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SMART AUTONOMOUS STREET LIGHT CONTROL SYSTEM USING IOT

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Abstract **—**Smart street light is an intelligent control of street lights to optimize the problem of power consumption of the street, late in night. Currently, usual street lights are automatically turn on when it becomes dark and turn off when it becomes bright. This is huge waste of energy in the entire world as it is an essential community service, but current implementation is not efficient. Conventional street lights are being replaced by Light Emitting Diode (LED) street lighting system, which reduces the power consumption. The focus of this project is to design a system of street lights controller to provide a reduction in power consumption. The prototype is design by using Light Dependent Resistor (LDR), Infrared sensor (IR), battery and LED. All this component was controlled by Arduino UNO as the microcontroller. The brightness of the lamps is being controlled in this project to reduce the power consumption. The dimming of the lamps depends on the speed of object motion detected such as pedestrians, cyclists and cars. The higher speed of moving object, the greater the level of intensity. For this idea, the innovation of street lights is not quite the same as conventional street lights that are controlled by timer switch or light sensorwhich automatically turns the street lights on during sunset and off during sunrise. According to the study, motion detection devices may help to save up to 40% of energy per month.

Keywords— Smart street light system, power consumption, sensor detection, LED street lights, etc.

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I. INTRODUCTION

Electricity consumed by lighting accounts for approximately 20% of the world electricity consumption, out of which is 5% is used in public area such as street lighting, parking lots lighting, pedestrian area lightning, and park lighting [1]. The number of street lights is not known accurately, but it is said that one hundred million or one billion street lights exist, each of them consume 20W [2].

Better luminance, better visibility and current rendering capability [6-7]. B.Controlled Sensors As shown in Figure 1 is the concept of smart street light in a city. The system is using controlled sensors to detect pedestrians or vehicles for the light to turn on during night time [2].If a person crosses the street starting at position A, sensor will detect the movement and turn on the light at lamp post 1 and 2 for instance.

When the pedestrian continues to walk until position E, sensor at lamp post number 3 and 5 will then detects movements and automatically light at these posts will turn on and the lamp post 1 and 2 will cease out and eventually turn off [2]. This will reduce the energy consumption instead of all the street lights are turn on during whole night .

II. OBJECT MOVEMENT

Object movement can be classified in three speed category. Firstly, in low mode which is pedestrians with the range of speed between 0-5 km/h [5] while second is medium mode indicates cyclists with the range between 7- 15 km/h and lastly is high mode for cars with the range of speed more than 16km/hr. Figure 2 shows two different situation and the different of light intensity respect to the speed of moving object.

In situation A, when the sensor detects a car with a speed of 30 km/h, the lightning level increases to 80% while in situation B, the lighting level decrease to 20% when sensor detects slow moving object. If there is no movement is detected, the luminaries work at a lighting level of 20% listed components are shown in table I

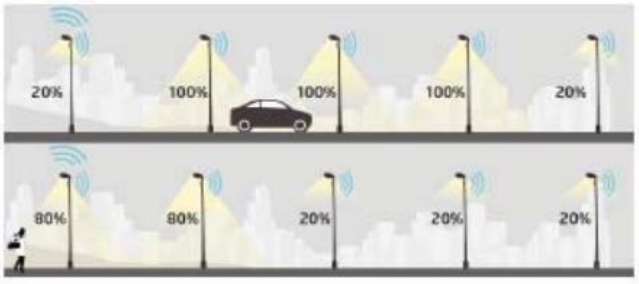

Fig 2. Different setting for different object. [1]

III. PROPOSED SYSTEM

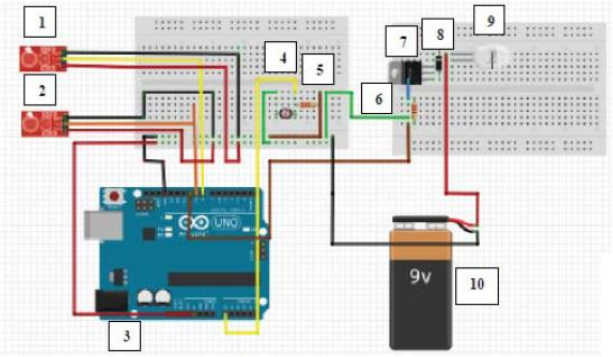

Fig 3. Overall proposed circuit diagram.

TABLE I. COMPONENTS USED

No.	Component	No.	Component
1	IR Sensor 1	6	Resistor 1600 Ω
2	IRSensor 2	7	NPN transistor
3	Arduino UNO	8	Zener diode
4	LDR	9	LED
5	Resistor 10 kΩ	10	9V Battery

This paper proposed a street light that will turn on at night but with different light intensity depending on the road users. The Light Dependent Resistor (LDR) will act as sensor that can adjust the light intensity for different situation. If less than 80% of sunlight is detect, light will turn on [1]. There are two Infrared (IR) sensors used to detect the speed of moving object. When the object approaches the Sensor 1, it will start calculating the time taken to reach at Sensor 2. The sensor will stop the time taken when the object reaches Sensor 2.

The distance between two sensors in this project is 6 cm. To obtain the speed of the object, the value of distance is divide by the time taken. Figure 3 shows the circuit diagram of proposed project which include Arduino Uno, battery and LED. The list components are listed in table 1.

Table II has listed the speed and the light intensity in three mode of movement which is low, medium and high

TABLE II . CLASSES OF SPEED AND THEIR INTENSITY

CONDITION	SPEED (km/h)	INTENSITY (%)
LOW	0-5	30
MEDIUM	<15	70
HIGH	>15	100

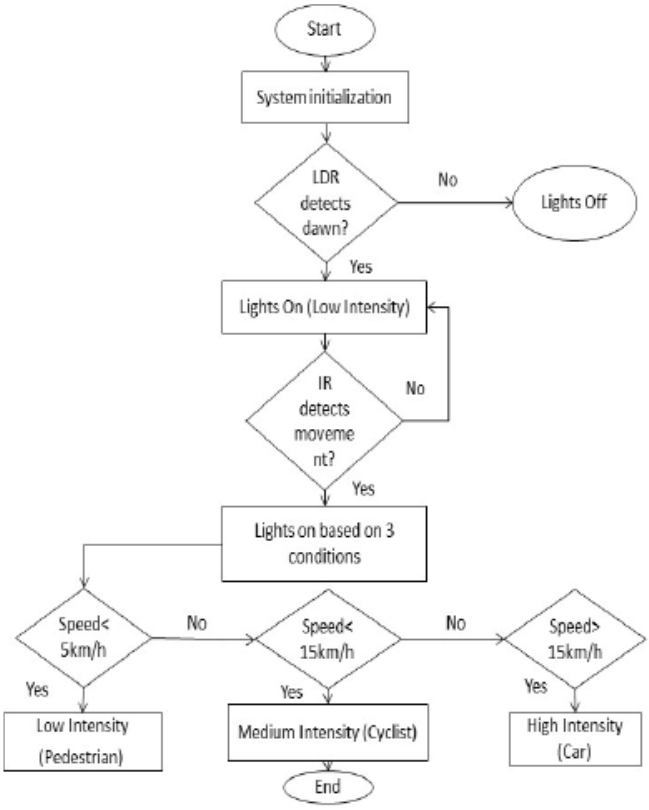

Fig 4. Flowchart to detect speed motion sensor.

A. System Flowchart

Figure 4 shows the flowchart of speed detection system. The speed detection system starts with the initialization. System initialization means that all the variables must be initialized to zero. Then, Light Sensor (LDR) will detect the intensity of the light [9]. If the intensity of the light is low, then the next step is to use IR sensor to detect the object movement. Once the movement is detected, there are three conditions of the light depending on he speed.

When slow moving object is detected for example the speed is less than 5km/h which is normal speed of human walking [5], the level of intensity will increase by 30%. In contrast, when the speed is more than 5 km/h but less than 15 km/h is detected, the speed is considered medium mode which it is a normal speed of cyclist, the light intensity will increase to 70%. Finally, the light intensity will be at its full brightness (100%) [10] when speed of more than 15 km/h is detected.

B. Design of prototype

This proposed smart street light system uses a small-scale model as a prototype. The unit used in this paper is in centimeter. Table III show the ratios between the actual distance and the ratio unit used in this proposed system. While Figure 5 use the distance in meters unit whereas Figure 6 in centimeters as ratio in this prototype. Figure 6 shows an example of a pedestrian passed by the street light during night. Besides pedestrian, other objects like a cyclist and car that have a different speed of motion was also being detected by the proposed smart street light. Different light intensity is produced for different object. The higher the object's speed, the greater the level of intensity.

TABLE III SUGGESTION RATIO IN REAL DISTANCE

Measurement	Sensor 1 to sensor 2	Sensor 2 to lamp pot
Prototype distance (cm)	6	5
Real distance (meter)	12	10

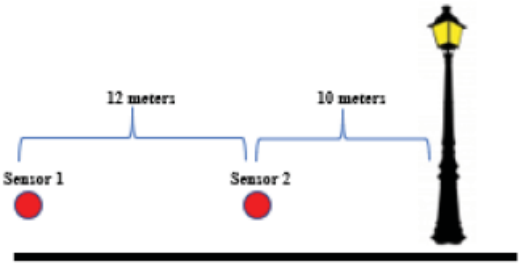

Fig 5. The dimension of real unit (meters).

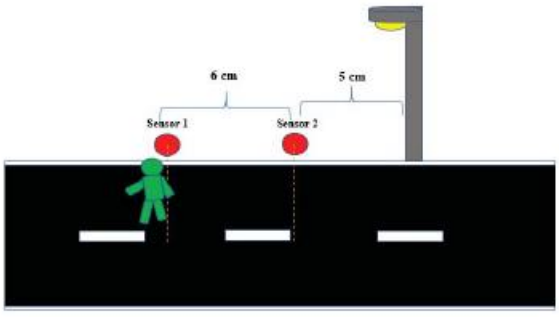

Fig 6. Dimension of the system proposed (cm) - Pedestrian detected.

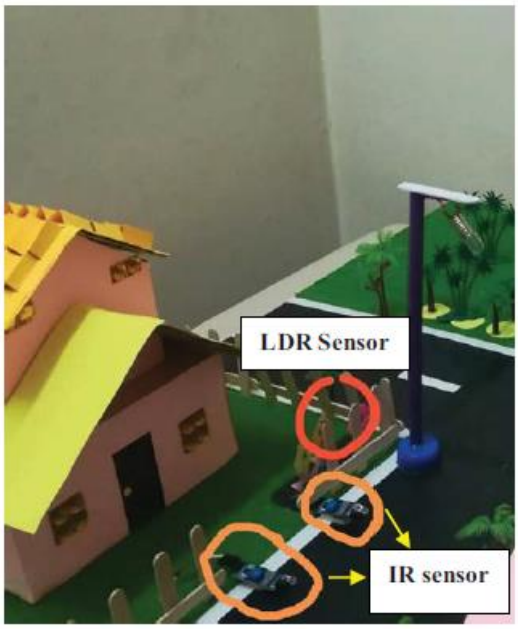

Fig 7 Design of prototype

Fig 8. The level intensity of street light.

Effect of LDR and IR sensor on light intensity The main concern in this project is to reduce power consumption used by street lights by controlling the light intensity. This can be implement in street light system by using sensor to detect the speed of movement. This proposed system is able to control the intensity of light as mentioned previously. LDR is used to detect darkness of surrounding while IR is used to detect the speed of the object. Figure 7 is the design of the prototype which consist of LDR and IR sensor as labelled in this figure.

The final result of the light intensity that are successfully obtained in this project is shown in figure

8. The light intensity level can be seen in different modes. Picture A is the condition of light when LDR detects darkness but with no movement. Picture B shows the 30% intensity of light such as a pedestrian is detected. While in picture C is the 70% intensity of light when speed of cyclist is detected and lastly picture D is the 100% level of light intensity when a car is detected.

TABLE IV. HOUR WISE POWER CONSUMPTION

Time duration	Intensity (%)	Theoretical Energy Consumption (kWh)	Energy Consumption at 100% intensity (kWh)	Estimated Energy Saving (kWh)
7pm–8pm	100	0.27	0.27	0
8pm-9pm	100	0.27	0.27	0
9pm-10pm	100	0.27	0.27	0
10pm-11pm	80	0.216	0.27	0.054
11pm-12am	70	0.189	0.27	0.081
12am-1am	60	0.162	0.27	0.108
1am-2am	50	0.135	0.27	0.135
2am-3am	40	0.108	0.27	0.162
3am-4am	10	0.027	0.27	0.243
4am-5am	15	0.0405	0.27	0.2295
5am-6am	15	0.0405	0.27	0.2295
6am-7am	50	0.135	0.27	0.135
	Total		**3.24**	**1.3767**

C. Effect of LED on power consumption

In order to reduce the power consumption, this paper proposed to use LED lamp with 9W of power. LED street lamps power is about 36W or more. Since this project used 9W LED power, therefore the energy consumption will be 9Watt-hour. The electricity is measure in kilowatt-hour, hence it is 0.009kWh. This calculation of power energy consumption by street light are estimated for a month (30 days). Therefore, the full intensity of LED for a month will be 0.27kWh. The intensity value [11] and the calculated energy consumption and estimated saving is tabulated in table IV.

$$\text{Estimated Energy saving} = \frac{\textit{Estimated energy saving}}{\textit{Energy consumption full brightness}} \quad (1)$$

$$\text{Estimated Energy saving} = \frac{1.3767}{3.24} \times 100\ \%$$

$$\text{Estimated Energy Saving} = 42.45\%$$

The formula to calculate estimated energy saving was obtained from [11]. In the Table IV, it is shown that the estimated energy saving for 12 hours is 42.45%. But it may save less than this value when the calculation takes into consideration the interrupts from IR and consumption of other hardware components. By using LDR and IR sensor as proposed in this paper, the light intensity will be varied according to that. Therefore, the system can save up to 40 to 45% for a month

IV. CONCLUSION

This paper discusses the technical aspect of smart street light system and the possible energy saved by implementing this proposed system. The current problem with the conventional system is the long hour operational time which cause a lot of electricity cost. This is a huge waste if it is not taken seriously. Thus, this project proposed the solution to save the energy consumption of street light. Two sensors were used in this proposed smart street light system which is IR Sensor and LDR sensor. By using IR sensor to detect speed, it can control the light intensity level which lead to saving energy. Besides, LED bulb used in this paper is also able to control the power consumption use by street light and saves the energy up to 40% to 45% per month. Other than that, it also reduces carbon dioxide (CO2) emission. All these were achieved in this paper.

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