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Lot Based Indoor Lightning System Based On Human Activity

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Abstrak

Lampu sebagai sumber penerangan masih memiliki kekurangan dalam efektifitas karena sistem ini dioperasikan secara manual dan tidak menggunakan pengaruh penerangan dari luar dan aktivitas manusia. Makalah ini bertujuan untuk merancang sistem pencahayaan dalam ruangan yang dapat mengatur pencahayaan dari luar dan aktivitas manusia sehingga sistem tersebut dapat mencegah pencahayaan yang berlebihan agar tidak terjadi pemborosan energi. Sistem ini memanfaatkan Internet of Things atau IoT sebagai pengaturan sistem pencahayaan dalam ruangan jarak jauh. Selain itu, sistem kontrol pencahayaan ini juga akan dikembangkan menggunakan metode logika fuzzy untuk menghasilkan aplikasi seperti sistem kontrol yang lebih fleksibel dan canggih dibandingkan dengan sistem konvensional. Hasil penelitian ini menunjukkan bahwa sistem pencahayaan ruangan dapat diatur secara fleksibel. baik dengan menggunakan beberapa sensor untuk menentukan aktivitas manusia maupun dengan menggunakan metode logika fuzzy, sistem dapat mengatur intensitas cahaya yang dihasilkan berdasarkan aktivitas manusia maupun dengan menggunakan IoT sebagai pengaturan jarak jauh.

Kata kunci: *Sistem Pencahayaan Dalam Ruangan, Aktivitas Manusia, Internet of Things, Logika Fuzzy, Sistem Pelokalan*

Abstract

Lamps as a source of lighting still have shortcomings in effectiveness because this system is operated manually and does not use the influence of outside lighting and human activities. This paper aims to design an indoor lighting system that can adjust lighting from outside and human activities so that the system can prevent excessive lighting in order to avoid wasted energy. This system utilizes the Internet of Things or IoT as a remote indoor lighting system setting. In addition, this lighting control system will also be developed using the fuzzy logic method to produce applications such as control systems that are more flexible and sophisticated compared to conventional systems.. The results of this study indicate that the room lighting system can be arranged flexibly either by uses multiple sensors to determine human activities and by using the fuzzy logic method, the system can adjust the intensity of the light produced based on human activities and either by uses of IoT as a remote setting.

Keywords : *Indoor Lighting System, Human Activity, Internet of Things, Fuzzy Logic, Localization system*

INTRODUCTION

Every home must use lights as a source of lighting. In general, the lighting control system only uses the on/off principle, which is the principle of turning on the lights when the room is dark and turning off the lights when the room is bright. In a study conducted by Putro & Kambey [1], the lamp control system that is still operated manually has shortcomings in terms of effectiveness, because this system ignores the influence and contribution of external lighting, namely solar lighting and the activities of its occupants. This lack of effectiveness can have an impact on a poor lighting system so that it has the potential to cause work accidents due to disruption of visual comfort and eye health [2]. In addition, system

operations that are carried out manually often lead to waste of electrical loads because users forget to turn off the lights when they are about to leave because they are in a hurry, causing the lights to stay on [1]. To overcome these shortcomings, we need a room lighting system that can adjust the light intensity, human activities, and also the comfort factor. Ramdan, et al. [3] confirmed that by adjusting the level of lighting needed in the lighting of the room, it can prevent excessive lighting. Thus, residents of the house can avoid wasted energy so that it is useful in saving electricity costs.

In this study, we will develop a lighting control system that can adjust light intensity, human activities, and comfort factors and is equipped with remote settings using the Internet of Things or IoT. The implementation of the Internet of Things (IoT) carried out in this study can realize a monitoring and control system for the room lighting system and the use of electrical energy based on the Wireless Sensor Network (WSN) [4-6].

This lighting control system will also be developed using the fuzzy logic method. The integration of fuzzy logic into the system can produce applications such as control systems that are more flexible and sophisticated compared to conventional systems [7]. This method will be used to set the lights off and on. If the outdoor conditions are bright, the Light Dependent Resistor (LDR) sensor will capture and send a signal to turn off the lights. If the outdoor conditions are read as dark by the sensor, the sensor will send a signal to turn on the lights. The LDR sensor is a light sensor that is used to adjust the required light intensity automatically by paying attention to the surroundings of the lamp.

In line with research conducted by Ramdan, et al. [3], researchers use PIR sensors and Ultrasonic sensors as presence sensors that function to turn on and turn off lights automatically based on the presence of people. The merging of the two sensors aims to complement the shortcomings of the two sensors so as to prevent false off and false on. False off is a weakness of the PIR sensor where the PIR sensor will turn off when there are still humans around the detection area, while false on is a weakness of the ultrasonic sensor where the ultrasonic sensor will turn on when there is a movement that is not from human movement.

In detecting human activities, researchers use webcams to obtain accurate and predictable tracking of human behavior. A similar study has been conducted by Chun and Lee [8] in detecting human activity using depth cameras and thermal cameras. The output of several sensors used by the author will then be further processed by the microcontroller to determine the mode of activity and the amount of light intensity required according to human activity.

METHODS

This research is expected to overcome the problem of lack of effectiveness in the lighting system, based on the activities carried out by humans in the place. There are three steps in the proposed method. The first step, using Light Sensors and Motion Sensors, where the Light Sensor here is like an LDR to detect the presence of light in the room and the Motion Sensor here is like a Passive Infrared Receiver (PIR) sensor to detect the presence or absence of humans.

Furthermore, after the sensor detects that there are humans, and there is no light from outside, then the next step is to detect the presence of humans, using a Distance Sensor, which is like an Ultrasonic sensor that functions to calculate the distance between humans and the sensor. Furthermore, after the existence of humans is known, it will enter Fuzzy Logic Controller to estimate human activities and regulate the light produced by the lamp.

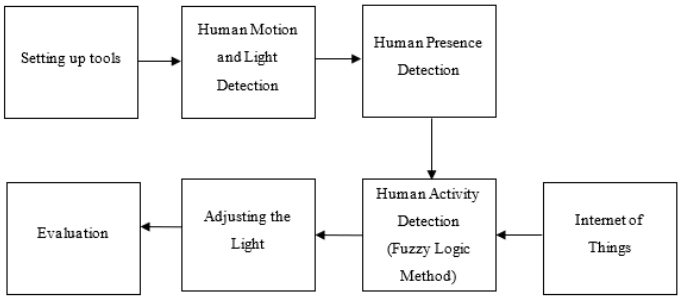

Figure 1. System Design Flow

The figure in Figure 1 above is the steps that will be taken, starting from preparing the tool to be used, then the tool will detect the presence of humans or light at that location. Furthermore, the tool will detect the presence of humans in that location, which will then enter into Fuzzy Logic, and the results of the adjusted light will be recorded for evaluation.

Theory And Methods

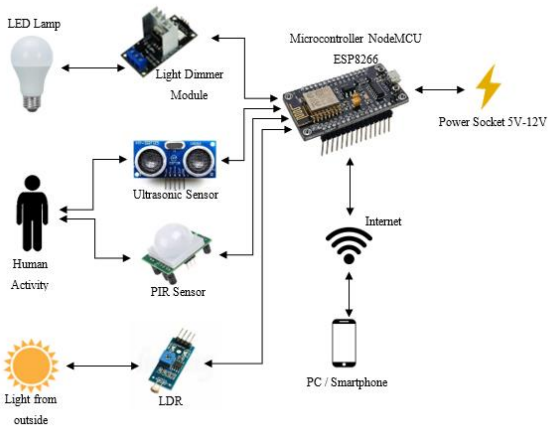

Figure 2. Sketch of System

The sketch in Figure 2. is an overview of the smart lighting system. In this research, the NodeMCU ESP8266 microcontroller is the controller of the developed smart lighting system. Broadly speaking, this microcontroller has three sensors, where the ultrasonic sensor and PIR sensor are in charge of detecting the presence and activities of humans, and the LDR sensor is in charge of detecting the level of light in the room. When the system is set to automatic mote, these three sensors carry out monitoring to determine the level of light that the system needs to produce. The level of light produced will be regulated through the Light Dimmer Module which is connected to the LED lamp, so that the brightness of the lamp can be adjusted by the microcontroller. This microcontroller is also connected to the internet which can be adjusted using a computer or smartphone to change the light produced as needed.

Proposed Methods

The next step is to design a Flow Chart, to show the flow of the proposed system. This flow chart contains an overview of the separate steps of a process sequentially. The flow chart of this research can be depicted in Figure 3.

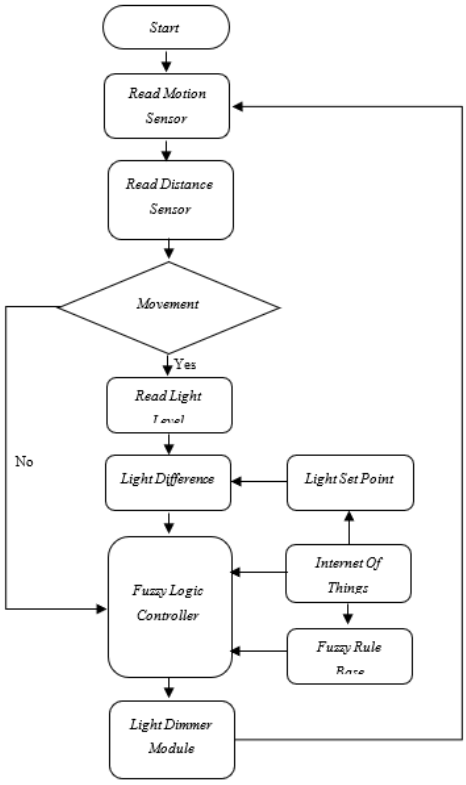

Figure 3. System Flowchart

The flow chart begins with detecting the presence of humans using Motion Sensors and Distance Sensors. If motion is not detected, the light will turn off and if motion is detected, the natural light in the area will be detected by the Light Sensor. The measured light will then be compared with the Light Set Point, then the difference is calculated, this difference is then given to the Fuzzy Logic Controller. The Fuzzy Logic Controller will then generate a signal to control the Light Dimmer Module according to the predetermined Fuzzy Rule Base. This control signal is connected to the LED lamp to control the amount of lighting that is emitted.

RESULT AND DISCUSSION

No	Activity	PIR	Ultrasonic	PIR + US	Description
1	Walking	On	On	Big	Big Movement
2	Playing cellphones on the bed	Off	On	Small	Small Movement
3	Sleeping	Off	On	Very Small	Sleeping

The main problem of using only one type of technology, namely the lack of accuracy and features provided, besides that there are many variables that make the system less accurate. By combining IoT, Sensors, and Fuzzy Logic, it should be able to increase accuracy and make the system flexible. To see the results of making this lighting control system work well or not, it is necessary to test first. This test is divided into several parts, that is:

(1) Testing the detection of human presence and activities in a room with a combination of PIR sensors and Ultrasonic sensors. This test is carried out to prove that by combining the two sensors at several locations that have been arranged, they can complement the advantages or disadvantages of the sensors, as well as adjust the light according to the

activities carried out by humans. The combination of these sensors can also prevent the occurrence of False Off and False On which may occur due to other moving objects (such as fans). Tests are carried out at several possible points of activity, namely:

a. Near the study table

Table 1. System testing near the study table

No	Activity	PIR	Ultrasonic	PIR + US	Description
1	Walking	On	On	Big	Big Movement
2	Typing on the computer	Off	On	Small	Small Movement
3	Playing computer	Off	On	Small	Small Movement
4	Watching a movie	Off	On	Small	Small Movement
5	Fan moving	Off	On	Off	Inanimate objects
6	Fan off	Off	Off	Off	Inanimate objects

b. Near the bed

Table 2. System testing near the bed

No	Activity	PIR	Ultrasonic	PIR + US	Description
1	Walking	On	On	Big	Big Movement
2	Playing cellphones on the bed	Off	On	Small	Small Movement
3	Sleeping	Off	On	Very Small	Sleeping

From the results of the tests in Table 1 and Table 2, it is proven that the False Off that occurs in the PIR sensor where the PIR sensor cannot detect small movements made by humans as the test results in number 2, 3, 4 in Table 1, while False On in number 5 in Table 1. Where the results of the merging of the two sensors can overcome the weaknesses of each sensor.

(2) Testing the replacement of the Fuzzy Rule Base using IoT, as well as changing the lamp to manual and automatic using IoT. And Testing the lighting level along with the error value generated by the system by providing light around the system.

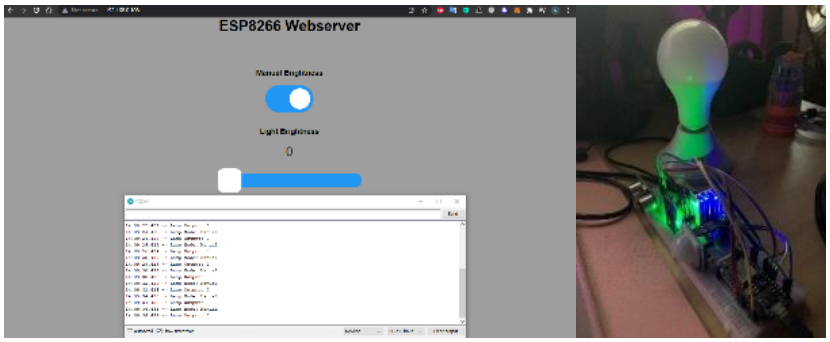

Figure 4. Testing IoT to turn off the light

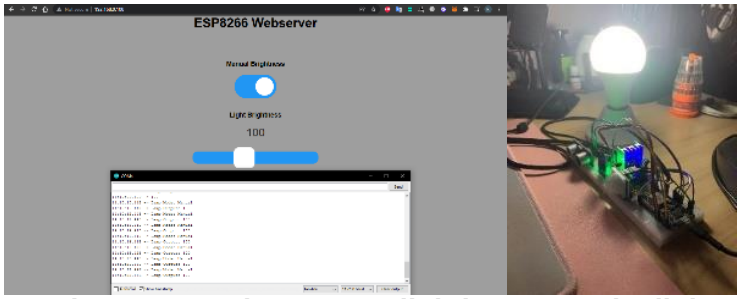

Figure 5. Testing IoT to slightly turn on the light

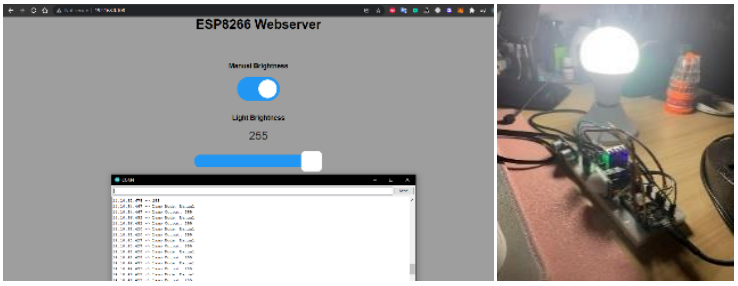

Figure 6. Testing IoT to turn on the light

From the results of the test in Figure 4 to Figure 6, we can see that the IoT application of the system is able to change the state of light manually or remotely. Where the user can flexibly adjust the lights at the time of activity that cannot be detected by the system.

(3) Testing the detection area range of the room lighting system is carried out by making large or small movements and walking around the sensors of the system. up to 200 cm.

```
18:32:33.349 -> Distance (cm): 149.21
18:32:34.382 -> Distance (cm): 150.30
18:32:35.416 -> Distance (cm): 170.75
18:32:36.403 -> Distance (cm): 195.53
18:32:38.514 -> Distance (cm): 202.69
18:32:39.502 -> Distance (cm): 174.93
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Figure 7. Testing the detection range of the sensor

Seeing the results of the above test, the maximum distance of this system is only 200cm and has a blindspot in the range of 2cm due to the weakness of the ultrasonic sensor detecting distance using high-frequency sound waves, where the sensor calculates the time it takes for the sound waves to return to be used as a measurement and if there is interference at the time of sending these sound waves, then the sensor will be inaccurate

CONCLUSION

This research was conducted by designing a room lighting system that can adjust the intensity of outside lighting and human activities so that the system can prevent excessive lighting to avoid wasted energy. This lighting control system will also be developed using the fuzzy logic method to produce applications such as control systems that are more flexible and sophisticated compared to conventional systems. In addition, this system utilizes the Internet of Things or IoT as a remote room lighting system setting. The results of this study indicate that the room lighting system that uses multiple sensors is able to determine human activities and by using the fuzzy logic method, the system can adjust the intensity of the light produced based on human activities. Systems developed with the Internet of Things (IoT) are also capable of remotely managing the system.

Overall, the system that the researcher developed in regulating the light intensity in the room showed decent results so that it could be developed further in further research. As a future development, the room lighting system can be equipped with the addition of a depth camera feature that allows the detection of human activity to be more accurate.

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