A Hardware based approach in designing Infrared Traffic Light System

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Abstract

Nowadays, a traffic light is currently used to control the traffic at the road. The trend is clear that the technology of the traffic light is growing rapidly. However, there is still problem for the emergency vehicles to bypass when the traffic light is red. This is because the emergency vehicle is unable to reach the destination in short as well as there is an emergency case. So, the purpose of this project is to solve this problem. This paper presents the design of traffic light system that response for emergency vehicles to immediately bypass the traffic light. Hence, the emergency vehicle can reach the destination at the right time to save lives.

1. Introduction

The trends of traffic lights technology is growing rapidly due to its usefulness in controlling traffic on the road. Conventional traffic light works based on configurations that has been set. These techniques found to be not practical nowadays due to the increasing high number of vehicles and lack of consideration for emergency vehicles to bypass especially during peak hours. Therefore, this paper intends to design the model the traffic light system to consider the emergency vehicles to bypass by adding the infrared receiver. There are three main components needs to be considered to perform the design infrared transmitter, infrared receiver and traffic light circuit integrated with microcontroller.

The basic operation of the system can be described as follows:

i) the infrared transmitter that is located at the emergency vehicle transmit the infrared signal;

ii) the infrared receiver then receive the transmitted infrared signal from the infrared transmitter;

iii) the microcontroller will change the operation from normal program to the interrupt program.

The 5mm infrared light emitting diode in the infrared transmitter circuit is used to transmit the infrared. A potentiometer is used to increase or decrease the range of infrared transmission.

For the infrared receiver circuit, the infrared receiver module is used to receive the infrared transmitted from the infrared transmitter. A potentiometer is also used in this circuit to increase or decrease the receiving range on infrared transmission.

The traffic lights circuit contains 12 LEDs that represent 12 lights of four traffic lights model. The model of four traffic lights are placed at the cross junction. The operations of the traffic lights are controlled by the microcontroller of PIC16F84A.

The language used to create the program for the microcontroller is PICBasic. There are 12 ports used for output LEDs and 1 port is used for input from the infrared receiver. The infrared receiver is connected to the microcontroller and traffic light circuit to complete the system.

2. Concept Design

In the operation of the infrared traffic lights, there are four main parts that have specific roles. Figure 1 shows the operation system of the infrared traffic lights.

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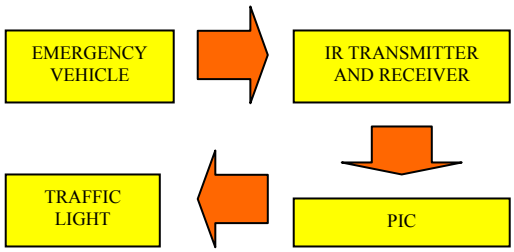

Figure 1: The operation system for infrared traffic lights

The connection of the diagram is stated below:

(i) The infrared is transmitted from the emergency vehicle.

(ii) The infrared transmitter is placed at the emergency vehicle while the infrared receiver is placed beside the road.

(iii) The PIC microcontroller is programmed to change the first traffic light from red to green and the other traffic lights to red.

(iv) The first traffic light will change from red to green and the other traffic lights to red.

3. Infrared Circuit

Infrared signal is absorbed by dark objects, diffusely reflected by light-colored objects, and directionally reflected from shiny surfaces. The infrared medium is a drawback medium due to it cannot be penetrated by solid medium such as walls [1]. Direct transmission of infrared maximizes power efficiency, since it minimizes path loss and reception of ambient light noise [2]. Figure 2 shows direct transmission of infrared between transmitter (T) and receiver (R).

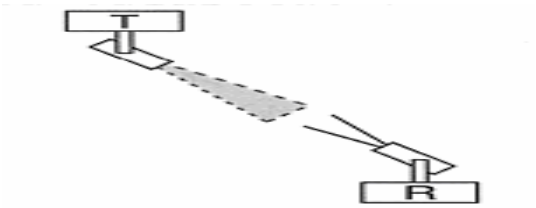

Figure 2: Direct transmission of infrared

The infrared circuit is divided into two part which are infrared transmitter circuit and infrared receiver circuit. In infrared transmitter, infrared LED is used to emit the infrared. Typical packaged LED's emit light into semi angles (at half power) ranging from about 10 –30, making them suitable for direct transmission [2].

In the infrared transmitter circuit for this model, there are nine types of components used to complete the circuit. Those components are resistors, capacitors, Light Emitting Diode (LED), Zener diode, infrared LED, integrated circuit (IC), potentiometer, transistors and tack switch. The resistor is used to resist the flow of electric current. The capacitor is used to store energy in its electric field. The LED is used to emit light when the switch button is pushed. The Zener diode is operating in condition of forward bias and reverse bias. The infrared LED is used to transmit the infrared to the infrared receiver. The IC that has been used is IC 4011 that operates as a NAND gate. The potentiometer is used to change the range of infrared transmission. Transistor is a component with three ports or base which it's current, voltage and output power are controlled by the input current or input voltage. The task switch is used to begin the transmission of the infrared from the transmitter circuit [3]. Figure 3 shows the infrared transmitter circuit.

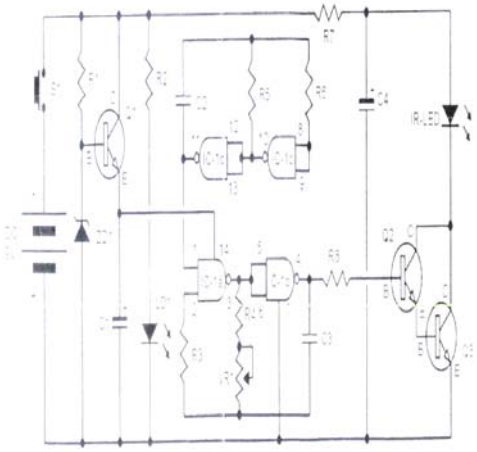

Figure 3: Infrared transmitter circuit

In the infrared receiver circuit for this model, there are ten types of components used to

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complete the circuit. Those components are resistors, diodes, capacitors, Light Emitting Diode (LED), potentiometer, transistors, relay 6V/5 pins, SPDT sliding switch, integrated circuits (ICs) and infrared receiver module. Diode is used to allow the current flow in one direction only. Relay is used as a contactor when the infrared receiver has received the infrared. Infrared receiver module is used to receive the infrared transmitted from the infrared transmitter [3]. Figure 4 shows the infrared receiver circuit.

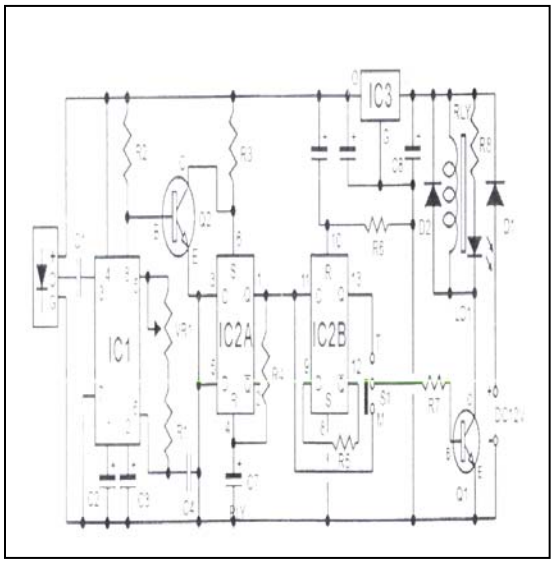

Figure 4: Infrared receiver circuit

4. Traffic Light Circuit

The traffic light circuit uses four components to complete the circuit. Those components are resistors, LEDs, crystal oscillator 4.0 MHz and capacitors. 12 LEDs are used for the outputs for the microcontroller PIC16F84A. The crystal oscillator 4.0 MHz used is to make the microcontroller able to read the program written in the microcontroller. The input for the microcontroller comes from the infrared receiver. The regulator is also used for this circuit to change the voltage from the power supply to 5V. Figure 5 shows the traffic light circuit.

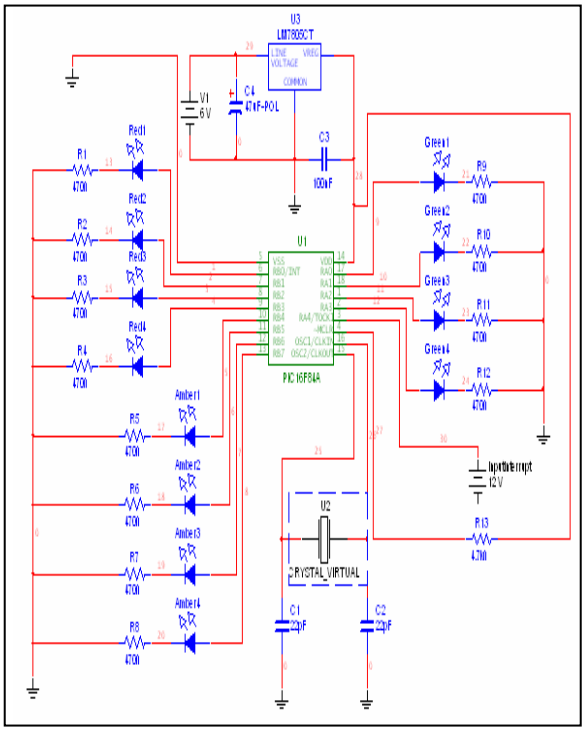

Figure 5: Traffic light circuit

The language used to write the program in the microcontroller is PicBasic as the language offer the easy way to read. In addition, this program also execute directly from code space PIC microcontroller MCU [4].

5. Results

The operation of this system is divided into two modes; that are normal mode and emergency mode. For the normal mode, the traffic light circuit operates without the input from infrared receiver circuit. The green LED of the first traffic light ON up for 20 seconds and in the same time; the other three traffic lights light up the red LEDs. After 20 seconds, the green LED in the first traffic light switched off and the amber LED will on for 3 seconds. Then, the amber LED switch off and the red LED of the first traffic light on for 20 seconds. After that, the same operation goes on traffic light 2, 3 and 4.

For the emergency mode, the traffic light circuit operates after receiving the input from the infrared receiver. The main purpose of this

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emergency mode is to light up the green LED of the first traffic light. The traffic light circuit then receives the input from the infrared receiver after the transmission of the infrared from the infrared transmitter to the infrared receiver.

In the infrared transmitter circuit, it uses a 9V battery for the power supply. When the switch is pushed, the LED emits the light. In the same time, the infrared LED transmits the infrared. The infrared receiver circuit uses a 6V battery for the power supply. The infrared receiver module in the infrared receiver circuit receives the infrared transmitted from the transmitter. The potentiometer in the receiver is adjusted until the LED in the receiver lights up. At that time, the relay is actuated.

The output from the relay is connected to the traffic light circuit through the PIC16F84A microcontroller. The operation of this system would be in normal mode if the green LED of the first traffic light is on. But, if the amber LED or red LED of the first traffic light is on at that time, the sequence of the operation is changed.

If the green LED of the traffic light other than the first traffic light is on, the green LED will off and the amber LED of the traffic light switch to on for 3 seconds. Then, the amber LED off and the red LED on for 20 seconds. After that, the red LED of the first traffic light will off and the green LED will on. Same goes if the amber LED of any traffic light is on at that time. The amber LED of the traffic light will off and the red LED will on for 3 seconds. The red LED of the first traffic light will off and the green LED will on after that.

The operation of the system is changed back to the normal mode until the PIC microcontroller get next input from the infrared receiver. Figure 6 shows the model of the infrared traffic light system.

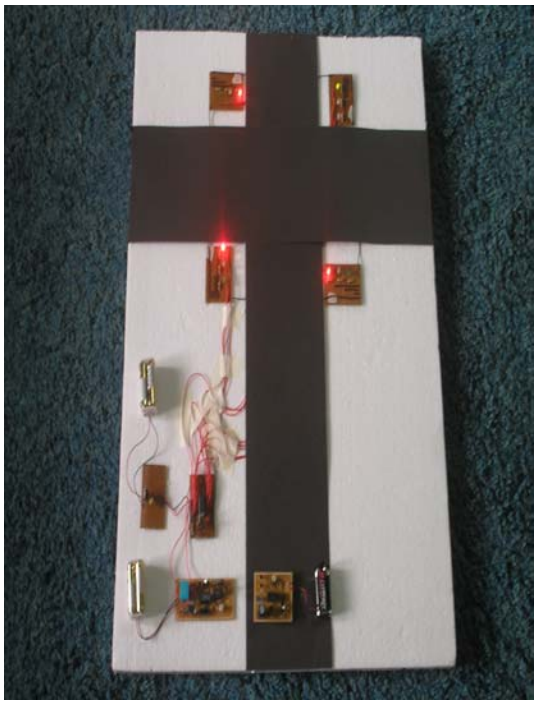

Figure 6: The model of the infrared traffic light system

5. Conclusion

This project is an alternative way to gain the performance of the traffic light system by extending the application of PIC microcontroller and infrared in a system of traffic light. The infrared ray is one of the best ways to use because it has longer wavelength compared to visible light, so it is relevant to be used. There are many applications that used infrared today, so there are many references can be made about infrared. The using of PIC microcontroller is made because it is low-cost component and can be used to control peripheral devices. For overall, the interfacing of all these components can develop a system that can ease some of road users such as emergency vehicle drivers.

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6. Future work

This project of infrared traffic light system is one of the best ways to smoothen the journey of an emergency vehicle. However, this system can be improved in future by designers. Some of the ideas are mentioned below:

(i) The using of laser diode instead of using the light emitting diode (LED) because the laser diode has wide modulation bandwidths. The infrared can be transmitted in longer range by using the laser diode rather than the LED.

(ii) The using of radio frequency (RF) to change the using of infrared transmission. With radio frequency, the radio wave is transmitted in radius and it is more practical rather than using the infrared that is transmitted in straight line.

7. References

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