SOLAR POWERED SPEED WARNING SYSTEM

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" I hereby declare that I have read through this report entitle "*Development of Solar Powered Speed Warning System*" and found that it has comply the partial fulfilment for awarding the degree of Bachelor of Electrical Engineering (Industrial Power)"

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DEVELOPMENT OF SOLAR POWERED SPEED WARNING SYSTEM

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A report submitted in partial fulfilment of the requirements for the degree of Bachelor of Electrical Engineering (Industrial Power)

Faculty of Electrical Engineering
UNIVERSITI TEKNIKAL MALAYSIA MELAKA

2015

"I declare that this report entitle '*Development of Solar Powered Speed Warning System*' is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree."

Signature : .....

Student's Name : Nur Adila Binti Misdar

Date : .....

To my beloved mother and father

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ABSTRACT

It was recorded that road vehicle accidents in Malaysia were increasing yearly. The major cause to road accident is mostly caused by human speeding. Police department have been enforced the speed limits of vehicle to control the road accidents. Thus, to monitoring the traffic more efficiently, the speed of moving vehicle is determined by using calculation from the known distance and time as an approach to estimate the vehicles speed. This system is designed to reduce the road accidents in development of speed warning system by using solar power energy. Solar is used to provide the energy to the system in terms of saving environment and energy wastage. It requires a battery for store energy that automatically recharged from solar panel. Three light indicator used in this system based on the speed level of vehicle which are green, yellow and red as indicator. The indicator shows the condition of speed warning system whether in slow, fast and very fast condition. It is used to control the system based on the speed level to motivate the people to follow the rule and enhance the responsibility on the road. It will facilitate the police traffic to deal with traffic flow. At the same time, this system is implement to increase awareness of people for remain safety. Lastly, the performance test is done to show the effectiveness of the system.

ABSTRAK

Kadar kemalangan jalan raya di Malaysia yang direkodkan meningkat setiap tahun. Punca utama berlaku kemalangan jalan raya adalah berpunca daripada pemanduan laju oleh manusia. Pelbagai usaha pihak polis telah menguatkuasakan had laju kenderaan untuk mengawal kemalangan jalan raya. Oleh itu, untuk memantau kelajuan kenderaan dengan lebih cekap, sistem ini adalah sebagai pendekatan untuk menganggarkan kelajuan dengan menentukan jarak dan masa untuk kelajuan kenderaan. Sistem ini direka untuk mengurangkan kadar kemalangan jalan raya dalam membangunkan sistem peringatan kelajuan kepada pengguna dengan menggunakan tenaga kuasa solar. Solar digunakan adalah untuk mmberikan tenaga kepada sistem dalam menyelamatkan alam sekitar dan pembaziran tenaga. Ia memerlukan bateri untuk menyimpan tenaga secara automatik yang dicas semula daripada solar. Tiga isyarat lampu yang digunakan dalam sistem ini adalah berdasarkan tahap kelajuan kenderaan yang diwakili hijau, kuning dan merah sebagai penunjuk. Penunjuk adalah sebagai sistem peringatan kelajuan dalam keadaan perlahan, laju dan sangat laju. Ia digunakan untuk mengawal kenderaan berdasarkan tahap kelajuan untuk memotivasikan pengguna supaya sentiasa mengikuti peraturan jalan raya dan juga meningkatkan sikap bertanggungjawab diatas jalan raya. Ia akan memudahkan pihak polis untuk menangani aliran lalu lintas. Pada masa yang sama, sistem ini dilaksanakan adalah untuk meningkatkan kesedaran pengguna bagi mengekalkan tahap keselamatan ketika berada dijalan raya. Akhir sekali, ujian dilakukan untuk menunjukkan keberkesanan sistem.

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CHAPTER 1

INTRODUCTION

1.1 Research background

The number of road accident keeps increasing yearly that created a problem such as traffic congestion, problem to deal with traffic monitoring and accident that gives negative impact to the road users. Traffic congestion becomes worse when the accident occur in high risky area such as in highway. It is due to the number of vehicles keeps arising from 326815 to 477204 cases for over 10 years. Based on the analysis of road accident that predictable of Malaysian Institute of road safety research (MIROS), the number of road accident is continues increase from 8,760 in year 2015 and up to 10,716 in year 2020 [1]. The major cause to road accident is mostly caused by human speeding.

Automated Enforcement System (AES) is a speed camera placed at several locations along highways. Their main goals are to discourage speeding, to increase safety and traffic flow to avoid congestion during peak hour [2]. Even though this system is implemented, there are still disadvantages such as people do not compliance with speed limit, increase the speed after AES is located and difficult to control traffic congestion. When road accident occur, it created inconvenient for road users to cross the road smoothly. So that, this project is used to reduce the road accidents in the development of speed warning system by using solar power energy. This system can be designed which able to detect the speed of vehicle and the cost will be effectives. It is used to control the system based on the speed level to motivate the people to follow the rule and enhance the responsibility on the road. A speed warning system is often called upon to improve safety and awareness to the users. They should be educated and reminded of their responsibility while driving.

This system uses two ultrasonic sensors for speed measurement which required Arduino Mega to set the program. This sensor determines the speed measurement due to the major factor of road accident. So that people are able to recognize their speed along highway depending on the light indicator. This system is functioned as warning system to alert the people about their speed in the highway. In development of this project, it used solar panel to supply the system in terms of saving environment and energy wastage. Solar panel known as renewable energy that produced directly energy electricity from the sunlight. It contributes to the decrease of harmful greenhouse gas emission.

1.2 Problem Statement

Statistics in Malaysia shows the road accident is increasing every year. Figure 1.1 shows road accident cause traffic congestion. The higher percentages of road accident are caused by speeding and carelessness. Speeding is the most commonly factors associated with crashes and it also contributes to the increased risk of losing vehicle control. Road accidents make traffic congestion that contributes to slower traffic flow. Most of the drivers do not aware with the danger that will occur on the road. There is a lot of risk that could happen on the road because it involve with many vehicle. Besides that, speed sensor is rarely used by available instrument in this market.

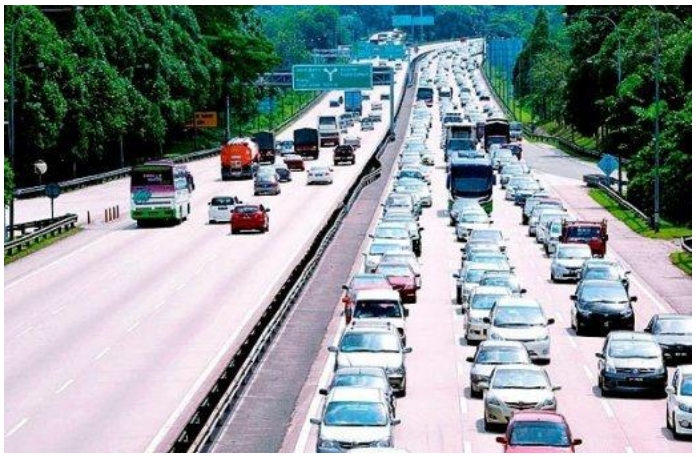


Figure 1.1: Road accident cause traffic congestion

1.3 Objective

The objective of this project is:

i) To develop speed warning system by using solar power energy.
ii) To control the system based on the speed level (km/h).
iii) To verify the performance of the system.

1.4 Scope of work

This project is develop a new technology by using 12 volts of solar panel to supply power energy to the system. It requires simulating the circuit by using Proteus ISIS software and Arduino compiler to program the Arduino Mega as a microcontroller. In addition, this provides the Liquid Crystal Display (LCD) to display the speed measurement of the vehicle. This project using ultrasonic sensor with the range is up to 6 meter.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

There are a few methods regarding speed detection and measurement of the vehicle by respective researchers such as video and image processing, camera, algorithm and sensor. Image processing is based on software that does not require a hardware in develop the system. Besides that, the speed of vehicle can be obtained from the image analysis by using digital camera and digital image. An algorithm also introduced to capture the speed measurement by normal camera. Different methods of each process will be explained in terms of inputs, data processing and outputs. The device of this method also discussed in subsequence so that it can be clearly understood. This chapter includes the theory and basic principles, review of previous related work, and summary to describe the method of speed detection.

2.2 Theory and basic principle

For the speed warning system, there are a few devices that required considering the best selection. This system used a sensor to ensure the effectiveness of speed measurement detection. Table 2.1 shows the comparison between infrared sensor and ultrasonic sensor that need to consider based on the characteristic such as specification, a wide range for transmit a signal, a feature and in terms of price. The application of each sensor shows the better instrument.

Table 2.1: Comparison between ultrasonic sensor and infrared sensor

Characteristic	Ultrasonic sensor	Infrared sensor
Figure		
Specification	It have a transmitter and receiver depending on high frequency sound to detect an obstacle [3]	Have a transmitter and receiver that has light intensity.
Input voltage	Operates from 2.5 to 5.5V which is easly used for microcontroller.	Operates from 6 to 36VDC
Range measurement	The range distance is up to 6m.	Measurement distance is 20cm if power voltage is 5V.
Advantage	Long range detection and does not provide other supply since solar and battery is used.	Obstacle detection is fast.
Disadvantage	Sensitive beam pattern	The measurement distance only depending on the supply given.
Price	RM108.89	RM 29.00
Application	Mostly used for distance measuring, robot ranging sensor, people detection and so on.	Mostly used at obstacle detection, mobile robot and automation machine.

2.2.1 Standard specification of road

Figure 2.1 shows the specification size of road in Malaysia that released by Jabatan Kerja Raya (JKR) [4]. This figure illustrated that sensor is able to detect the vehicle at the first lane due to the distance that only 1 meter from the left road side. For the second lane, the sensor able to detect up to 6 meter due to the total width of road is 7.5 meter.

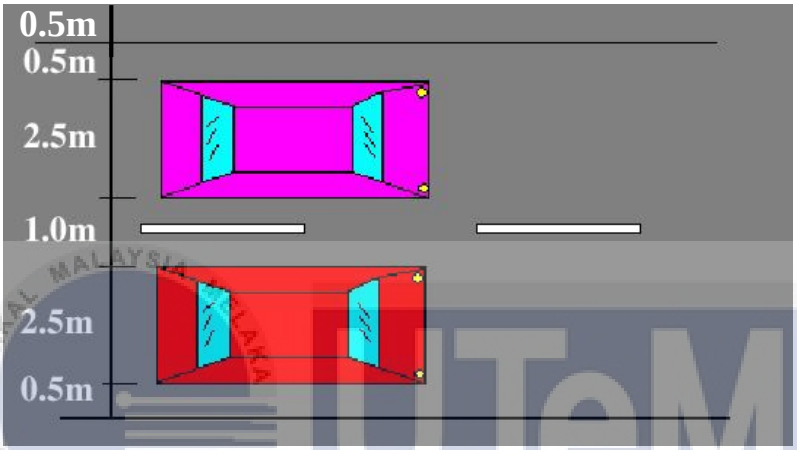


Figure 2.1: The specification size of road in Malaysia [4]

2.2.2 Wavelength for ultrasonic sensor

Transmit a signal and receiving an echo is a frequency sound wave which is occur obstacle detection. This sensor can be divide into two categories which is separate and combine of transmitter and receiver component as Figure 2.1. However, there are still same with their basic operation as mentioned in [5]. In development in this project, it used ultrasonic sensor where it is separated of transmitter and receiver. The main feature by using this sensor is there are easy to measure the distance to an object and time is taken when echo is turning back.

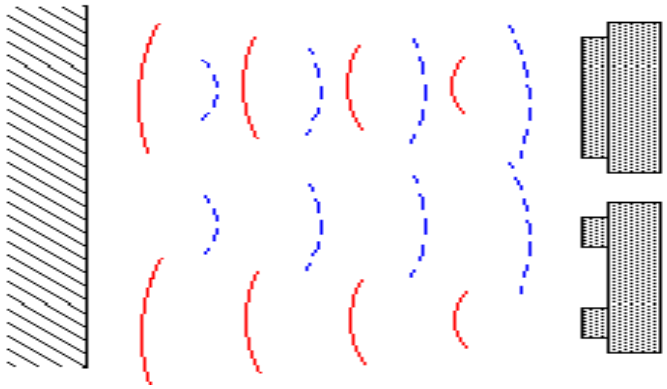


Figure 2.1: Principle of ultrasonic sensor [5]

According to [6], the distance of sensor is determined from time that measure from the pulse after sending the sound wave and multiple it with the speed of sound which is 341m/s since Then, it will divide into two since it send a signal and back. The formula 2.1 shows the calculation of the distance from an object as follows:

$$Distance\ of\ object = \frac{Time\ x\ Speed\ of\ sound}{2} \quad (2.1)$$

2.2.3 Input and Output waveform of ultrasonic sensor

Mostly the range is suitable for target distance from an object which is 20mm to 10mm. Their principle is transmitting a signal with high frequency and receiving the echo where the echo is reflected back. This can compute the distance by measuring the time. However, this sensor can be categorized into two groups which is piezoelectric and electrostatic sensor where it used to generate the ultrasonic wave. Apart from distance measurement, this application of ultrasonic sensor is widely used. Figure 2.2 below shows the input and output waveform of ultrasonic sensor [7].

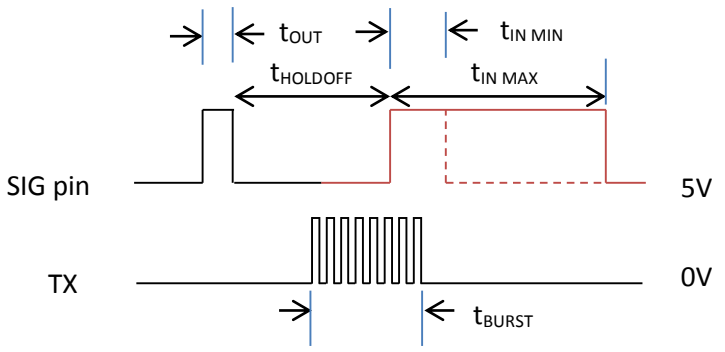


Figure 2.2: Ultrasonic sensor input and output waveform [7]

2.3 Related previous work

There are a few methods regarding to determine vehicle speed detection. A camera system with single motion blurred image is used in [8] to produce speed detection of a vehicle. The speed of a vehicle can be identified within estimated range according to the imaging geometry and the relative position between the cameras by using Passive device. The device consists of two which is the RADAR receives a signal of moving vehicle and converts it to the speed and LIDAR is calculate the speed estimation by using formula. The parameter estimation and image deblurring processes is determined by calculation. Motion blur is a result of practical cameras and relative motion between the camera and moving objects. Blurred image is captured based on a single image taken by a stationary camera. It occurs in a region of the image corresponding to the dynamic object for an extended period of camera exposure time. The blur image which is selected from the image restoration provides a way to identify the license plate of vehicle if the motion blurred image is taken. Unknown background of image is difficult to remove and the location of the camera must be installed far away from the vehicle. The application of this technique is focused on the total blur region and the estimation of motion blur parameters such as license plate of the vehicle.

In [9], video and image processing it used to determine the speed of vehicle detection for traffic surveillance. Doppler shift is a method used in this paper to detect the frequency shift in reflected wave where the more the Doppler shift, the greater the speed. An error occurred when the radar gun is not affected to the incoming vehicle. This technique is used

new algorithm and camera optics to detect vehicle speed. This algorithm has a few components such as video camera, a computer as software and detects the speed of vehicle in different lane. There are five major components that require processing the data such as the background extraction and removal, moving vehicle detection and localization, vehicle shadow removal, applying filter for image correction and calculation of the vehicles' speed. This technique is used combination and saturation values (CVS) methods for the purpose of background extraction and removal the mark point from background of moving object detection and calculated at the image frame. The image that has been subtracted is declared to transfer the image in binary image for analysing. Image analysis consists of image thresholding, vehicle recognition and vehicle tracking. The speed of the vehicle is calculated using the position of the vehicle will be the final step.

An algorithm for automatic vehicle speed detection using video camera is applied in [10]. This paper presents a method based on digital image processing to realize the real-time automatic vehicle speed monitoring using video camera. The new algorithm required to detect the vehicle speed in automatically and accurately with only a single video camera. There are two steps to processing the data which are the mapping of coordinates from image domain to real-world domain and vehicle detection in video images. The image has been transform from 2D to 3D when video images are taken on the road traffic by the Formula for Coordinates Mapping. The camera was set up on the road to record the video on the road traffic. The calibration of the coordinate mapping is required to deduce geometrical optics. There are three coordinates system which are the real-world coordinate system (x, y, z) where represent transverse direction in the road surface plane. The relationship between real-world coordinate system and the camera coordinate system is analysed based the assumptions that have been made. The video images are used to compare with background image to distinguish the foreground. This algorithm able to operate and can simultaneously detect vehicle speeds in multiple lanes with high accuracy.

Magnetoresistive Giant effect (GMR) of sensor is the vehicle detection and car speed monitoring system as the method used in [11]. The system consists of two GMR sensors, a Microcontroller PIC and semiconductor IC memory. The first sensor is obtained in a digital oscilloscope when a vehicle detected by the sensors in its sensitivity direction. The distance

between the two sensors is 20 cm for detect the speed. The system is located on the left road side of highway to obtain the speed and length of the car in real-time. It required the microcontroller to process the signal of sensors with an AID conversion when a vehicle detected. The signal processes provide a lot of information to recognize the type of vehicle with different signal. In IC memory, ROM is used to store such as dates, speed and the number of vehicle while RAM is used to process the signal with a fast memory. This system could be used for an automatic traffic monitoring system.

Vehicle detection and speed estimation based on Radio frequency is applied in [12]. The presence of moving vehicle will be detected in an RF environment. This technique did not require hardware. The system gathers all the information by used software as application to the server from the monitoring points and processes them. This method has RF transmitter and receiver to transmit and receive wireless signal strength of detection to estimate the speed and the traffic. Vehicle speed estimation can be categorized into two techniques such as statistical and curve-fitting technique. For statistical focused on the speed measurement of vehicle is based on the time taken when the system detect the vehicle. While curve fitting estimated the car speed from the relation between fitted curve. The capabilities of detection by using RF are tested from three different tests conducted which are silence, stationary car and moving vehicle.

The automated enforcement system used image captured to determine the speed of vehicle proposed in [13]. Three type of camera such as for photograph, video camera to collect the data and digital imaging camera are installed to detect red light violation. At intersection junction only one camera is required to record light red violation while video camera installed in highway to process the speed detection. Piezo were installed on the road to detect the speed of vehicle. The camera automatically recorded the several information such as speed, vehicle number plate and the image of the driver. Then all the data will be forward to the road transport department (JPJ) [14]. The summon letter will directly send to the owner of the vehicle. The capability of this camera is to prevent reflection from smearing the image and has the higher resolution.

In [15], by combining a non-contact photoelectric speed sensor and a Single Chip Microcomputer (SCM) with Bluetooth technology, the vehicle speed measurement system is able to

precise. SCM is the board whereby to store the program under development in the RAM, the I/O ports is provided to direct access and easily transferred into the ROM [16]. This method consists of process which are a photoelectric speed sensor, a signal conditioning circuit, a data acquisition module, a Bluetooth module, an outside display plate and a notebook computer is implemented in this method. A photoelectric speed sensor is a unit which is composed of an illuminated part lights of the ground under the lens, a long lens, a comb-type illuminated part and an instrument amplifier to increases the signal output. The signal conditioning circuit was designed by combining SCM and Bluetooth technology used to sample the signal and transform it from an analog signal to a digital signal. it is gather vehicle speed data from the sensor is designed. The Bluetooth module communicates with the notebook computer, which has a wireless Bluetooth function. The speed measurement indicate of a highlighted LED is compared with the radar speed indicator for make the measurement precision by 0.1%.

2.4 Summary of review

There are many types of method used for the speed measurement. Method that has mentioned in [8], [9], [10], [11], [12], [13] and [14] has difference in a method such as advantage on their own particular system, the instrument that are used and many things characteristic that only focused on how speed measurement is determined. Based on the system developed in [8] the speed detected is measured by using the camera system. Doppler shift method is used indicator detector to obtain the accuracy of speed known as an electromagnetic pulse [9]. However, radar detector can only track one vehicle compared to the AES system. This method is similar to that method in [13] the different is that only three types of camera installed in [9] various applications. They are used to detect red light violation that concern about their safety and traffic offense. Even though AES system reduced the number of accident, but awareness of user on the road is still decrease.

Through system in [10], there are two parts to measure the speed detection. There are based on image processing which to produce accurately the coordinate of map by using monitoring video while another part is focused on vehicle detection in video stream. This method is capable to monitor the speed measurement in multiple lanes. The calibration of camera is required to setting at least 5 meter from the road surface to ensure the accuracy. This system used the software in Visual C++ language where to carry out the more accurate with

speed detection of a distance measurement to an object. From the observation from the previous technique, it did not used available instrument as ultrasonic sensor to measure the speed detection. So that, by using this technique, perhaps it can monitor the traffic flow in convenience environment. This project is focusing how to measure the speed measurement of vehicle by a new technique. For the programming, Arduino is used as microcontroller to process the system based on the speed level of vehicle [17]. It is designed to reduce the increasing of road accident.

2.5 Data collection of review

Table 2.2: Comparison of product

Specification	**Aes system**	**Radar gun**	**Speed camera alert system**
Figure			
Description	Piezo were installed on the road to detect the speed of vehicle.	i. Used combination of radio transmitter and receiver. ii. Measuring speeds up to 600 MPH	It used GPS to alert and detect speed cameras on the road.
Advantage	The camera is used for recorded several information such as speed, number plate and the image of the driver.	Capable to calculate the fast detector speed of speed vehicle.	Used a variety of different technology inside a speed trap detector.
Disadvantage	The summon letter will directly send to the owner of the vehicle.	Detect about 1-2 miles from the location of speed gun	It can detect the speed trap on the road.

CHAPTER 3

METHODOLOGY

3.1 Introduction

The methodology is a part that gives an idea and more understands the performance to measure the speed detection based on literature review. It will cover several details that includes planning process, principle of the project and finding the components. Figure 3.1 shows the work flow of methodology project in completing this development. This system consists of two parts which are software and hardware that are useful to be success and completed. The software is conducted to design the schematic diagram by using Proteus ISIS software with an Arduino compiler of the system. The program is set by Arduino compiler that should be rewrite until the command is executed with the system. Simulation is done to ensure the connection of the system to the hardware parts. The hardware part is the combination of the components that used in this system such as LCD display, Arduino Mega, relay and ultrasonic sensor. It requires troubleshoot the hardware design to ensure the connection of the system. Besides that, the arrangement and position of the component is designed by using the component that has been selected.

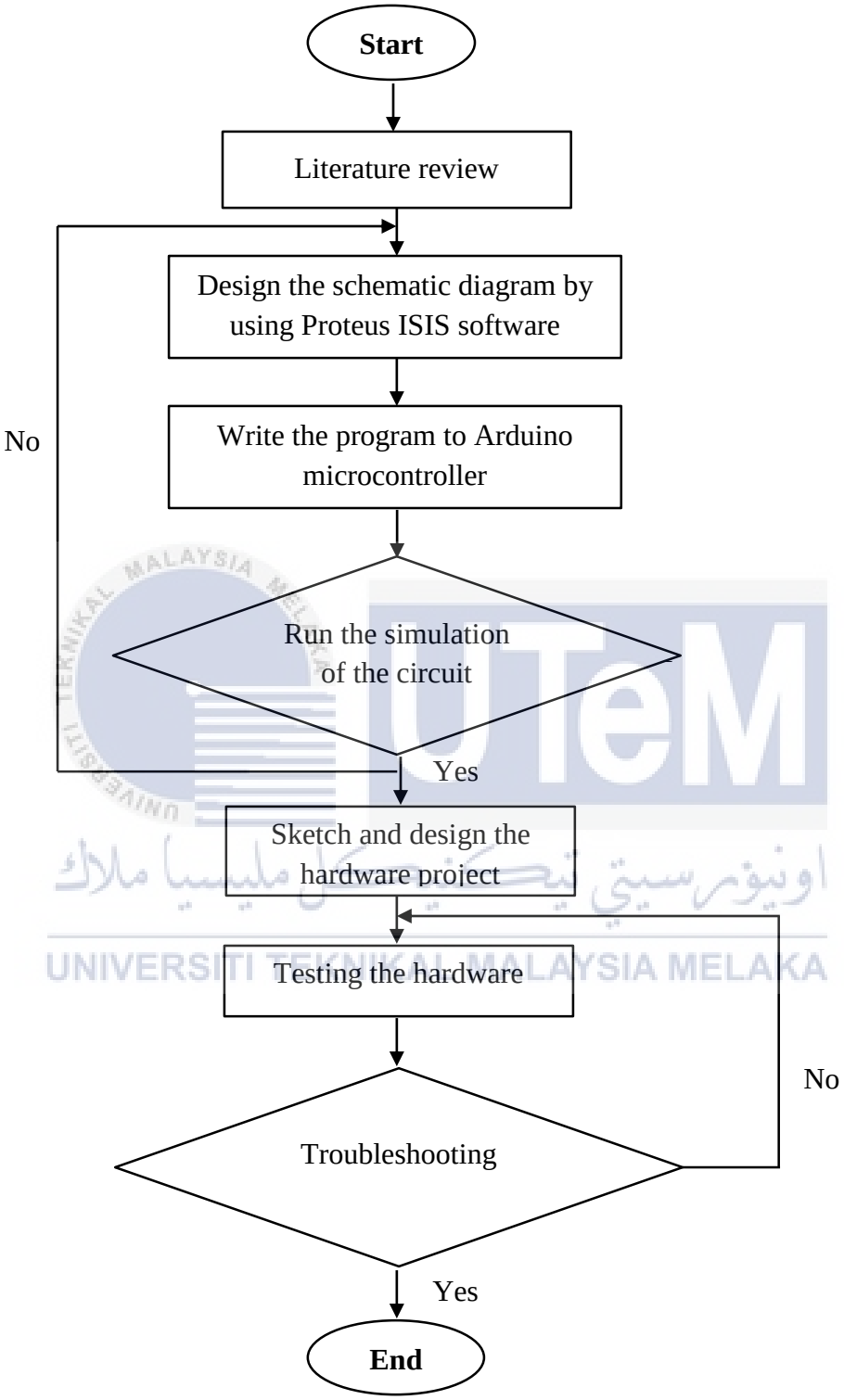


Figure 3.1: The work flow of methodology project

3.2 General system design

3.2.1 Component of system

Figure 3.2 shows the component of solar powered speed warning system. The purpose of this system is focused in development of speed warning system by using solar power energy. Solar panel is used to generate electricity directly from the sun to supply the system in terms of saving environment and energy wastage. It contributes to the decrease of harmful greenhouse gas emission [12]. The energy is stored to the battery while charger controller used to keep the battery from overcharging. Through the proposed of project, ultrasonic sensor is used to determine the speed which required Arduino Mega to set the program. This system requires two sensors to determine the speed measurement. It also presents a description of the various components of a solar powered speed warning system design as in Table 3.1 which includes the solar panel, charge controller, battery, light indicator and ultrasonic sensor.

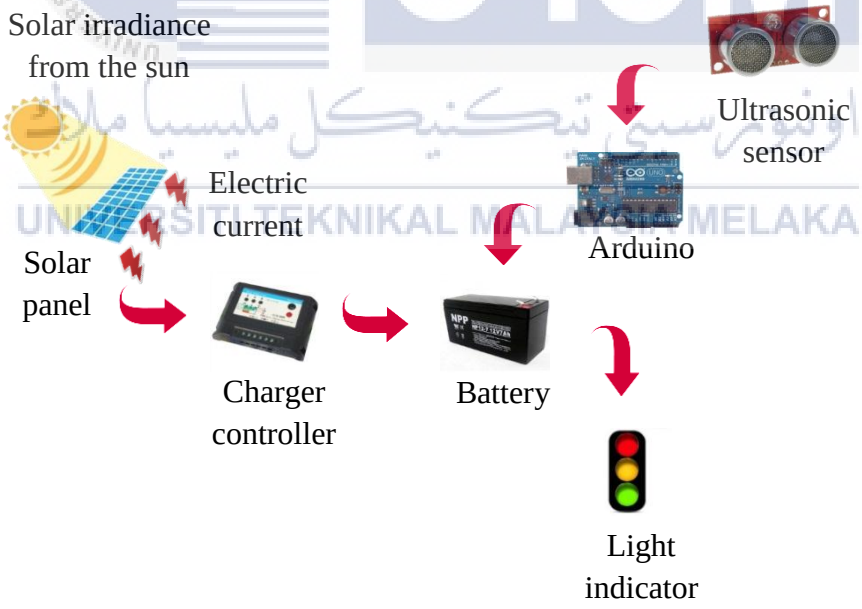
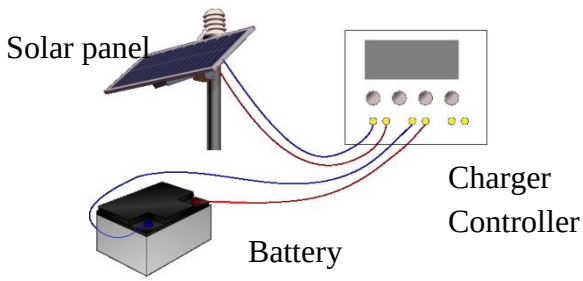
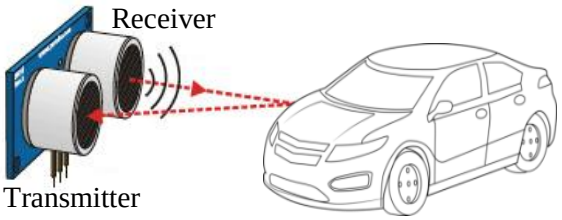


Figure 3.2: The component of solar powered speed warning system

Table 3.1: Description of the various components of a solar powered speed warning system

Type	Description
Solar panel 	i) The capacity of solar panel used in this system is 12V and 50W as a supply. It directly generates electricity from the sunlight. ii) Polycrystalline is the type of solar panel that made from semiconductor. It gives more energy and at the same it reduces greenhouse gasses [16]. iii) Solar panel required diode to prevent the charge current from flowing.
Charger controller 	i) PWM (pulse width modulation) is the type of charger controller to regulate the charge from the solar panel to the batteries [17]. ii) Charger controller is the most important to the whole system because to prevent the battery from overcharging and being damaged. It also increases the battery life by preventing overcharging iii) It charger the battery with constant voltage and current. iv) Figure below shows the connection of charger controller of solar panel and battery. v) Charger controller consists of led to recognize level of the battery when it charging. 

Battery 	i) Solar energy produce direct current (DC), this system used lead acid battery to store the energy which often charge and discharged by the battery rating 12V and 7AH. ii) Currently, it used for photovoltaic application known as deep cycle battery because due to the charge and discharge sequence are do rapidly [18].
Light indicator 	i) Light indicator consists of three indicators such as red, yellow and green to represent the speed of vehicle. ii) Speed level of light indicator a) Green – 50 km/h and below indicate very fast speed condition. b) Yellow – between 50km/h and 100kmh mentioned the fast speed condition c) Red – 100km/h and above mentioned slow speed condition.
Ultrasonic sensor 	i) Ultrasonic sensors are device that convert from electrical energy to mechanical energy. It consists of transmitter and receiver to detect the presence of the vehicle [19]. ii) The sensor transmitted a data to the Arduino Mega. iii) It is located at the left of road side which able to detect the speed of vehicle up to 6 meters. 

3.2.2 Flow chart of system

Figure 3.3 shows the flow chart of project that to develop the system. This system consists of input and output to design the flow of the process. Firstly, solar panel is setup with the battery. It connected with the charger controller and into the system. Solar panel as input to gives a supply to the whole operation system. After setup, the hardware is designed that includes LCD display, relay, Arduino and ultrasonic sensor with require a circuit as reference for the connection. Sensor also as input to initialize the project that sent the information to the Arduino Mega for data processing. The connections of the system need to test for the functionality. Thus to measure the speed detection of the vehicle, the Arduino compiler is the part to set the programming. The programming must be suitable to achieve the desired speed of the system. After done follow the flow chart, the testing of the speed detection must relevant with the system.

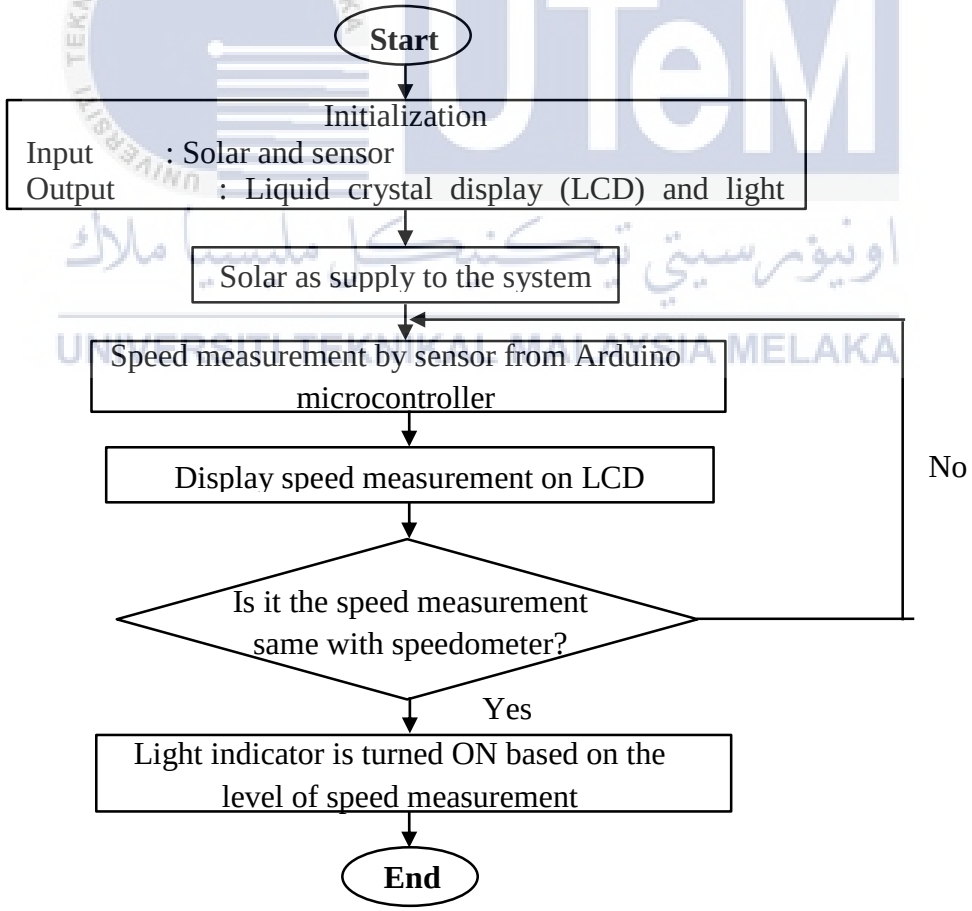


Figure 3.3: The flow chart of solar powered speed warning system

Figure 3.4 shows the flow chart of speed measurement which indicates the process to determine the speed of vehicle by using two ultrasonic sensors. When both ultrasonic sensors received a signal and the distance is detected up to 6 meter of the vehicle, the sensors start to read the data which include the time taken that has been programmed. Speed measurement is the speed detection that set the distance to be constant. The distance is set at 1 meter between both of the sensor and the time taken is getting along both of the sensor. All this process is repeated until an accurate speed is gained.

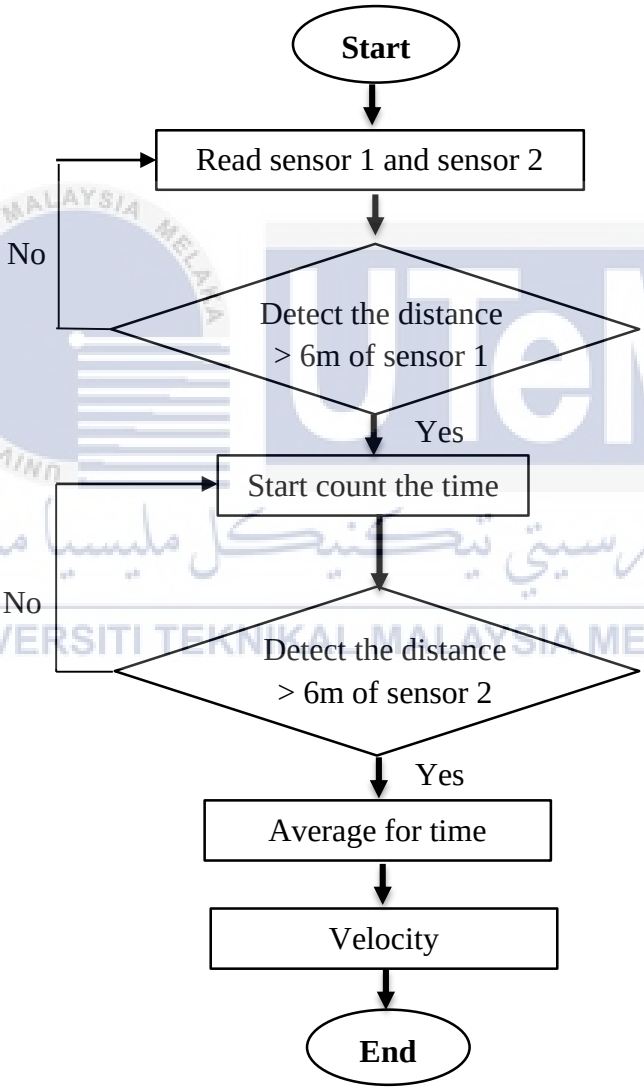


Figure 3.4: The flow chart of speed measurement

3.2.3 Block diagram of system

Figure 3.5 illustrates the block diagram of solar powered speed warning system. The block diagram starts from the solar panel that needs to supply energy to the load. The energy generated from solar power stored to the battery for system operation. Charger controller is designed to prevent batteries from overcharging. From Arduino, data is received from the battery known as the time battery charging. Ultrasonic sensor includes transmitters, receiver and control circuit where it transmits a signal to the Arduino. The Arduino Mega known as microcontroller received the data and transmits a signal to the light indicator to display the level of speed detection. The speed of vehicle and the time taken is viewed by LCD.

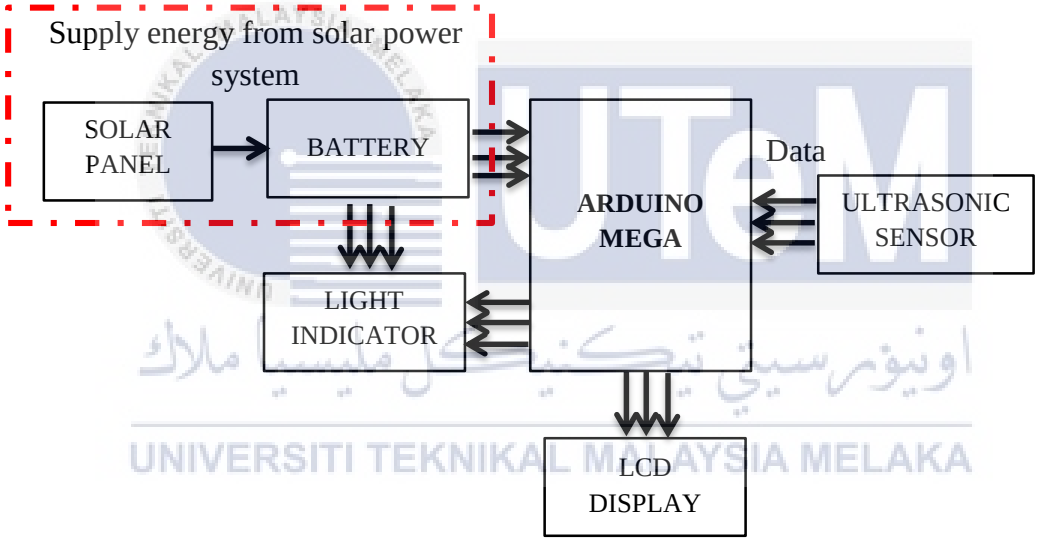


Figure 3.5: Block diagram of solar powered speed warning system

3.2.4 Schematic circuit of system

This system requires two types of software which are Proteus ISIS software and Arduino software. Proteus ISIS software is a simulation that used to implement the circuit from the component library. The schematic circuit is designed to test the hardware with suitable connection of the system. Arduino software is the part to set the programming to the Arduino microcontroller. Figure 3.6 shows the schematic circuit of the solar powered speed warning system. It consists of three parts which are ultrasonic, display and light indicator. This schematic circuit is the connection of the component that are considered as input and output of the system. The light indicator part requires relay and switch relay to control light indicator based on the speed of the vehicle. This ultrasonic sensors part requires two sensors to detect the speed of vehicle. Lastly, the LCD is used to display the speed measurement of the system.

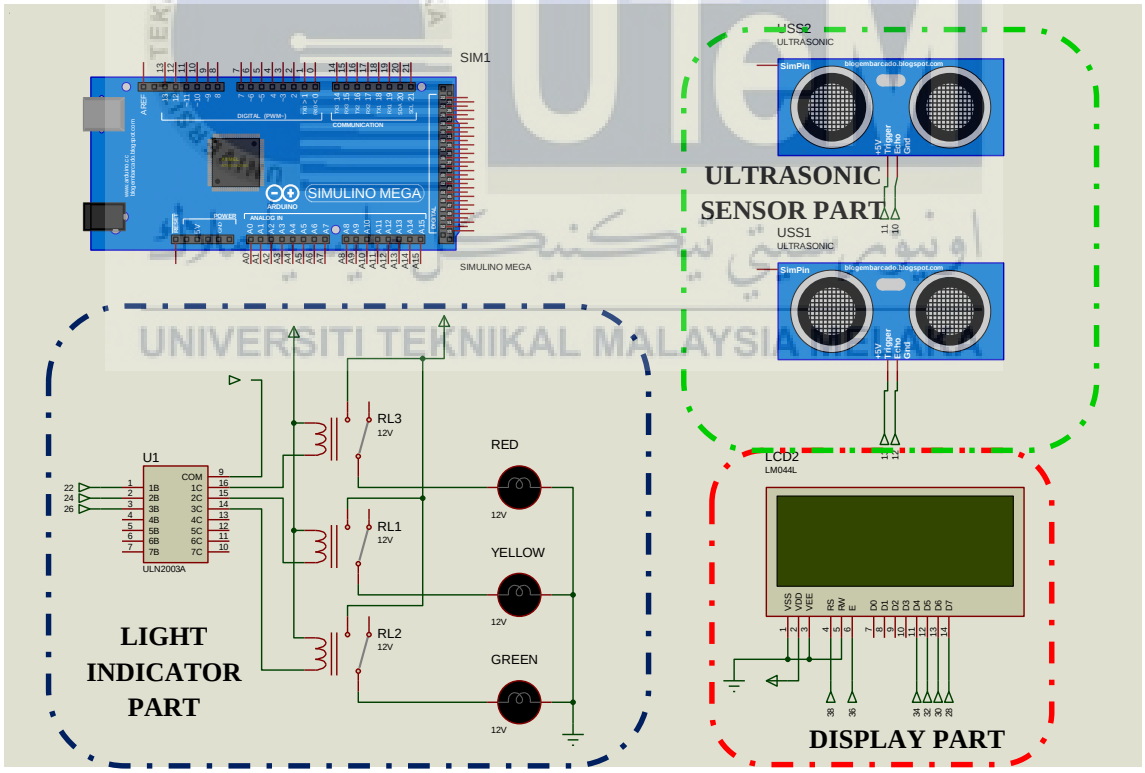


Figure 3.6: Schematic diagram of solar powered speed warning system by using Proteus ISIS

3.3.5 Operation of system

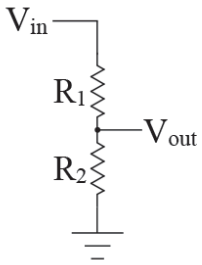
This project is designed to detect the speeds of vehicle equipped solar panel, battery, ultrasonic sensors, light indicator and LCD display. Solar panel as known renewable energy is the best solution in order to reduce gas emission. This project consists of Arduino Uno as microcontroller that used ultrasonic sensor as input to detect speed detection. A light indicator consists of red, yellow and green as indicator. All components are prepared to perform each task. Below is the function of each part.

a) Solar panel

The type of the photovoltaic (PV) is a semiconductor that produces electricity. The system of photovoltaic includes photovoltaic array, charge controller, power storage system and sensors. Solar panel is converts sun energy into electricity to supply energy to the system. The pollution such as smoke, carbon monoxide is reduce regarding used this solar panel and contribute to global warming. PV technology is the renewable energy technology that has that avoid greenhouse gases occur [20]. The capacity of a solar panel should be concerned based on the design of the system

b) Battery for solar energy

The battery is used to store direct electricity that produces energy from the solar panel. Deep cycle batteries able to stand long lifespan, charge and discharge repeated compared to other types [21]. Input of Arduino is a 5V and it capable to receive the supply only 5V. So that voltage divider is used to produce the needed voltage that prevents the battery from damaging. It changes from large voltage to a smaller voltage at the input. The circuit shown Figure 3.7 portrays the circuit of voltage regulator. The circuit consists of two resistors to measure the suitable voltage. The circuit with the particular values shown has an input impedance of 100Ω + 150Ω = 250Ω. Hence, this formula able to expressed the voltage divider to measure the voltage.



(a)

$$V(\text{analog input}) = \frac{R1}{R1+R2} \text{ x } Vs$$

(b)

Figure 3.7: (a) Voltage regulator circuit and (b) the formula of voltage divider

c) Arduino Mega

Arduino Mega known as microcontroller based on the ATmega328 that many outputs can be measured such as level of battery, speed, distance and time. Figure 3.8 shows the example for Arduino Mega. The input and output can implemented the information of the data to the microcontroller to further processing. Input devices of this system such as sensor transmit a data that require upload the program with connected to the USB cable Arduino. Arduino categorized into two parts which are hardware and software. Arduino compiler is the software that includes programming to the Arduino Mega. An Arduino board consists a variety of component such as USB Plug, external power supply, reset button, Analog and digital input and output pin. This parts able to perform a specific command to process data or desired circuit [22]. The Proteus ISIS library has many type of components to construct the circuit with Arduino. Likewise ultrasonic sensor, it also has Proteus library that used in this simulation.

Figure 3.8: Arduino Mega board [22]

d) Ultrasonic Sensor

HCSR04 is the type of ultrasonic sensor used in this system to detect the speed of vehicle. Figure 3.9 shows the type of ultrasonic sensor that consists of four pins which operating voltage at 5.0V as the Vcc, trig pin is transmitting a signal to control, Echo pin as the receiver and lastly the ground. It consists of a transmitter and receiver to detect the presence of the vehicles. The transmitter is transmitted 30kHz pulse and receive back the signal after the vehicle is detected [23].

Figure 3.9: Ultrasonic sensor type HCSR04 [23]

Figure 3.10 illustrates the model with a single vehicle on the road. It analyses the performance of speed detection with calculated distance and time. As shown in equation 3.1, the speed measurement is calculated.

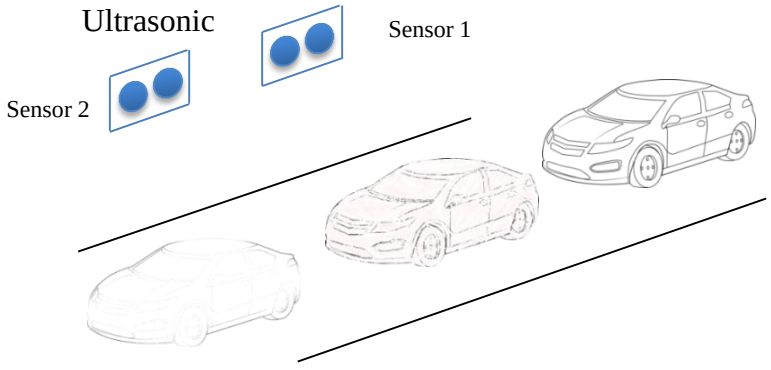


Figure 3.10: The model with a single vehicle

$$\text{Average speed} = \frac{\text{Distance}}{\text{Time (tn}-\text{t0)}} \left(\frac{\text{km}}{\text{h}}\right) \quad (3.1)$$

Assume where:

T = is the difference between t_n and t_o

D = is the real distance between two marking points (start point and end point) measure in meter

t_n = is the time measured in seconds

t_o= is the time measured in seconds

e) Relay

Figure 3.11 shows 4 channel relay Arduino for the component of speed warning system. This relay is connected to the light indicator to display the level of speed detection. The relay is able to control the light indicator directly by Microcontroller. It consists of the input and output which are required for the supply 5V. Besides that, it is equipped with 4 pin that connected to the output of the system and to the battery. Indication LED's at the relay is to show the output status of the system [24].

Figure 3.11: 4 channel relay Arduino [24]

3.3.6 System located

Figure 3.12 shows the component arrangement on the roadside. This figure is designed to be used in green energy environment. The sensor is located 4 meter from the light indicator to alert user about their vehicles speed. Then, light indicator is turned ON based on the speed of the vehicle. This system required two ultrasonic sensors to set the distance of the speed measurement. This sensor is controlled by Arduino microcontroller to measure the speed.

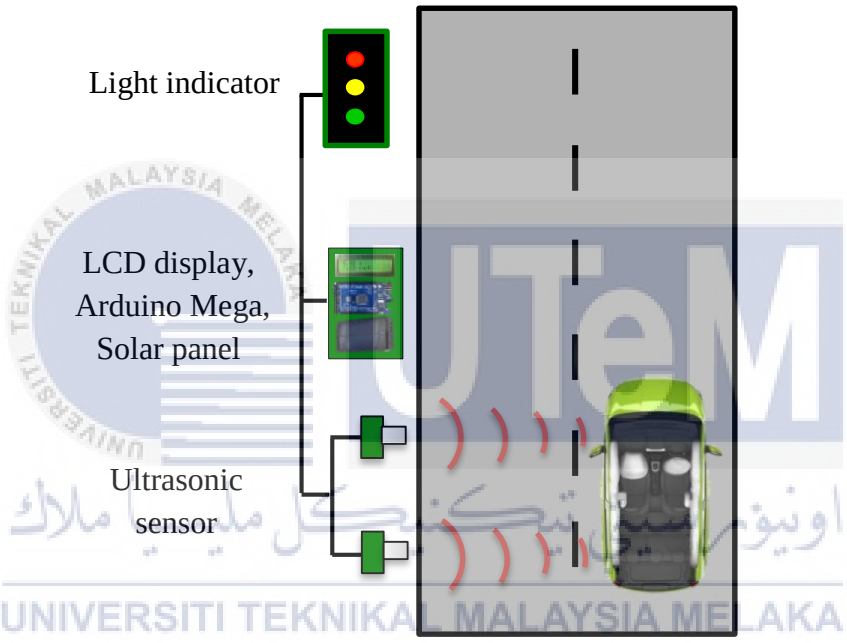


Figure 3.12: The illustration of the component arrangement

3.3.5 Hardware implementation

Figure 3.13 and 3.4 described connection of the component for solar powered speed warning system that consists of solar panel, battery, charge controller, ultrasonic sensor and light indicators. This construction is the designed that used in speed detection system.

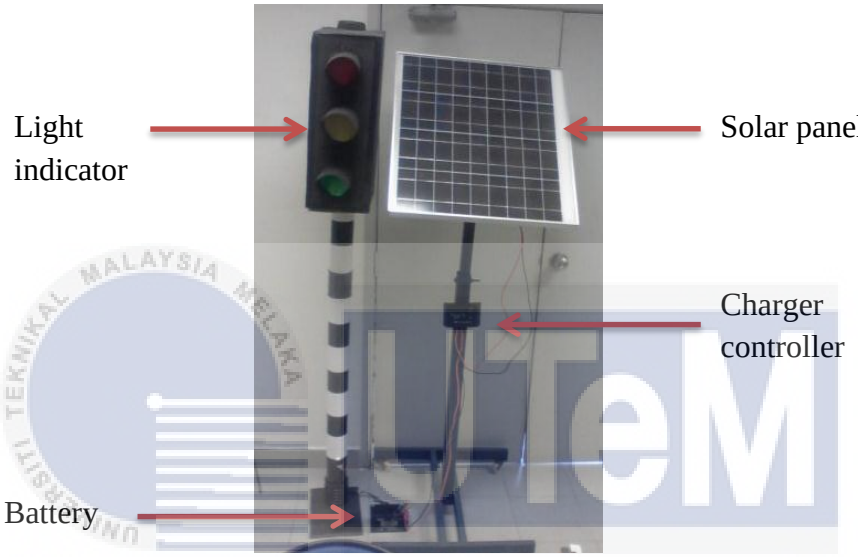


Figure 3.13: Connection of the component for solar powered speed warning system

Figure 3.14: The illustration of speed warning system

3.3 Project Gantt chart

Table 3.2 and 3.3 shows the project of Gantt chart for Final Year Project I and II. The Gant Chart is the most important for this project. This project planning shows the process which easily to follow smoothly and ensure it more organized. So, these projects are following the right timing to be done.

Table 3.2: Project of Gantt chart for FYP1

	Week													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Selection of title project														
Briefing of FYP 1														
Literature review researchers														
Sketch circuit design using Software.														
Hardware development														
Preparation for the complete report														
Seminar 1 (presentation)														

Table 3.3: Project of Gantt chart for FYP2

	Week													
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Hardware development														
Software development														
Troubleshooting														
Performance test														
Preparation for the complete report														
Seminar II (presentation)														

CHAPTER 4

RESULT AND ANALYSIS

4.1 Speed Warning System

In development of this project, the results are tested and verified in order to ensure the system functionality and performance. The screen shows parameters of the vehicle speed detection that programme by using Arduino microcontroller. From Figure 4.1, the parameters such as current speeding, time taken and speed status are displayed by LCD. The parameters indicate the maximum speed detected by vehicle. Sensor (S1) and sensor (S2) are represents as ultrasonic sensor. Both of the sensors are functionally to detect the speed of vehicle. Therefore, if one of the sensor or both of the sensor are detected then it displayed on the screen of the system.

Figure 4.1: The parameter of system displayed on LCD

Figure 4.2 shows the connection of the component of the Speed Warning System that has been designed with specific functions. The components consists are LCD display, switch button, relay, ultrasonic sensor, and Arduino Mega. The function of LCD display is to display the current speed measurement of vehicle. While relay used in this system is to control the light indicator based on the speed of vehicle that programme by using Arduino microcontroller. It is detected by ultrasonic sensor from the speed measurement. The switch button is used as a power to control of the system.

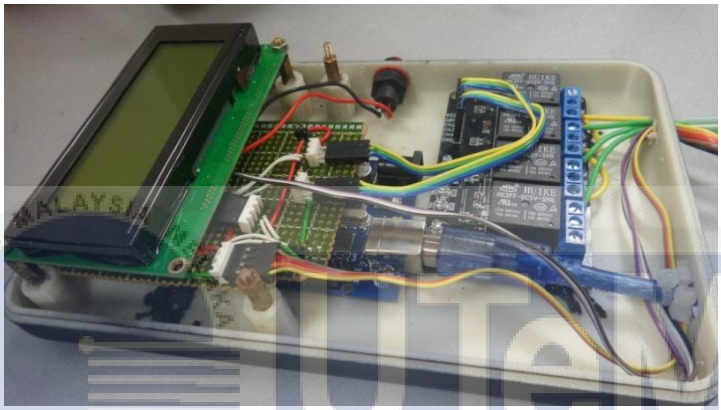


Figure 4.2: Connection of the component for the system

Figure 4.3 shows the placement of the speed warning system. It has been tested on the road whereby system is located on the left of the road side. The speed detection system is located four meter before light indicator placement to alert the people about their speed in the highway. After the system is tested, the data is collected to analysed the performance of the speed vehicle.

Figure 4.3: The placement of the speed warning system

4.2 Limitation of speed detection

In this section, the limitation of speed detection to observe the performance test is described. It is conducted to determine the effective speed used by available instrument sensor. Particularly, there are three conditions regarding on the measuring speed. Table 4.1 depicts the testing performance condition for the status of light indicator, the time taken and condition based on speed detected by the system. The first condition is when the status of light indicator shows green indicator to represent the 'slowest' condition. The time taken is above 0.072s, then the speed captured is below 50 km/h. Next, the time taken to detect the speed is between 0.072s and 0.036s, whereby the speed limit detected is between 50 km/h and 100 km/h represent 'fast' condition. Thus, the status of light indicator displays yellow indicator. For last conditions, the light indicator appears in red indicator when the speed limit is above 100 km/h. Then, the time taken to detect the speed is 0.036 indicates 'very fast' conditions. The range of speed is programmed by using Arduino compiler depending on location such as highway, school and urban area. The capability to detect the speed is proven if the speed fulfilled in this condition.

Table 4.1: The testing performance condition

Speed (km/h)	Time	Status light indicator	Condition
100km/h and above	0.036s and below	Red	Very fast
Between 50kmh and 100km/h	Between 0.072s and 0.036s	Yellow	Fast
50 km/h and below	0.072s and above	Green	Slow

4.3 Validity of system

To validate the system, there are ten trials test that have been recorded to show the system is accurate. The vehicle test is done on the road side. Table 4.3 presents the result for the percentage error of the vehicle test includes time taken, testing speed and exact speed. The speed measurement is the speed detection that being displayed on LCD, while actual speed refers to the speedometer. The time taken is to determine the performance of the speed detection because the distance is set to be constant at 1 meter. However, the measurement speed should have the exact value as the actual speed. In this case, when the measurement speed did not meet the requirement of the actual speed, then the error percentage is calculated to reduce the error. The percentage error of the system is obtained as shown in:

$$Percentage\ error\ (\%) = \left| \frac{Measuremet\ speed - Actual\ speed}{Actual\ speed} \right| x\ 100\% \quad (4.1)$$

Systematic error is an error that having during process programming of Arduino compiler. When the first trial is testing, the error shows the maximum percentage due to the first problem detection in programming of Arduino. Besides that, random error can occur when the speed is recorded from the speedometer. The error is decreases after the problem detected.

Table 4.3: Percentage error for vehicle test

Trial	Time Taken (s)	Measurement speed (km/h)	Actual speed (km/h)	Error (%)
1	0.094	38	48	20.83
2	0.088	41	50	18.00
3	0.090	40	48	16.67
4	0.092	39	46	15.22
5	0.099	36	42	14.29
6	0.102	35	40	12.55
7	0.105	34	38	10.52
8	0.099	36	39	7.69
9	0.099	36	38	5.26
10	0.083	43	44	2.27

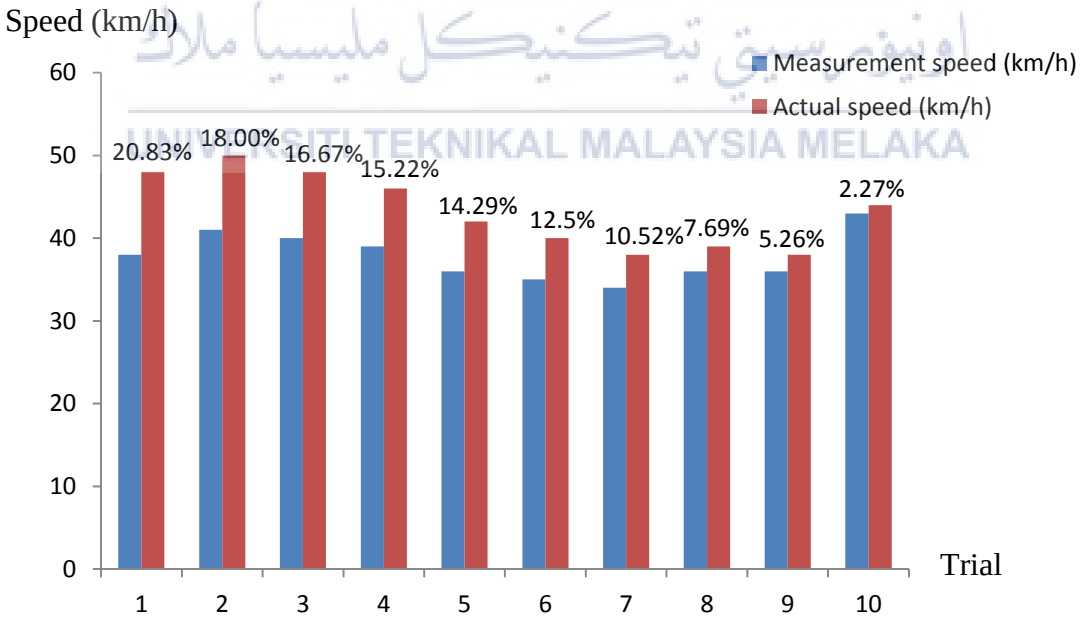


Figure 4.4: The percentage error of vehicle speed detection

To further evaluate the accuracy of the system, Figure 4.4 shows the percentage error of vehicle speed detection. The graph is plotted of speed against trial for vehicle speed detection. The line graph indicates the speed measurement and actual speed to show an error during the testing. Several trials are done to reduce the error. The maximum percentage error that detected at the trial 1 is slightly different because of systematic error such as detection of sensor and an error at the Arduino. At trial 2 until 5 shows slightly decreasing, by means it is at constant percentage of error at 16.63%. While the percentage error for trial 5 until 7 at 35 km/h speed, it presented only minor percentage of error due to the less of error at the time recorded between sensor 1 and 2. The minimum percentage of error at trial 10 is reduced when more trial is repeated. Based on the analysis, the speed measurement has the lowest error which below 2.27% that gives a better result. The effectiveness of the system is improved when more trial is conducted as to reduce the error, thus the system is valid to be used. The percentage of error is obtained to ensure the system reached the desired speed.

4.4 Performance test

The validity of speed is to verify the speed measurement of a vehicle. The performance testing conducted on the road to ensure the system is accurate. Table 4.3 shows the data has been tested under different period of days. From the data, it presents the current traffic condition that response to time. The longer the period tested, the more accurate the results. As requirement for speed detection based on the time taken that displayed on the LCD, it should have the exact time that can make the speed is correctly. From the table, it shows that the time taken is between 0.072s and 0.036s. Then, the speed is in fast condition. Besides that, in slow condition the time taken is below 0.072s.

Table 4.4: Performance testing of speed detection system

Day	Time	Time Taken (s)	Speed (km/h)	Condition
1	**8.00 am**	0.060	60	Fast
	12.00 pm	0.070	51	Fast
	5.00 pm	0.090	40	Slow
	8.00 pm	0.052	70	Fast
2	**8.00 am**	0.045	80	Fast
	12.00 pm	0.061	59	Fast
	5.00 pm	0.090	40	Slow
	8.00 pm	0.060	60	Fast
3	**8.00 am**	0.055	65	Fast
	12.00 pm	0.082	44	Slow
	5.00 pm	0.102	35	Slow
	8.00 pm	0.06	60	Fast
4	**8.00 am**	0.048	75	Fast
	12.00 pm	0.075	48	Slow
	5.00 pm	0.080	45	Slow
	8.00 pm	0.055	65	Fast
5	**8.00 am**	0.050	72	Fast
	12.00 pm	0.072	50	Slow
	5.00 pm	0.085	42	Slow
	8.00 pm	0.053	68	Fast

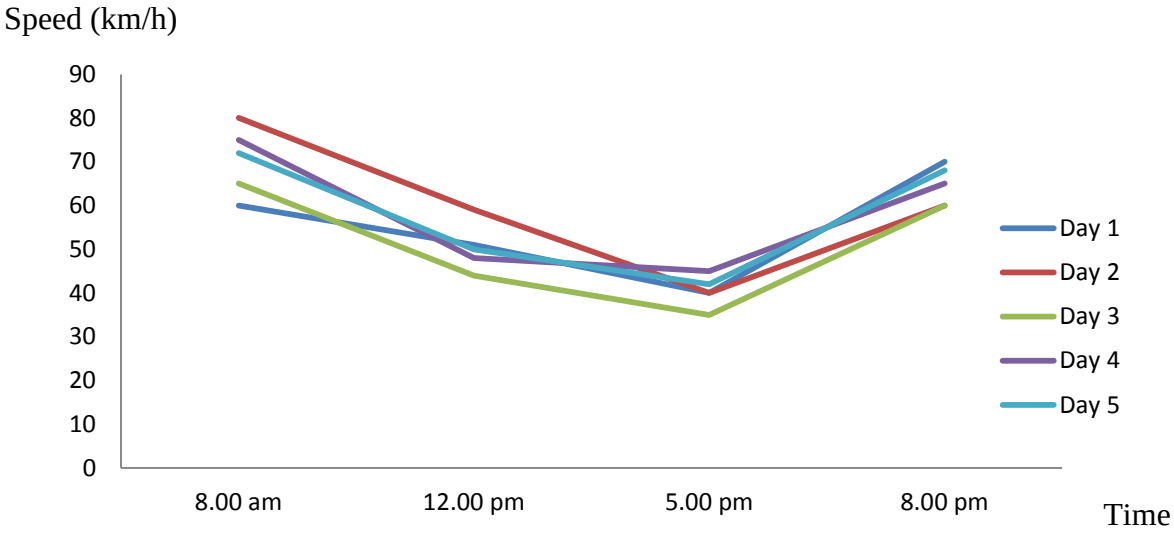


Figure 4.5: Testing performance of speed detection

Figure 4.5 shows the testing performance of speed detection for the graph of speed against time that conducted on the road side. As for traffic road monitoring system, this graph analyzed the speed detection during peak hour to compute the effectiveness of the system. The average of speed detection for all trials at the morning is 70.4 km/h. This condition operates at high speed which can be categorized in fast speed condition. Traffic conditions between 8.00 am and 12.00 noon shows slightly decrease of speed detection. During this hour, the average of speed detection is 50.4 km/h. The speed can be considered as fast speed conditions. The speed between 40km/h and 45 km/h at the 5.00 pm represents the slow speed detection and the average of speed detection is 40.4km/h. At 8.00 pm, the average speed is increased to 64.6 km/h. The testing performance shows the efficiency of the system to be applied on the road.

4.5 Discharge current of battery

The battery is required to store the energy from the solar panel as a supply. Lithium ion battery is the type of rechargeable battery. The capacity of the battery used in this system is 12V and 7.2Ah. Table 4.5 shows the parameter of light indicators based on the datasheet as appendix A. It required the parameter of load to know the time for charging and discharging. Voltage of the light indicator that used in this system is 12V, while the power energy of each light indicator is different. The value of power and current for light indicator of red is 7W and 0.58A. For the yellow indicator the power is 8W while the current is at 0.66A. Then the green indicator indicates the power is 9W and the current is at 0.75A. The charge and discharge current has been done testing. The testing start from the battery is empty until it is fully charging.

Table 4.5: The parameter of light indicator

	Red	Yellow	Green
Voltage (V)	12	12	12
Current (A)	0.58	0.66	0.75
Power (W)	7	8	9

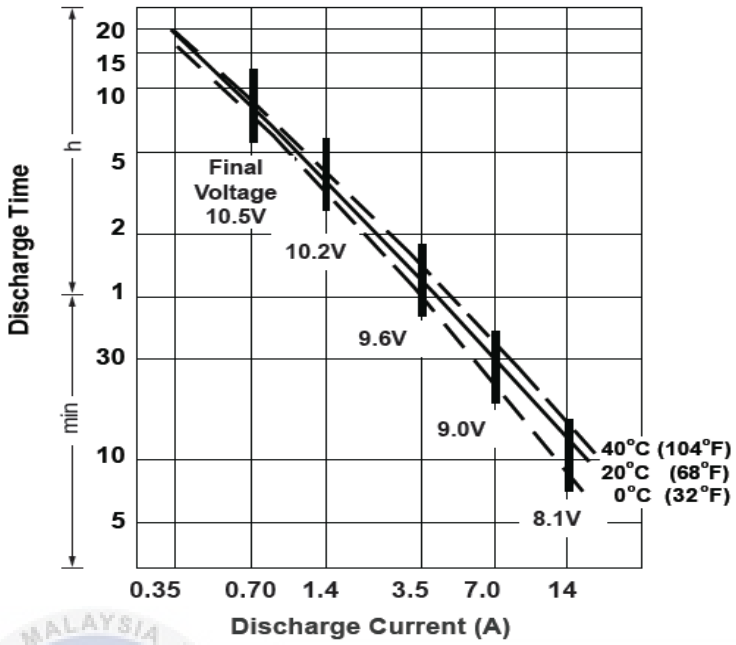


Figure 4.6: The time discharge current for the battery

Figure 4.6 represent the graph of time discharge current for the battery. The total current of the light indicator is 1.99A. The battery life is depending on the capacity of the current battery. By referring the graph as in appendix B, the battery can last long up to 2 hours for discharge. The bigger the size of capacity of the battery, the longer is the battery life span.

CHAPTER 5

CONCLUSION AND RECOMENDATION

5.1 Conclusion

As a conclusion, the performance test of speed warning system shows the ability for speed detection by vehicle. Speed measurement is done by placing two ultrasonic sensors where the distance is constant and the time is taken between the two sensors. It is verified by performance of the test vehicle with a speed detection system. As an approach to recognize the vehicle speed, speed measurement is obtained from calculation that is programmed in Arduino microcontroller. The error between speed measurement and actual speed has been reduced to ensure the system is in desired speed. Experimental results show the accurate speed is gained at minimum error of 2.27%.

The speed warning system used solar power energy as a supply to reduce the gas emission and green energy. The battery is required to store energy that capable 2 hour for discharging. The life span of battery is depending on the capacity of battery. This system has presented the design of a speed warning system that can be used for real application in traffic monitoring. Therefore, it is the effective ways to reduce the road accident, improve and create a safe driving environment because it can because it can be controlled based on the speed level (km/h). It also could be a very powerful and cost-effective in helping enforcing the speed limit law and automatic traffic information reporting. Finally, it is shown that this system is to motivate the people to follow the rule and enhance the responsibility on the road.

5.2 Recommendation

Speeding is contributes the increasing of road accident. Speed warning system as a portable is located anywhere that mostly accident occur. There are several suggestions on improving the speed warning system such as battery, light indicator and LCD display. Solar panel as renewable energy that used in this system is 12V and 50W and the capacity of battery is 12V and 7Ah. The battery can last long up only 2 for charging and discharging. For the real application, it requires the larger of capacity battery to make longer the life span. For speed detection system, the system is to alert the people about their speed on the road. To integrate this system, camera as an approach to capture the speed and the plate register of the vehicle that display on the screen. So that it can recognize which one the vehicle speeding. Besides that, the light indicators also can change into the suitable form that can display the level of speed detection. This system can be located each of 2km as warning to the people about their speed. Finally, this system has been prove for speed detection that testing in single lane road.

5.3 Achievement

This project has been participating in International Engineering Exhibition Invention & Innovation (i-ENVEX) competition on 17th April 2015 at Universiti Malaysia Perlis and has won a bronze award.

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APPENDICES

APPENDIX A: Characteristic of traffic light system

Sunlight-Visible. Direct-Replacement. Energy-Efficient.

12" (300mm) 12VDC Type-1 LED Traffic Light Arrows (TrafficLED™)

Features

- Major Energy Savings
- Solid-State, High Shock/Vibration Resistant
- Conforms to Industry Standards
- Five-Year Warranty
- Lens Design Improves Brightness
- Lamps Can be Retrofitted into Existing Traffic Housings
- UV Resistant Polycarbonate Unit Eliminates Dust/Dirt Buildup
- Available in Red, Yellow, Green
- Very Low Power Consumption, Super Intensity
- 12 VDC For Solar Power Optional

Applications

- Traffic Signal Lights
- Traffic Warning Lights
- Railroad Crossings
- Road Closure Signs
- Tunnel Warning Lights

There are no known ITE and Caltrans Traffic Arrow light specifications at this time.

Only 7-9 Watts Energy Compared to 150W Incandescent

Dimensions

Part Number, Type 1 TRF12A-0ER-012V TRF12A-0PY-012V TRF12A-0G3-012V

Signal Color	Red	Yellow	Green
Wavelength nm	626	590	505
LED Material	AlInGaP	AlInGaP	InGaN
Lens Material	UV Resistant Polycarbonate		
Intensity	>400cd	>400cd	>700cd
Power Consumption	7W	8W	9W
Power Factor (PF)	>0.9	>0.9	>0.9
Total Harmonic Distortion	20%	20%	20%
IP Rating with housing	IP34	IP34	IP34
IP Rating without housing	IP65	IP65	IP65
Operating Temperature	-40 ° C ~ 70 ° C	-40 ° C ~ 70 ° C	-40 ° C ~ 70 ° C
Signal Diameter	300mm	300mm	300mm
Weight (Module only)	1000g	1000g	1000g
Intensity loss due to single LED failure	4%	4%	4%

Note: Outer Rubber seal ring supplied with module

Log# 139F Rev. 07/2001

LEDTRONICS, INC.
THE FUTURE OF LIGHT

ISO LED 9001 REGISTERED

23105 Kashiwa Court, Torrance, CA 90505
Phone: (800) 579-4875 or (310) 534-1505 Fax: (310) 534-1424
E-mail: webmaster@ledtronics.com
Website: http://www.ledtronics.com

APPENDIX B: Characteristic of rechargeable battery

POWER SONIC

PS-1270 12 Volt 7.0 AH

Rechargeable Sealed Lead Acid Battery

We've Got The Power.™

Features

- Absorbent Glass Mat (AGM) technology for superior performance
- Valve regulated, spill proof construction allows safe operation in any position
- Power/volume ratio yielding unrivaled energy density
- Rugged impact resistant ABS case and cover (UL94-HB)
- Approved for transport by air. D.O.T., I.A.T.A., F.A.A. and C.A.B. certified
- U.L. recognized under file number MH 20845

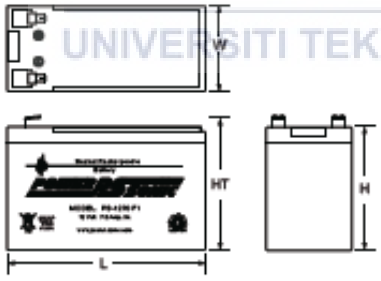
Terminals (mm)

- F1 - Quick disconnect tabs, 0.187" x 0.032"- Mate with AMP. INC. FASTON "187" series

— OR —

- F2 - Quick disconnect tabs, 0.250" x 0.032" - Mate with AMP. INC FASTON "250" series

Physical Dimensions: in (mm)



L: 5.95 (151) W: 2.56 (65) H: 3.70 (94) HT: 3.86 (98)

Tolerances are +/- 0.04 in. (+/- 1mm) and +/- 0.08 in. (+/- 2mm) for height dimensions. All data subject to change without notice.

Performance Specifications

Nominal Voltage	12 volts (6 cells)
Nominal Capacity	
20-hr. (350mA to 10.50 volts)	7.00 AH
10-hr. (650mA to 10.50 volts)	6.50 AH
5-hr. (1.2A to 10.20 volts)	6.00 AH
1-hr. (4.5A to 9.00 volts)	4.50 AH
15-min. (14A to 9.00 volts)	3.50 AH
Approximate Weight	4.80 lbs. (2.18 kg)
Energy Density (20-hr. rate)	1.49 W-h/in3 (90.95 W-h/l)
Specific Energy (20-hr. rate)	17.50 W-h/lb (38.58 W-h/kg)
Internal Resistance (approx.)	23 milliohms
Max Discharge Current (7 Min.)	21.0 amperes
Max Short-Duration Discharge Current (10 Sec.)	70.0 amperes
Shelf Life (% of nominal capacity at 68 °F (20 °C))	
1 Month	97%
3 Months	91%
6 Months	83%
Operating Temperature Range	
Charge	-4 °F (-20 °C) to 122 °F (50 °C)
Discharge	-40 °F (-40 °C) to 140 °F (60 °C)
Case	ABS Plastic
Power-Sonic Chargers	PSC-12800A, 12800A-C

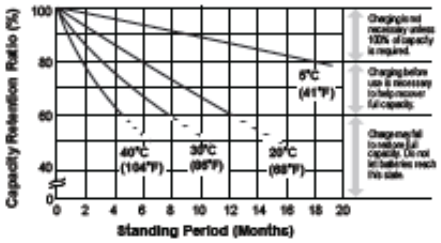
To ensure safe and efficient operation always refer to the latest edition of our Technical Manual, as published on our website. All data subject to change without notice.

www.power-sonic.com

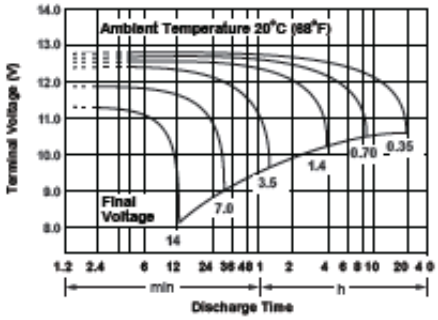
POWER-SONIC

PS-1270 12 Volt 7.0 AH

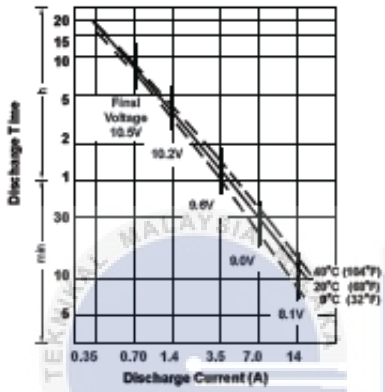
Shelf Life & Storage



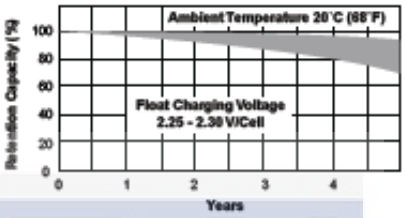
Discharge Characteristics



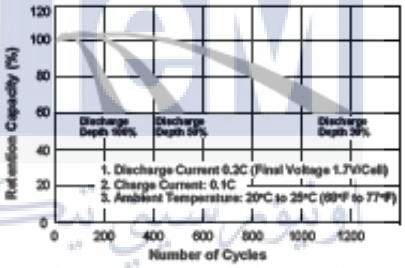
Discharge Time vs. Discharge Current



Life Characteristics in Stand-By Use



Life Characteristics in Cyclic Use



Charging

Cycle Application: Limit initial current to 2.1A. Charge until battery voltage (under charge) reaches 14.4 to 14.7 volts at 68°F (20°C). Hold at 14.4 to 14.7 volts until current drops to under 70mA. Battery is fully charged under these conditions, and charger should be disconnected or switched to "float" voltage.

"Float" or "Stand-By" Service: Hold battery across constant voltage source of 13.5 to 13.8 volts continuously. When held at this voltage, the battery will seek its own current level and maintain itself in a fully charged condition.

Note: Due to the self-discharge characteristics of this type of battery, it is imperative that they be charged within 6 months of storage, otherwise permanent loss of capacity might occur as a result of sulfation.

Chargers

Power-Sonic offers a wide range of chargers suitable for batteries up to 100AH. Please refer to the Charger Selection Guide in our specification sheets for "C-Series Switch Mode Chargers" and "Transformer Type A and F Series". Please contact our Technical department for advice if you have difficulty in locating suitable models.

Further Information

Please refer to our website www.power-sonic.com for a complete range of useful downloads, such as product catalogs, material safety data sheets (MSDS), ISO certification, etc..

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