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Development of Portable Traffic Lights System Using Radio Frequency, Infra-Red Sensor and Controller PIC 16F877A

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Abstract: Controlling the traffic during road construction, maintenance and blockage can be a hassle to manage. Thanks to the idea of portable traffic lights system (PTLS), road workers can fully focusing on fixing the road without have to worry about the traffic situation. By taking advantage of radio frequency (RF) and infra-red (IR) sensor technology, two set of portable traffic lights has been developed. It can automatically sense an approaching object and send a wireless signal to communicate with the other traffic lights. The command setting is set to keep both traffic lights to show a different set of lights of green and red at all time. The paper discusses the process of combining wireless, sensor and controller technology by specifically choosing RF module set, 315MHz, Sharp GP2Y0A21YK IR sensor and PIC16F877A as a main components to develop a wireless control system device. A much more advance wireless system can be produced using the same process but different main components.

Keywords: Wireless Communication, Distance Sensor and Portable Traffic Lights.

1.0 INTRODUCTION

PTLS is also known as portable signal controller (PSC) is commonly being utilized in United Kingdom and United States [1]. PSC is the same size and mounting height as permanent traffic signals, together with the type of layout seen at permanent pedestrian crossing installations [2]. PSC are linked to the signal heads and detector are using two methods either cables and radio controller [3]. The power supply get is from diesel or Liquefied Petroleum Gas (LPG) generator, battery or mains through a suitable transformer [4]. Each portable signal controllers is provided with a vehicle detector unit. These units normally use microwave technology which is MVD (Microwave Vehicle Detector) [5]. The MVD can detect most moving motor vehicles, including larger motorcycles, up to 40 meters away, but with smaller motorcycles and cycles the distance is 25 meters [6]. MVD can detect the vehicle travelling towards the MVD at speeds greater than 10 mph and the detector is correctly aligned. Some detectors may be able to work outside these limits. An indicator is illuminated when a vehicle is detected and the 'detect' message is sent from the MVD to the controller [7].

The concept of existing PSC are followed and studied. The objective of this paper is to provide an idea of using other existing technology and creating a device that could function and can be used for the same application in much more economical and affordable way.

2.0 MATERIALS AND METHODS

The wireless control device is designed to have two (2) lights which are green and red as an indicator for 'STOP' and 'GO'. The super bright LEDs (Light Emitting Diode) used as displays for the output. The device is a portable paired device which is control by PIC (Peripheral Interface Controller). The portable paired devices named as 'Master' and 'Slave' circuit. These two device then will be placed at a certain distance to control traffic.

The control mechanism will be triggered by distance sensor installed in the 'Master' circuit. Initially, the red lights are set to brighten up in order to inform the moving objects that is going to appear in front of the 'Master' to STOP. When the distance sensor sense there is an object appear in front of it, the programmed timer will hold the red light for 20 seconds to order the incoming object to stay unmoving. During this period, the 'Slave' circuit which is located at different location is set to display a green light to allow the moving objects in front of it to GO. After 20 seconds, the light color of 'Master' and 'Slave' will switch from red to green and vice versa. This

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condition is set to happen for another 20 seconds. The system then will continuously repeat the setting when 'Master' detects another object in front of it. The operation will resume again and again until the devices is turned off. The system block diagram is shown in figure 1.

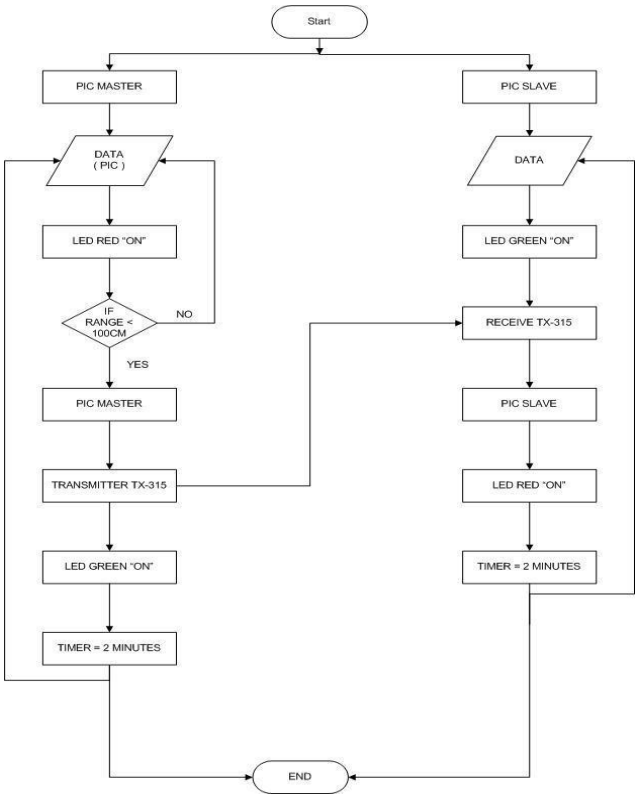

Figure 1: Overall System Flow

2.1 Programming Software

The PIC controller is programmed using C programming language. Later, C source code is converted to assembly language by compiler and assembly language into machine code. The machine code is stored in a hex file. The software and the compiler used for this part are MPLAB IDE and HI-TECH COMPILER. PTLS have a paired of PIC which labelled as 'Master' and 'Slave'. Hence, the programming also must be in paired. The listed of input output PIC pin is shown in table 1.

PIC	I/O	MASTER PIC	PIC	I/O	SLAVE PIC
RA0	I	RANGE SENSOR	RB0	O	RED LIGHT
RB0	O	RED LIGHT	RB1	O	GREEN LIGHT
RB1	O	GREEN LIGHT	RC7	O	RECEIVER 315MHZ
RC6	O	TRANSMITTER 315MHZ			
RD0	O	LCD R			
RD1	O	LCD W			
RD2	O	LCD S			
RD4	O	LCD 4			
RD5	O	LCD 5			
RD6	O	LCD 6			
RD7	O	LCD 7			

Table 1: List of input and output pins

2.2 Simulation Software

Proteus 7 Professional software is used for simulation purpose. The source code hex file from the MPLAB IDE is loaded into the Proteus 7 Professional software for simulation process. This software enable the desire circuit to be designed quickly by the designer. Figure 2 and Figure 3 show the circuit simulation for Master and Slave.

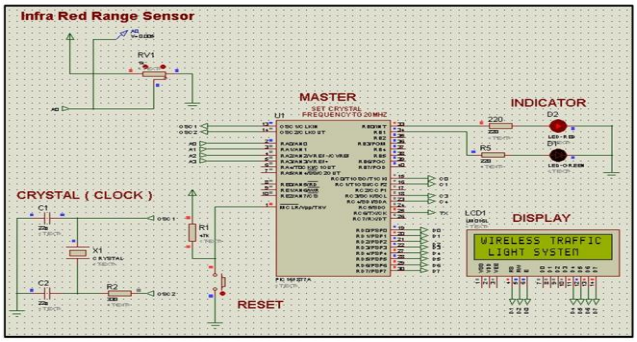

Figure 2: Circuit Simulation for Master Circuit

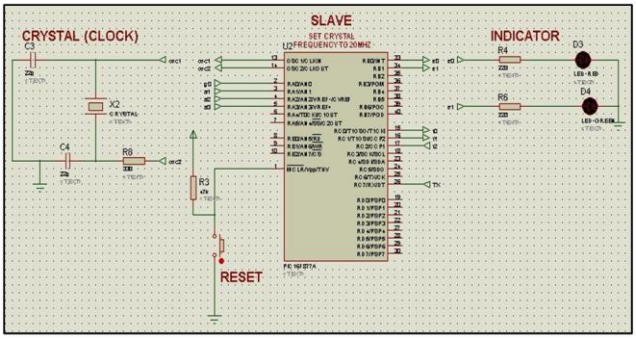

Figure 3: Circuit Simulation for Slave Circuit

2.3 PCB Outline Design Software

After running a simulation on the circuit and verified it. The PCB outline is then designed using Ares software. Figure 4 show the PCB outline design for Master circuit and Figure 5 show the 3D visualization for Master circuit.

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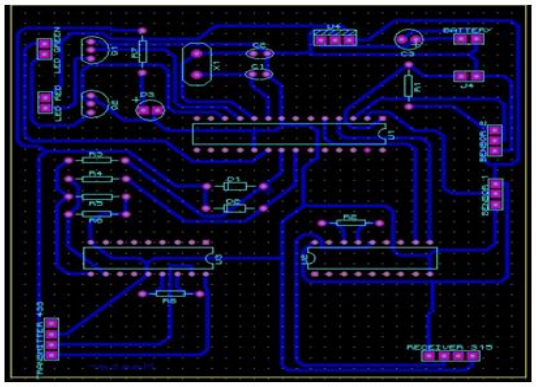

Figure 4: Master PCB Outline Design

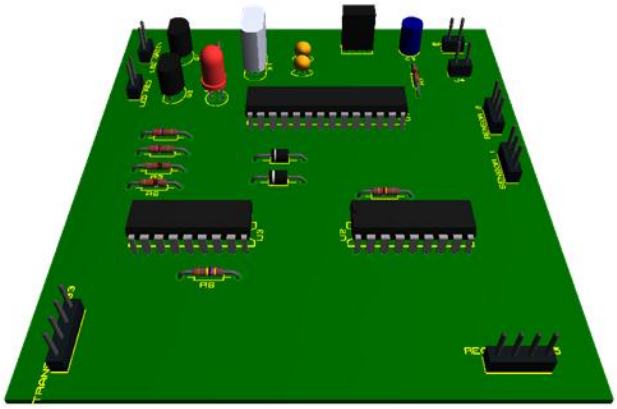

Figure 5: 3D Visualization for Master Circuit

There are three stages need to done in order to complete the PCB printing process which are bottom layer, top copper layer and top silk layer. Before the board is undergo the laminating process, the PCB surface need to be clear from dust to ensure excellent circuit functionality.

3.0 RESULTS

After going through the making process of PTLS. The constructed PCB board is nicely placed in a compartment which make it look presentable as a PLTS system as shown in Figure 6.

Figure 6: Finished product

IR range sensor is tested in order to limit the distance between of the object which is going to be placed in front of master circuit position. The result of the IR sensor capabilities is shown in the Figure 7.

The analogue voltage produced by the IR range sensor is obtained from this experiment. By knowing the IR range sensor, the configuration between the IR range sensor and PIC16F877A becoming much easier. The procedure is done by giving 5V supply to the IR sensor and placing an object in front of it. The infrared sensor will produce a voltage depending on the distance of the object.

DISTANCE (CM)	OUTPUT VOLTAGE (V)
10	2.30
15	2.75
20	2.50
30	2.04
40	1.50
50	1.25
60	1.05
70	0.93
80	0.75
90	0.73
100	0.68
110	0.60
120	0.57
130	0.50
140	0.49
150	0.46

Figure 7: Data for IR Range Sensor Testing

Referring to the graph shown in Figure 8, when the distance between object and IR sensor are close, the voltage produced by the IR range sensor is high but when

the object are placed far from the sensor, the voltage produced is lower keep on reducing until it become 0V. From this result, the accurate detection of IR range sensor can be said is between 10 cm to 60 cm. When the distances between IR sensor and object is increasing, the IR sensor having difficulties to communicate with the receiver. In addition, the suitable bit-resolution for this sensor is 10 bit since the voltage produced by the IR sensor are unbalanced.

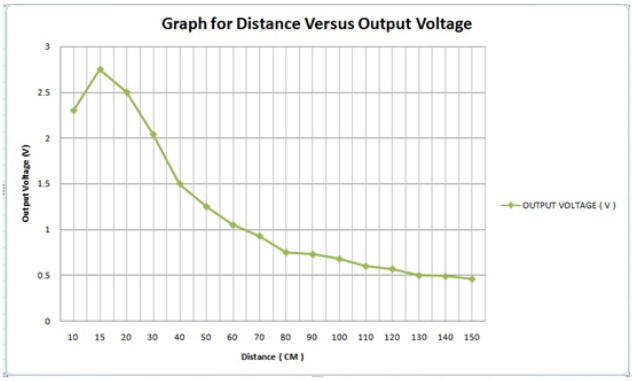

Figure 8: Graph for Object Distance VS Output Voltage for IR Range Sensor

The radio frequency devices is tested to investigate the maximum distance the PTLS can be separated between each other. On the PIC16F877A, the transmitter (Master) for radio frequency is connected to the RC6 and the receiver (Slave) at RC7. This experiment are done by using breadboard and PIC16F877A board. Figure 9 show the radio frequency testing.

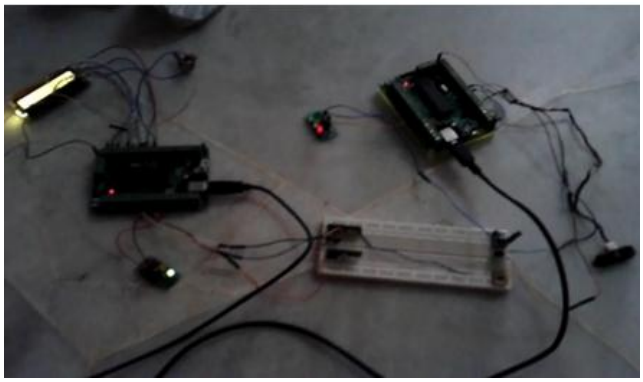

Figure 9: Radio Frequency Testing

The maximum distance between both circuit which are labelled as master and slave is about 9.6 meter. The expected distance between them are supposed to be more than 9.6 meter but the problem is caused by the non-constant 5V voltage supply to the radio frequency due to heavy power consumption of the PIC circuit. Besides, the length of antenna used also contribute to limit the communication range between master and slave circuit.

4.0 CONCLUSION

The project's aim to produce a low cost wireless traffic control device is achieved. The developed system manage to configure the input and output to follow the required instructions. The limitation on distance and wireless coverage are fairly noticed. However, it can be solved by exploring other available components which are more advanced. For example, the wireless communication device can be upgraded to other type such as Bluetooth and XBEE. XBEE is a device that can send data in 2-way directions which mean it could send and receive data on its own. XBEE also had a longer coverage range which is 30 meters. IR sensor used in this project is considered simple and weak because it can be easily interrupted during the operation. Hence, it is better to change to ultrasonic sensor that have a longer sensing distance which is around 6.4 meter. Ultrasonic sensor is a sensor that transmit sound wave and reflected by the object. More advance controller like ARDUINO is highly recommended to replace the PIC to control the input output signal. ARDUINO is compactable, small, easy to program and the most important part is it is more compatible to be configured with XBEE.

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