Smart Lighting based Fuzzy Logic Controller to Reduce Energy Consumption

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Abstract

The use of electrical energy for offices is quite burdening the company's cash flow. In addition, inadequate lighting levels will reduce the quality of our eye vision. In this work, the fuzzy logic controller is used to reduce energy consumption. The work system is used to detect human movement and light intensity. If movement is detected in a location, the surrounding lights will light up according to the desired light intensity. In the same room, not all lights are on, only in areas that detect human movement. This system is integrated with the Internet of Things so that electric power can be monitored and predicted in the future. The tests that have been carried out resulted in savings in electrical energy of 50.7 % from the previous month.

Keywords: Fuzzy logic, smart lighting, energy consumption, PIR

I. Introduction

The easy electronic controllability of LEDs as light sources triggered a new change of paradigm: integration of LED based luminaires into smart systems [1]. Every time there is always an increase in the number of people, the electrical energy usage will also increase. Every year there is always an increase on electricity bill for household, office, or industrial use [2].

This study aims to reduce energy consumption, especially the use of electrical energy consumption for lighting in offices and industries. The research that has been done is to make a smart lighting system that can work automatically.

II. System Model

1.1 Smart Lighting

The system workflow can be seen in Fig [1]. The first thing to do is detect communication with the server. Next, read the presence or absence of activity in the room through motion sensors. If the sensor detects their activity, the light intensity sensor activates and starts reading the light intensity value. The value of the sensor readings will be sent to the server. Then the system will receive the setpoint data from the server so that the light intensity level in the room matches the setpoint sent by the server.

1.2 Fuzzy

Fuzzy logic is a method of making decisions based on fuzzy set theory. The fuzzy set theory allows a set to represent the value closer to human expressions, such as "a bit hard" or "a little fast.", in contrast with strict sets, which represent only Boolean values 1 and 0.

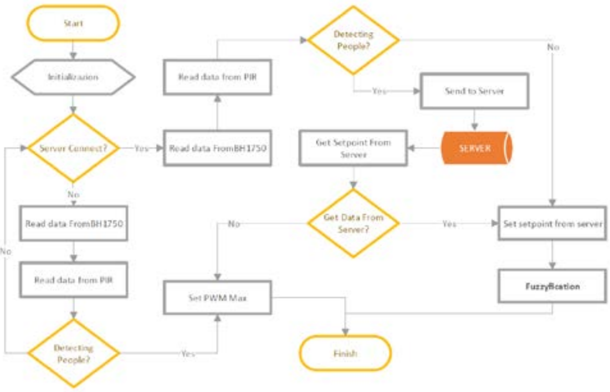

Fig 1. Flowchart System Smart Lighting

1.3 PIR Motion Sensor

The motion sensor HC-SR501 is a motion sensor that works based on changes in infrared light emission. The essential components in this sensor are a pyroelectric sensor and a Fresnel lens. PIR sensors perform well for the human/object detection [3].

1.4 Light Intensity Sensor

The BH1750 light intensity sensor is a sensor that uses the I2C communication protocol so that it can be easily used on a microcontroller.

1.5 MOSFET IRF520

The IRF520 MOSFET module is a dimmer module with the main component of the IRF520 N-Channel Power MOSFET transistor.

III. Experiment and Result

The block diagram system can be seen in Fig [2]. The input signal in the FLC method is in the form of light intensity error values and intensity error delta values to light. The error value is a measure of the difference between the detected light intensity and the light intensity at the set point. Meanwhile, the delta error is the difference between the current light intensity error and the previous light intensity. Both of these values will be processed by the microcontroller using the FLC method. The output of the FLC becomes a value PWM (Pulse Width Modulation), which is the input to the dimmer module for controlling the voltage entering the lamp. The flowchart in Fig [3] can represent control of light intensity using the FLC method.

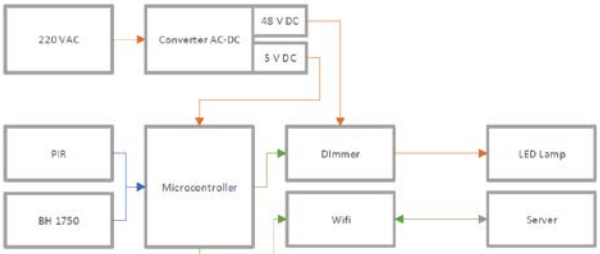

Fig 2. Block Diagram

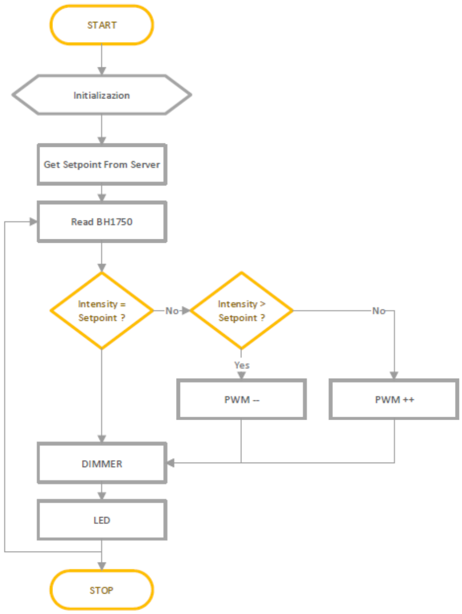

Fig 3. Fuzzy Flowchart system

The test was carried out using three variations. Variation 1 uses TL lamp AC 220 V. Variation 2 uses LED lamps, and variation 3 uses LED lamps with Fuzzy System. Table [1] shows the comparison of the electricity consumption per hour for three variations. From retrieved data, there is a difference in the results of electric power consumption with an error percentage of 1.02% for variation 1, 1.14% for variation 2, and 0.37% for variation 3. Thus, it can be said that the electric power consumption test with a duration of 300 minutes and seven days has a small error so that it can be used to calculate the power consumption of electricity in the workspace in 1-day work.

Table 1 System accuracy power consumption

Variation	5 hours (KWh)	7 Day (KWh)	Total
1	0.0494	0.0489	0.0005
2	0.0260	0.0263	0.0003
3	0.0274	0.0273	0.0001

Table 2 Power Consumption

Variation	7 hours (KWh)	1 hours Break (KWh)	Total
1	0.3423	0.0489	0.3912
2	0.1841	0.0263	0.2104
3	0.1911	0.0018	0.1929

Table [2] shows the calculation of electrical power consumption in 1 working day. Variation 1 consumes electrical power of 0.3912 KWh from the obtained results, variation 2 consumes power electricity is 0.2104 KWh, and variation 3 consumes 0.1929 KWh of electrical power. In comparison with variation 1, variation 2 can save electric power consumption of 0.1808 kWh or 46.22 %, while variation 3 can save electricity consumption by 0.1983 kWh or 50.7 %.

IV. Conclusion

FLC designed in adaptive lighting systems can work well in controlling light intensity. The amount of power consumption that this adaptive lighting system can save amounted to 0.183 kWh or 50.7% compared to without lighting using an adaptive system.

ACKNOWLEDGMENT

This work was supported by Priority Research Centers Program through the National Research Foundation of Korea(NRF) funded by the Ministry of Education, Science and Technology”(2018R1A6A1A03024003)

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