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Development of an Intelligence Street Light Using Fuzzy Logic in Control System

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Abstract: This paper focused on the energy saving by controlling the light intensity of street light according to the street condition which be measured by the sensor such as light dependent resistor (LDR), passive infrared sensor (PIR), and rain sensor module. LDR detects the natural light intensity which are low, medium, high light intensity. PIR sensor detects the movement of vehicle on the street while the rain sensor module detected the weather at variation phase of water drops (rain) as a safety purpose. In this project, the light intensity of street light is controlled using a functional controller known as the fuzzy logic controller. This type of controller is not based on the model but based on the power detection mechanism. The functional of the system simulates using Proteus Software. The results show the rectangular sinusoidal of the limit of street light intensity.

Keywords: Light Dependent Resistor (LDR), Passive Infrared Sensor (PIR), Rain Sensor Module

1. Introduction

Smart city has captivated the great interest in the last couple of years because the technologies are automation, power consumption, and cost-effectiveness [1]. The main aim of carrying out the smart city ideas is to minimize manpower and provide people with the information facilities and achieve the sustainability of their infrastructure [2]. Street light is one of the electricity consumables which are integral parts of everyday life [3]. Smart Street Lighting System is a project that deals with the smart control of street lighting during off peak hours at night, based on vehicles and pedestrians detecting movement on the road [4]. The impetus for this project was derived from the lack of wasted resources.

This paper promoting the expansion of the current street lighting system with additional sensor integration, control and communication capabilities. Due to the main purpose of smart city is the use of energy effectively, the street lights controlled by automatically switching them when there are vehicles or pedestrian around the sensor when it is dark [4]. According to the previous project, light-emitting diode (LED) sensor and passive infrared (PIR) sensor is used. Function of LDR sensor is to detect light intensity while PIR sensor is to detect the vehicles or pedestrians passing by the road. Street lighting

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systems are now being replaced by LEDs that can reduce the power consumption. To detect any weather, rain sensor module is connected to the network.

2. Materials and Methods

This section described the method and technique that proposed to use for measuring the range of intensity of surrounding light, rate of movement of vehicles or pedestrians passing by the street, rate of rain and the rate of power consumption supplied to the light or LED.

2.1 Materials

All tools have their special measuring function. But to contribute to street light, devices are used as a platform to monitor the light intensity of street light. Table 1 shows further clarification concerning the functionality of devices to be used in this study.

Table 1: The Function for every tools in input, process and output system

	Tools	Function
Input	PIR sensor	To detect the motion of vehicles and pedestrian passing along the street [5]
	LDR sensor	Sense the surrounding natural light intensity [6]
	Rain sensor module	Used as a switch when raindrop falls through the raining board and measure rainfall intensity [7]
Process	Arduino Uno Microcontroller	As a controller to make sure the system will be well operated .
Output	Arduino IDE	Software to program the Arduino Uno microcontroller.
	LCD Display	To monitoring the detection of motion, surrounding light intensity, and raindrop.
	LED street light	As an output which produce light.

2.2 Methodology

In this project, related sensors are used as an input to control the output of street light. Arduino Uno is embedded hardware device. Therefore, it used as a tool for implementing multiple design concepts with one device and compatibility with new and existing sensors or actuators. In addition, Arduino IDE is a software for designing framework and development environment from Arduino Uno tools to build a visual programming language. For the output in this project, the device will monitor the light intensity and movement of vehicle and notify the power consumption of street light. The system response is simulating by MATLAB. It is quite obvious that the input is set to three (3) which is LDR, PIR and rain sensor module. Only one (1) output that is light intensity of street light as shown in Figure 1. Figure 2 shows the details of the process from three sensors when connected with Arduino Uno. All sensors will interconnect to each other to know the situation from FLC system.

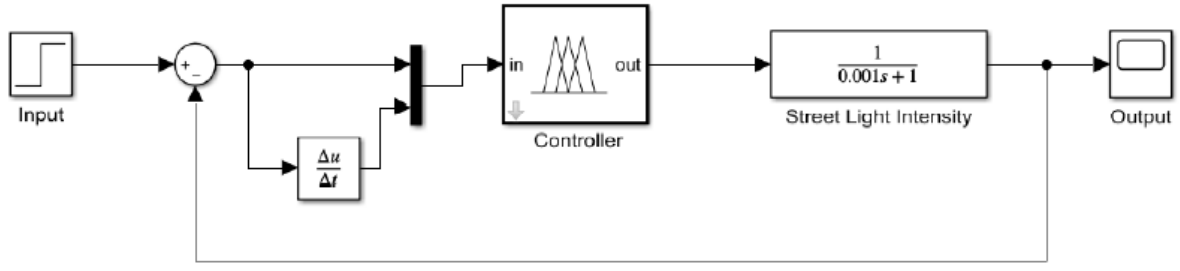

Figure 1: Block diagram of the street light by using matlab simulink

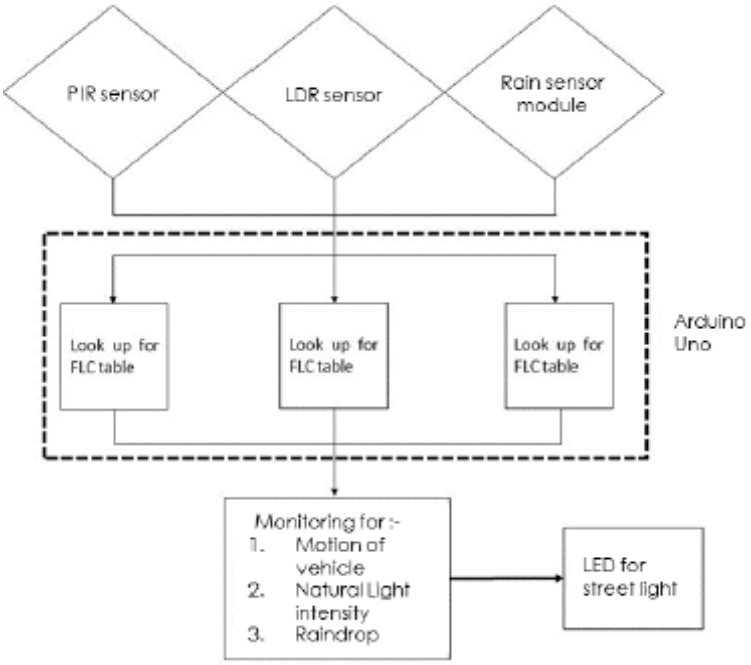

Figure 2: Flowchart of sensor process

2.3 Equations

The fuzzy inference for position control has adopted from the Mamdani's Min-Max method due to its simplicity. The fuzzy control output, μu, μe and μΔe:

$$\mu u = \bigvee[\mu e \wedge \Delta e] \quad \text{Eq. 1}$$

Where ⋁ and ⋀ denote the minimum and maximum operators respectively while μu, μe and μΔe denote the degree of membership function of the voltage output, error and delta of error respectively. Then, In order to convert the fuzzy value to the crisp value of light intensity, the Centroid of Gravity (COG) defuzzification method is used. The equation of COG that has been use as below:

$$uo = \Sigma AreanNn = 1 \,.\, COGn\Sigma AreanNn = 1 \quad \text{Eq. 2}$$

Where Arean = widthn (heightn - $\frac{heightn^2}{2}$)

3. Results and Discussion

To check the output of the controller layout, MATLAB R2019b software and Fuzzy Logic Toolbox Simulink is used. The toolbox provides a user friendly Graphical User Interface (GUI) which made the testing faster and more efficient. The system performance with well-known model based on controller of PID is compared to non-model based on controller of FLC with common triangular membership functions which are gaussian, trapezoidal and generalised bell. All the simulation results for this controller are shown in the next section.

3.1 Results

Figure 3 shows the sinusoidal result that has been set up for 18 mode of situation. PIR has been set to two (2) which are yes and no traffic detected, LDR has been set to three (3) which are low, medium, and high natural light intensity detected, and rain sensor has been set to three (3) which low, medium, and high detection of rain. Including the output has been set to four (4) which are 0%, 50%, 75% and 100% light intensity of street light condition.

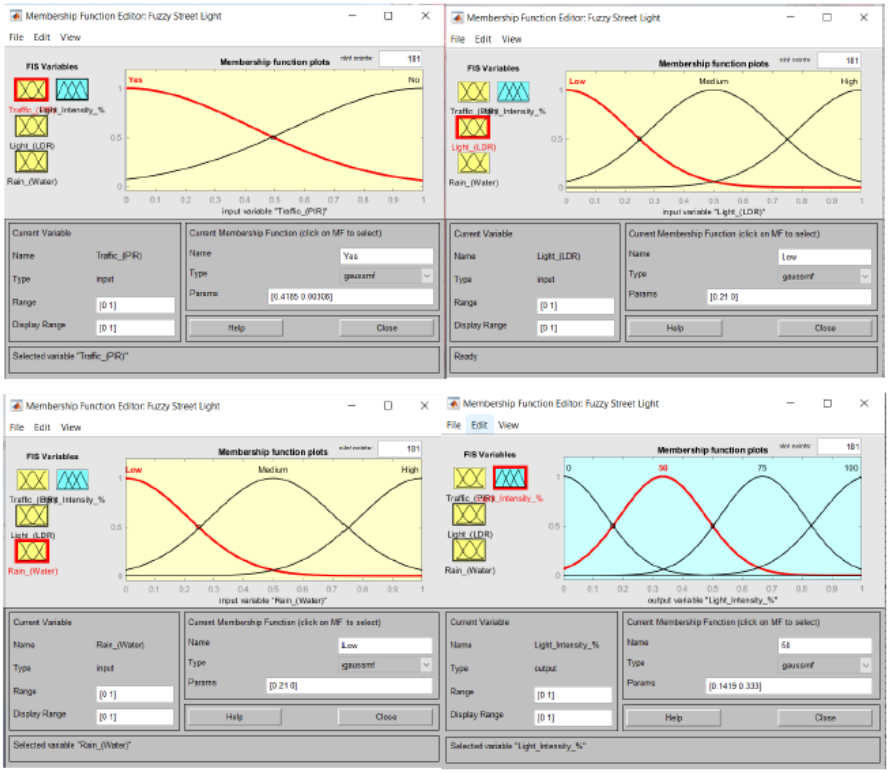

Figure 3: Input and Output have been set follow the condition

Based on the circuit connection, it been connecting to the oscilloscope to prove the output that has been set from FLC system. Table 2 shows the output result from digital oscilloscope for Rule 1 and Rule 15 condition.

Table 2: Condition of Sensor

Rule No.	PIR	LDR	Rain	LED
1	0	297	297	0
15	1	522	788	255

3.2 Discussions

Based on Table 2, there are two rules that have been choose to simulate the system. Rule 1 shows PIR sensor is set to No which means there are no movement detection, LDR sensor is set to 297 of analog value which means Low detection of surrounding light intensity, and RAIN sensor also is set to 297 which Low detection of rain intensity. The output shows the analog value of LED is 0 which means 0% of street light intensity. Rule 15 shows PIR sensor is set to Yes which means there are movement have been detected by the sensor, LDR sensor is set to 522 of analog value which means Medium detection of surrounding light intensity, and RAIN sensor also is set to 788 which High detection of rain intensity. The output shows the analog value of LED is 255 which means 100% of street light intensity. Based on the result obtain, the rectangular sinusoidal obtain to show the functional of the output. At the upper limit of the result shows the light intensity of the street light gain to 100%. Therefore, the lower limit of the rectangular sinusoidal is the time delay of 100 milliseconds to show the amplitude of output.

4. Conclusion

The system focused on an intelligence street lighting system that consist with the controller of the PIR, LDR and rain sensor module and the intensity of street light by LED. The street light control system has been started by PIR sensor circuit, LDR sensor circuit, rain sensor circuit, and the LED of

the street light. Based on the result, this device is to determine the detection of movement of vehicle, the rate of surrounding light intensity, and the rate of raindrop. Through vector can be detected using both Arduino Uno connected circuits and Arduino IDE as monitor. This system is easy to deploy and maintain. This device is reliable, simple to use and can be placed on any street light. Therefore, FLC is a non-based model that does not require mathematical derivation sophistication. Also recorded and evaluated results of different types of membership feature implemented on FLC. Gaussian membership feature gives some better time to rise and time to settle among them. Generally speaking, there is no such major difference for all membership functions being measured in terms of rise time and settling time efficiency. It can therefore be inferred that the output of the fuzzy logic controller is minimally affected by the membership function types. Based on the result, the street light intensity can be controlled by using those sensor according to the street condition.

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References

[1] M. I. Md. Ali, and M.Muhamad. "IoT Based Solar Smart LED Street Lighting System," Faculty of Electrical Engineering, Universiti Teknologi MARA, 2018

[2] Antonio J. Jara, Antonio. F. G. Sehgal. Miguel Castro. "Smart Lighting solution for Smart Cities," International Conference on Advanced Information Networking and Applications Workshops, pp. 1374-1379, 2013

[3] G. Prince Devaraj T. Anto Theepak D. Joseph Pushparaj, and J. Monica Esther, and Caroline Viola Stella Mary, "Intelligent Energy Efficient Street Light Controlling System based on IoT for Smart City," International Conference on Smart Systems and INventive Technology, pp. 551-554, 2018

[4] Preethi B., Parinitha R., Sumana G., A. Kumar, and Deepak K. Srivatsa, "Smart Street Lights," Texas Instruments India Educators's Conference, pp. 103-106, 2013

[5] How PIR Sensor Works and How To Use It With Aduino. [Online]. Available: https://howtomechatronics.com/tutorials/arduino/how-pir-sensor-works-and-how-to-use-it-with-arduino/ [Accessed: December 13, 2019]

[6] How do Dusk-to-Dawn LDR Work? [Online]. Available: https://www.premierltg.com/how-do-dusk-to-dawn-ldr-work/ [Accessed: December 12, 2019]

[7] Rain drop Sensor Module. [Online]. Available: https://components101.com/sensors/rain-drop-sensor-module [Accessed: June 30, 2020]