American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-6, Issue-7, pp-375-382
www.ajer.org
Research Paper Open Access

Solar Powered Microcontroller–Based Smart Four Way Junction Traffic Light Controller System using Seven Segment Display

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ABSTRACT: *The steady supply of public power has always been a challenge in third world countries. The proposed solar based smart four-way junction traffic light is to work independent of public power supply using abundant renewable energy (solar). The solar traffic light is powered by battery which is charged during the day with solar PV and the battery continues working during the night. Managing traffic at a four way junction by humans can be a very complex and daunting job. A Four-way traffic light can be used to solve this problem. The traffic lights on each lane controlled by a microcontroller and the four microcontrollers are interconnected. The system displays the time allowed for passing and for waiting for each of the four lanes using a seven segment display. Ambulances are given special preferences and therefore have a Radio Frequency Transmitter; their corresponding radio frequency Receiver is connected to one of the microcontrollers. This enables the system to activate the red LED on all lanes to enable the ambulance to have the right of way. The system was designed and simulated using Proteus, and then the hardware was implemented. The Circuit can be used to control traffic at four way junctions.*

Keywords: *Four–way traffic controller, traffic lights, smart traffic, Radio Frequency (RF) receiver, RF transmitter.*

Date of Submission: 19 -05-2017 Date of acceptance: 31-07-2017

I. INTRODUCTION

Solar energy can be used to generate power in two-ways; solar thermal conversion and solar electric (photovoltaic) conversion. Solar thermal is employed in heating of fluids to produce steam to drive turbines for large scale centralized generation while solar electric (photovoltaic) which is considered in this paper, is the direct conversion of sunlight into electricity through photocells. A charge controller is an essential part of nearly all power systems that charge batteries, whether the power source is PV, wind, hydro e.tc [1]. A PV system consists of a PV array which converts sunlight to direct – current electricity, a control system which regulates the battery charging and operation of the load, energy storage in the form of secondary batteries and loads. The main function of a charge controller in a PV system is to keep batteries properly charged and safe for the long term, and to protect it from deep discharging [1], without a charge controller, the battery will overcharge. Absence of charge controller in PV system results in high maintenance cost including frequent battery replacement. Hence, a charge controller is important to prevent battery overcharging excessively, over discharging, reverse current flow at night and to prolong the life of the batteries in a PV system [1].

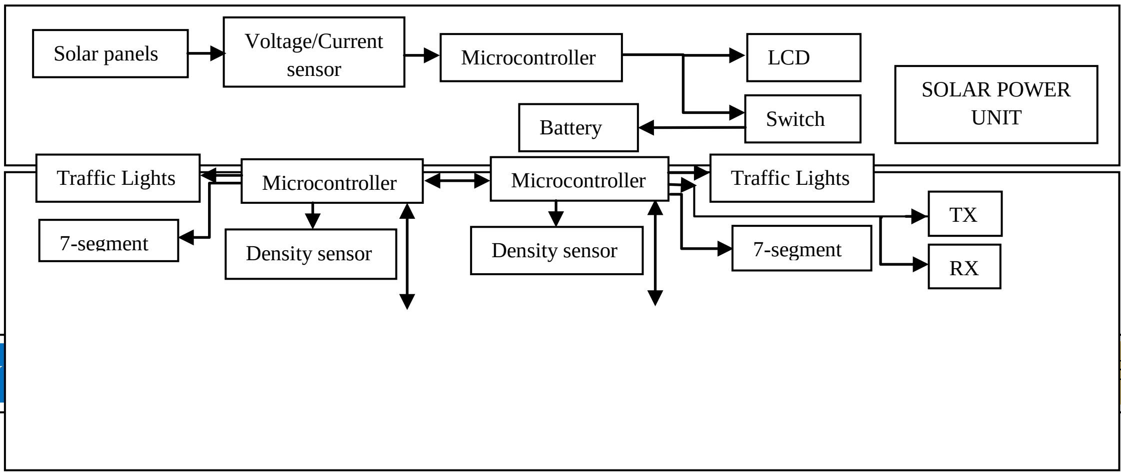
Traffic monitoring and controlling is a difficult task. The flow of the traffic constantly changes depending on the time of the day, day of the week and time of the year. At times, road construction and accidents further influence the complexity. Even for single junctions there might be no obvious solution and the problem becomes even more complex for the multiple junctions, as the state of one light in one junction directly influences the flow of traffic towards many other lights. With the ever increasing vehicles on the road and the number of road users, the limited resources provided by current infrastructure leads to ever increasing travelling times. Hence, intelligent control of traffic is an important issue to be considered. The services of our traffic wardens as well as that of the policemen can no longer adequately contain the situation; they cannot carry out a twenty-four hour duty. One way to improve the traffic flow and safety of the current transportation system is to apply automation and intelligent control methods to roadside infrastructure and vehicles. There are several models for traffic simulation. In our research, we intend to develop a cost effective system using Radio frequency (RF) technology, switches and latest high speed microcontroller [2] to achieve the desired results. The primary objective of this project is to identify the road emergency vehicle such as ambulances and police cars and give them the right of way. Traffic jams may arise due to large red light delays which are hard coded and is independent of traffic [3]; in order to solve this problem an attempt will be made to design, and construct a four-way traffic light control system. Traffic lights alternate the right of way accorded to road users by displaying lights of a standard colour (red, amber, and green) following a universal colour-code and the whole system being powered by solar/battery. In the typical sequence of colour phases:

- The green light allows traffic to proceed in the direction denoted, if it is safe to do so
- The yellow/amber light denotes prepare to stop short of the intersection, if it is safe to do so
- The red signal prohibits any traffic from proceeding

Timed Colored Petri Net (TCPN) formalism [4] was used to design and simulate a model for a multi-phase traffic light controlled intersection with an associated fixed signal timing plan using T-type junction, while [5] proposed a system which can minimize the possibilities of traffic jams, caused by the traffic lights, to some extent by clearing the road with higher density of vehicles and also provides the clearance for the emergency vehicle if any. The system is based on a microcontroller, IR (infrared) sensors and Radio Frequency Identification (RFID) technology. In [6] the proposal was a multiple traffic light control and monitoring system using micro-controller 89V51RD2 (MCS-51 family based) with IR transmitter and IR receiver which are mounted on the either sides of roads respectively to count vehicle and the count is recorded. This data is then sent to a central control room where an administrator can make decisions to reduce traffic congestion. The major disadvantage of this system is that it requires major human input and this defeats the use of automation. The system designed in [7] focused on emergency vehicles, once a signal is received from an emergency vehicle, the sequence of right of road use is changed and once the vehicle passes the junction, the normal sequence is restored. It makes use of Radio frequency and PIC16F877A. Transmission through RF is better than IR due to the following reasons. First, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter and receiver. RF transmission is stronger and more reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources. Conventional technologies for identifying the emergency vehicle use some image processing systems. But these image processing systems are affected by the bad weather conditions like wind, rain, fog, etc., during the bad weather conditions, the image received by the camera is distorted by noise and it is not clear for the system to identify the vehicle. Thus, we propose a system using RF transmitter and receiver. The advantage of RF is that it is a cost effective system and it provides uninterrupted communication even in bad weather conditions.

II. MATERIALS AND METHODS

The Block diagram of the system is shown in Figure 1. It comprises two major sections; the first section is the solar/battery power unit and the second section is the traffic light unit. The power unit consists of a solar PV that generates the voltage and current depending on the sun intensity. The current and the voltage values of the PV is measured by connecting a current and voltage sensor to a microcontroller and the values of the solar voltage, battery voltage, percentage of charging of the battery are displayed on the LCD. When the solar PV voltage is below minimal the battery commences the powering of the circuit. There are four microcontrollers for the four lanes. Each microcontroller is connected to traffic lights and Seven–segment display. All the Four microcontrollers are connected to each other. Each traffic light block has a Red LED, a Yellow LED and a Green LED. The Red LEDs represent the “stop” signal; the yellow LEDs represent “get ready”, while the green LEDs represent the “go” signal. The red LED comes on for 90seconds while the Yellow LED comes on for 5 seconds and the Green LED comes on for 30 seconds. The seven segment display is used to show the time countdown for each colour of the traffic light.



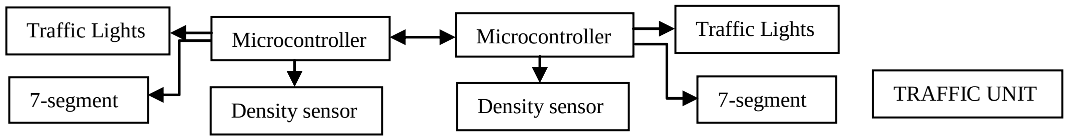


Figure 1: Block diagram of a four-way traffic system.

The Radio Frequency Receiver is connected to one of the microcontrollers. The Radio Frequency Receiver communicates with the RF transmitter located in the ambulances to determine right of way in the case of an emergency. This **RF module** comprises an **RF Transmitter** and an **RF Receiver**. The transmitter/receiver (Tx/Rx) pair operates at a frequency of **434 MHz.** An RF transmitter receives serial data and transmits it wirelessly through its antenna connected at pin 4, as shown in Figure 2. Transmission in the RF module occurs at the rate of 1Kbps to 10Kbps. The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder [8].

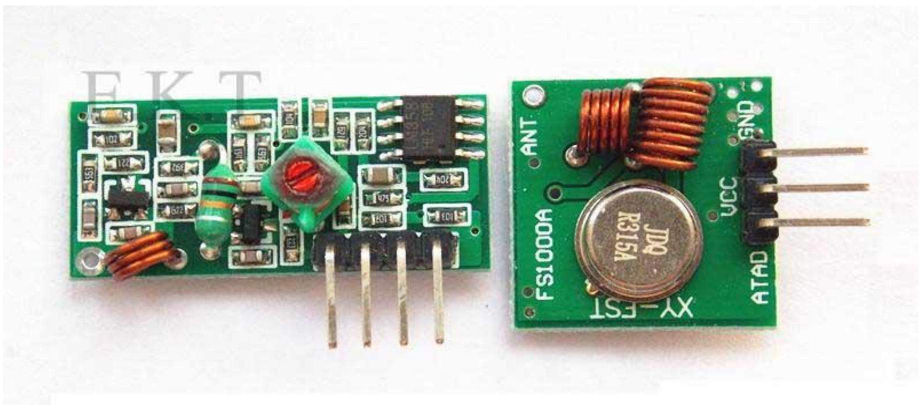


Figure 2: transmitter and receiver with RF module pin diagram [8].

There may arise a case that Ambulances are approaching from all four lanes. In this case, the ambulance who's Transmitter comes in contact with the Receiver first will be given priority. In the case that two Ambulances are at exactly equal distance from traffic light, and then the traffic light receiver will give priority to the Transmitter of any one of the Ambulances at random.

The circuit shown in the Figure 3a is the solar/battery power unit that is used in powering the smart traffic light. The solar PV charges the battery while powering the whole circuit. The microcontroller is to measure the solar PV voltage and the battery voltage while charging the battery during the day and disconnects the battery during the night while the battery takes control of the whole circuit. Figure 3b is the complete circuit diagram of an intelligent traffic light control and monitoring system with some peripherals interfaced to the PIC16F877A microcontroller [9]. 7-segment LED displays are used to show the current count value. Since all of the traffic lights are working simultaneously, each one is set to display a different time than the other. When a traffic light turns green, its corresponding 7-segment displays start counting down from 30 seconds and decrements until it gets to zero. After this the 7 segment displays a new count value of 5 seconds at the moment the yellow LED turns on. When the red LED turns on the count starts from 90 seconds and continues to decrement until it gets to zero. This means that the 7-segments, on each set of traffic lights, are used to display the time the cars can pass or wait.

The flowchart of the program for the system is shown in figure 4. Using this flowchart a program was written and simulated in mikroC integrated development environment (IDE) [10]. Proteus 8.4 [11] was used to simulate the hardware of the system and the state of each lane is shown in Table 1.

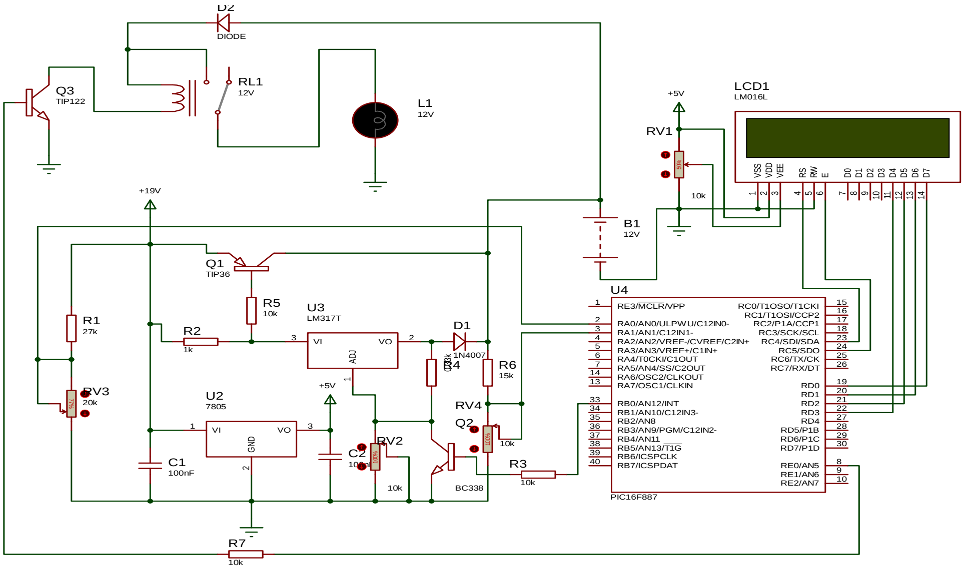


Figure 3a: Circuit diagram of the Solar/Battery power unit.

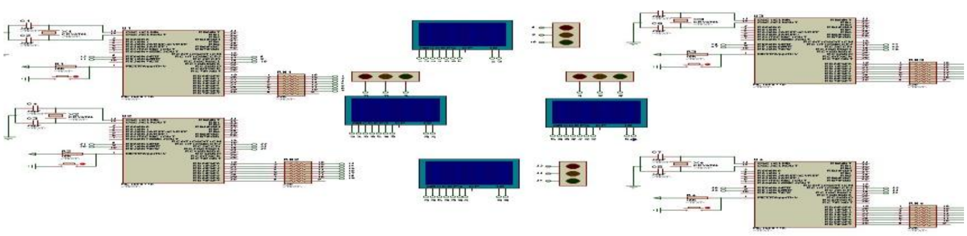


Figure 3b: Circuit diagram of an intelligent auto traffic signal controller.

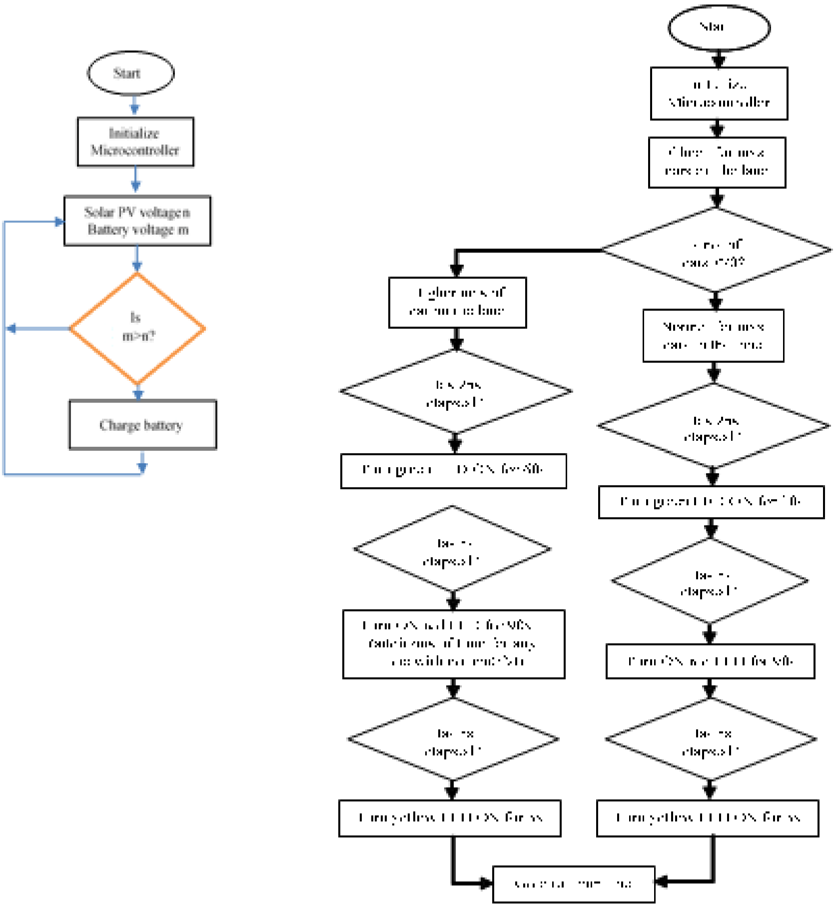


Figure 4: Flowchart for single lane

Table 1: state of the four lanes

	LANES			
State	L1	L2	L3	L4
1	G	R	R	R
2	G	Y	R	R
3	R	G	R	R
4	R	G	Y	R
5	R	R	G	R
6	R	R	G	Y
7	R	R	R	G
8	Y	R	R	G
9	G	R	R	R

III. RESULTS AND DISCUSSION

The program for the microcontroller was written in C language and was then compiled into an executable file using the mickroC IDE. The executable file was next imported into the Proteus Design Suite IDE where the hardware circuit was designed and simulated as shown in Figure 3a and b. The program development is done in mickroC. Figures 5 to 8 shows the proteus simulation of the traffic light for each lane. Upon successful completion of the software simulation, the system's hardware was constructed on a vero board and programming of the microcontroller was carried out using PICkit 2 programmmer [12]. The hardware construction displaying connections is shown in figure 9 and 10.

Figure 5 shows when lane 1 is allowed to pass and others to wait. Figure 6, 7, 8 show when lane 2, 3 and 4 are allowed to pass respectively and others to wait. Figure 9 shows the charge controller displays voltage values of the solar PV, battery and charging percentage when the solar is been used.

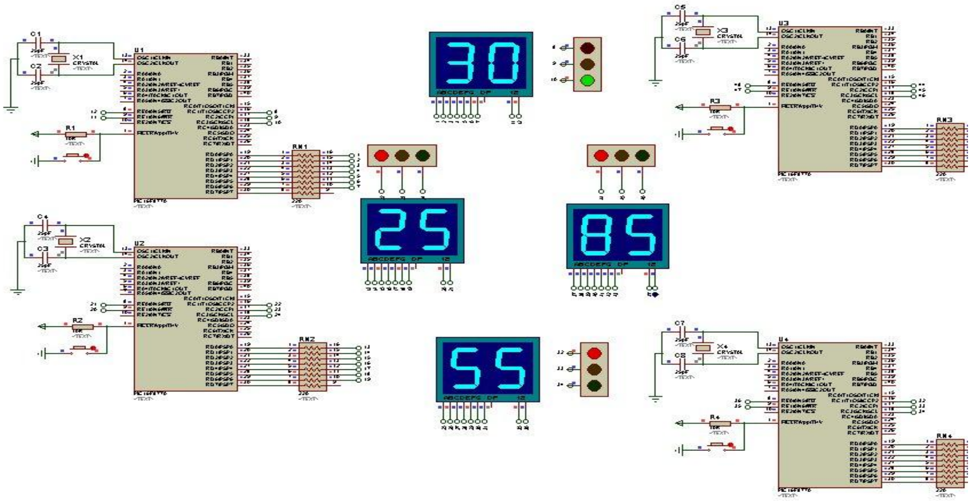


Figure 5: Lane 1 pass

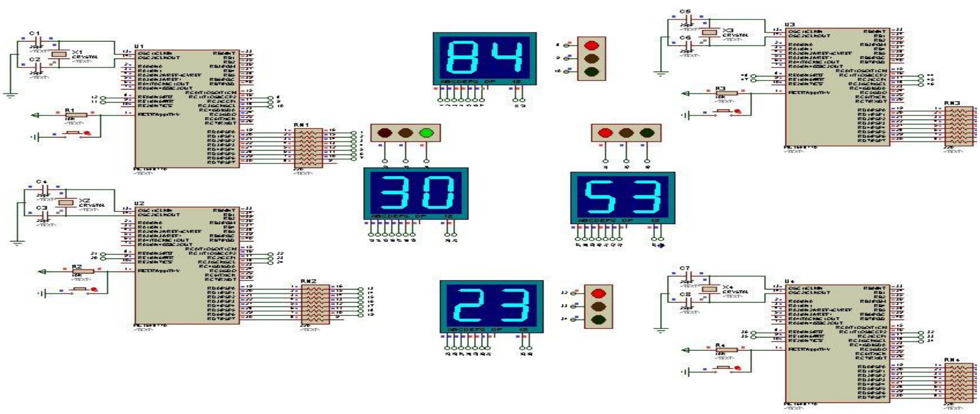


Figure 6: Lane 2 pass

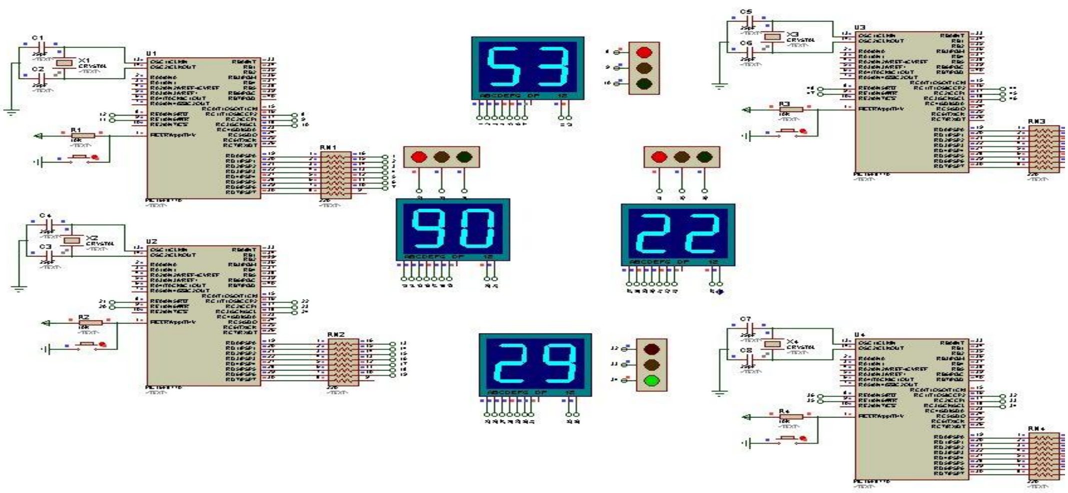


Figure 7: Lane 3 pass

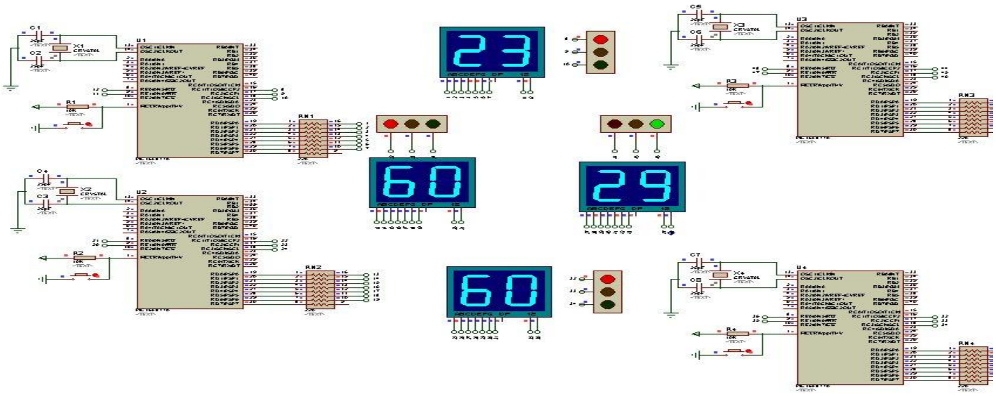


Figure 8: lane 4 pass

Figure 9: Battery in used and 91% charging

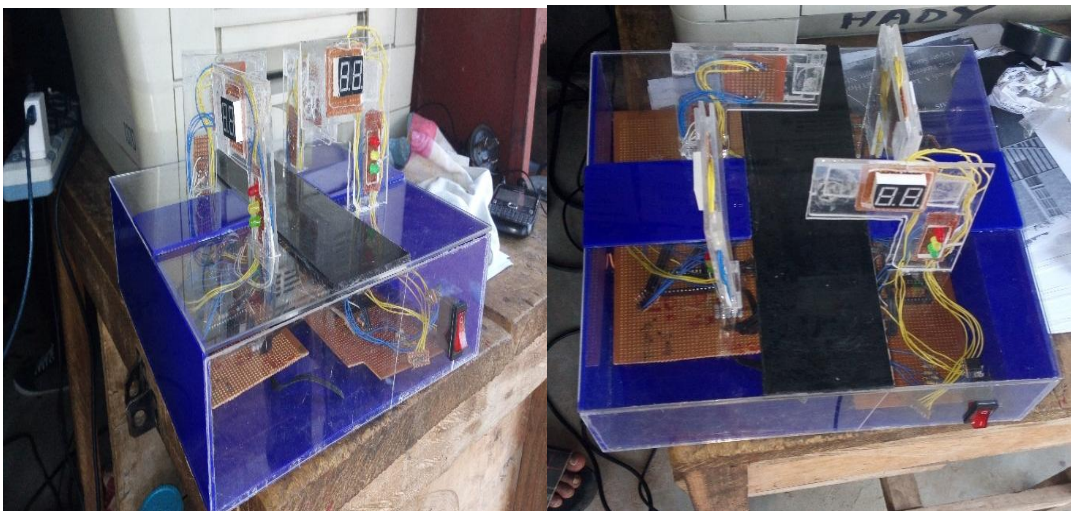


Figure 10: Completed construction.

IV. Conclusion

Traffic light control system is used in controlling traffic at any intersection and with the integration of an emergency priority; the system developed would monitor traffic condition to control the traffic efficiently. The microcontroller gives the right of way using the emergency priority. The right of way accorded is shown to the user with the aid of traffic light consisting of a Green LED, Yellow LED and Red LED. The timing countdown is shown using a 7segment display. Each lane has a double digit 7 segment display to allow for 2 digits output.

REFERENCES

[1]. Jaya, N. I (2012): PIC Based Solar Charging Controller For Battery. *International Journal of Engineering Science and Technology* (IJEST), Pp 384.

[2]. Gazi, S.M., Muhaiminul, I and Salim, K.M (2009): Design and Construction of Microcontroller Based Maximum Power Point PWM Charge Controller for Photovoltaic Application. *Development in Renewable Energy Technology (2009) 1 st International Conference,* Pp. 1 -4.

[3]. Enric, P.U and Michael M.D (1998): *Recommended Practices for Charge Controllers*. Renewable Energy and Hybrid System Group CANMET Energy Diversification Research Laboratory.

[4]. R. Ganiyu and S. Olabiyisi, "Modelling and simulation of a multi-phase traffic light controlled T-type junction using timed coloured petri nets", *American Journal of Scientific and Industrial Research*, vol. 2, no. 3, pp. 428-437, 2011.

[5]. E. Geetha, V. Viswanadha and G. Kavitha, "Design of an Intelligent Auto Traffic Signal Controller with Emergency Override", 2014. [Online]. Available: http://www.ijesit.com/Volume%203/Issue%204/IJESIT201404_92.pdf. [Accessed: 05- May- 2017].

[6]. P. Sinhma, "Intelligent Traffic Light and Density Control using IR Sensors and Microcontroller", *International Journal of Advanced Technology & Engineering Research*, vol. 2, no. 2, pp. 30 - 35, 2012.

[7]. N. Hashim, "Traffic Light Control System for Emergency Vehicles Using Radio Frequency", *IOSR Journal of Engineering*, vol. 3, no. 7, pp. 43-52, 2013.

[8]. http://electronics-diy.com/arduino-rf-link-using-433mhz-transmitter-receiver-modules.php

[9]. "PIC16F877A - Microcontrollers and Processors", *Microchip.com*, 2017. [Online]. Available: http://www.microchip.com/PIC16F877A. [Accessed: 03- May- 2017].

[10]. MikroElektronika, MikroC, 2013. http://mikroe.com/

[11]. "Proteus PCB Design & Simulation software - Labcenter Electronics", *Labcenter.com*, 2017. [Online]. Available: https://www.labcenter.com/. [Accessed: 05- May- 2017].

[12]. "PICkit 2 Development Programmer/Debugger - pg164120 | Microchip Technology Inc.", *Microchip.com*, 2017. [Online]. Available: http://www.microchip.com/DevelopmentTools/ProductDetails.aspx?PartNO=pg164120. [Accessed: 05- May- 2017].

*Agbo David O " Solar Powered Microcontroller–Based Smart Four Way Junction Traffic Light Controller System using Seven Segment Display." American Journal of Engineering Research (AJER) 6.7 (2017): 375-383.