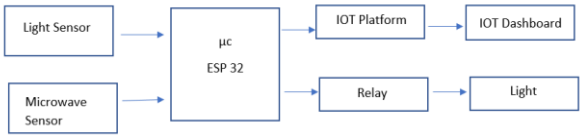


Figure 4: The block diagram of Automatic Light Controlling Management

when LDR detects the dark surrounding, the system will be activated with the microwave sensor. In the meantime, the microwave sensor will work to detect the motion. The selection of a microwave sensor instead of an infrared-based sensor is due to the microwave sensor's effectiveness in detecting fine movement in dark times. Furthermore, this sensor can be adjusted to detect only the human size instead of the PIR sensor to detect the object's movement. Node-RED served as an online system to perform the monitoring via the Node-RED dashboard. The relay will be a function to turn the light on or off based on the movement captured by the microwave sensor. When a human movement is detected within the specified range of the microwave sensor, the light will be turned on. At the same time, the dashboard in Node-RED UI will appear with a notification saying that someone is across the respective area.

The flow-based programming in Node-RED, the system used the HTTP Protocol to communicate between hardware and the internet of things middleware. The flow chart in figure 6 explains the mechanism of this system.

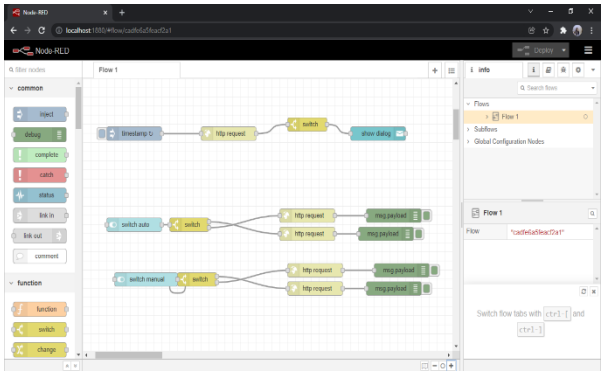


Figure 5: The Node-RED flow for the system

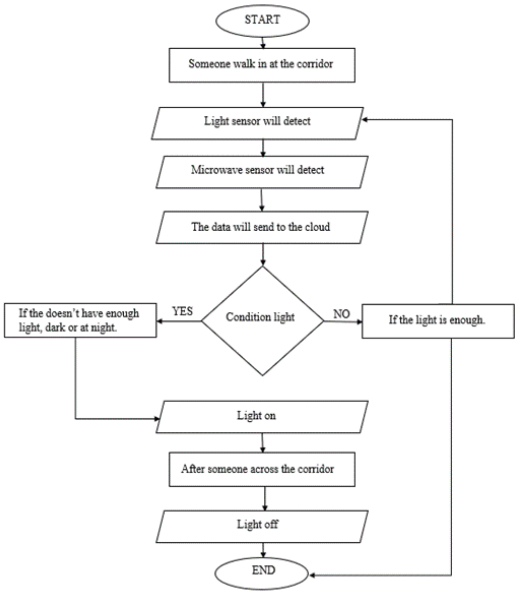


Figure 6: The flow chart of the system

4. Results and Discussion

The Automatic Light Controlling Management can be set into two modes: manual or automatic operating mode. In automatic operating mode, the system is designed to turn on and off based on the presence of human movement.

By using the microwave sensor, the human size can be determined accordingly. When LDR detects no presence of light, the system will set on. The light will remain off if there is no human movement detection in the area. When human movement is detected, the microwave sensor will send the signal to the microcontroller ESP32. When sensing the signal of human movement from the microwave sensor, the Node-RED UI will pop up the notification informing the presence of the human movement. In the meantime, the ESP32 will

send a signal to the relay, an automatic switch to turn on the bulb (light) if the sensor detects human movement. When the movement is a way out of the microwave sensor range, the light will take around ten seconds to turn off. Figure 7 shows the Automatic Light Controlling Management with the light turned on and the pop-up notification via Node-RED UI when sensing the presence of human movement. This system was appropriate for the walk-away area, where rarely been used. It is to make sure not to waste the energy consumption to allow the light to turn on even if no human uses it.

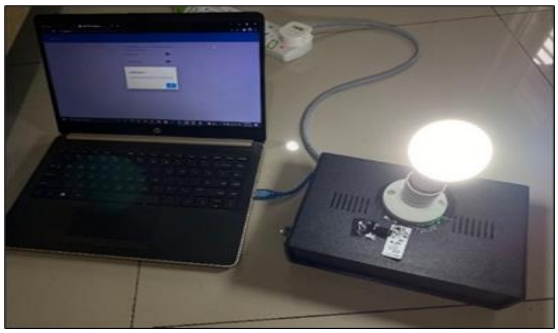


Figure 7: Automatic Light Controlling Management while turned on.

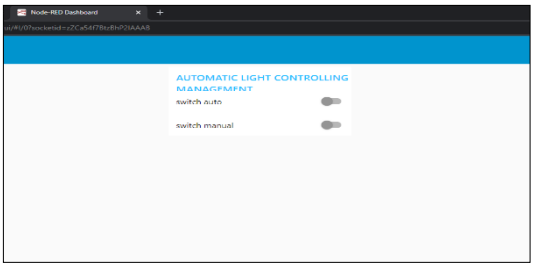


Figure 8: The selection switch operation mode shown in Node-RED Dashboard

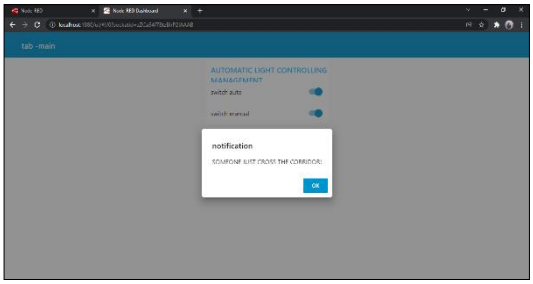


Figure 9: The notification box will appear when the microwave sensor senses the presence of human movement.

Table 1 shows the analysis for the detection range of microwave sensors towards the presence of human movement in the setting area. The analysis was done in a dark condition where the microwave sensor could optimally work with low interference from any moving object. The analysis shows that the microwave sensor can only detect human movement in the dark within a 3.5-meter to 4.0-meter radius, which means that the system can only monitor human movement in an area bounded by the microwave sensor range.

Table 1 Analysis of microwave sensor detection towards the presence of human movement

Distance from Microwave Sensor	Light Condition
1.5 meter	Turn On
2.0 meter	Turn On
2.0 meter	Turn On
2.5 meter	Turn On
3.0 meter	Turn On
3.5 meter	Turn On
4.0 meter	Turn Off
4.5 meter	Turn Off
5.0 meter	Turn Off

Meanwhile the manual operating mode, the bulb will remain turned on despite the notification will pop up based on the presence of human detection detected by the microwave sensor. This manual system was appropriate to be set in the house yard where the light will remain on while the sensor will notify human movement detection.

5. Conclusion

The Automatic Light Controlling Management was designed to turn the light on when detecting human movement. The notification will appear on the online dashboard to show the presence of the human movement, and the light will turn on when the movement is detected at a certain distance. For the future recommendation of this system, the MQTT protocol can be used to communicate the hardware with the internet of things middleware. Also, the project can be linked with other mobile monitoring apps using smartphones and online desktop monitoring. Moreover, the lighting system's analyzing chart can be added to the online monitoring dashboard for future work. This action will enhance more effectiveness and practicality of supporting energy saving to the light system.

6. Acknowledgements

Thank you to all parties involved in completing this project directly or indirectly. The help and support were very much appreciated.

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