RAILROAD INSPECTOR FOR RAILROAD DEPARTMENT IN MALAYSIA

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Report submitted in partial fulfillment of the requirements
for the award of Bachelor of Mechatronic Engineering

Faculty of Manufacturing Engineering
UNIVERSITI MALAYSIA PAHANG

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this project and in my opinion, this project is adequate in terms of scope and quality for the award of the degree of Bachelor of Mechatronic Engineering.

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Position : …….
Date : 19 JUNE 2013

STUDENT'S DECLARATION

I hereby declare that the work in this project is my own except for quotations and summaries which have been duly acknowledged. The project has not been accepted for any degree and is not concurrently submitted for award of other degree.

Signature : ……..
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DEDICATION

I specially dedicate to my beloved parents

and those who have guided

and motivated me for this project

ACKNOWLEDGEMENTS

First and foremost, the deepest sense of gratitude to the ALLAH, who guide and gave me the strength and ability to complete this final year project successfully. Infinite thanks I brace upon Him. I would like to express my sincere gratitude to my supervisor Mr. Wan Hasbullah Bin Mohd Isa for his continuous guidance, support and encouragement, which gave me huge inspiration in accomplishing this research. His practice of professional ethics and conducts which encourages me to become confident and competent person to work individually as well as in group with minimal supervision.

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ABSTRACT

This thesis is the design of an autonomous robot which this robot can detect defect on railroad to prevent the future accident. This final year project carry out by the author to fulfillment the requirement for award the degree of Bachelor Mechatronics Engineering. This designed robot which has two stages of development and included two models. The first model is for PSM 1 and the second is fully functional model is for PSM 2. Basically, the design of robot quite more interesting, modern, unique and environmental friendly which using Arduino Uno and Agilent Instrument as a platform. In this report, I had made entire analysis requirement, design circuit, check output and input data and other important parameters to realization the design of the working robot that can be implementation by railroad department. On the other hand, this report is to aim to provide objective and scope of the research, the literature review study, research methodology, and fabrication process with result analysis and conclusion as part requirement in submitted the report to PSM supervisor. Although railroad inspection and development is still new technology in Malaysia and no domestic consumption in this technology, but through this project can help the industry a step further. It is because this project can categorized as successful and working as expected. Finally, I wish this project can categorized on research and design development by interesting mechatronics student.

ABSTRAK

Kajian ini adalah reka bentuk robot autonomi dimana robot ini dapat mengesan kecacatan pada jalan kereta api untuk mencegah kemalangan masa depan. Projek tahun akhir yang dijalankan oleh penulis untuk memenuhi keperluan untuk anugerah ijazah Sarjana Muda Kejuruteraan Mekatronik. Robot yang direka ini mempunyai dua peringkat pembangunan dan termasuk dua model. Model pertama adalah untuk PSM 1 dan yang kedua ialah model berfungsi sepenuhnya adalah untuk PSM 2. Mesra Pada asasnya, reka bentuk robot agak lebih menarik, moden, unik dan alam sekitar yang menggunakan Arduino Uno dan Agilent Instrumen sebagai platform. Dalam laporan ini, saya telah membuat analisis keperluan keseluruhan, reka bentuk litar, daftar output dan input data dan parameter lain yang penting untuk merealisasikan reka bentuk robot kerja yang boleh dilaksanakan oleh jabatan kereta api. Sebaliknya, laporan ini adalah untuk bertujuan untuk menyediakan objektif dan skop penyelidikan, kajian kajian literatur, kaedah penyelidikan, dan proses fabrikasi dengan analisis keputusan dan kesimpulan sebagai keperluan bahagian dalam mengemukakan laporan kepada penyelia PSM. Walaupun pemeriksaan dan pembangunan kereta api merupakan teknologi baru di Malaysia dan tiada penggunaan domestik dalam teknologi ini, tetapi melalui projek ini dapat membantu industri langkah seterusnya. Ia adalah kerana projek ini boleh dikategorikan sebagai berjaya dan sibuk bekerja seperti yang diharapkan. Akhir sekali, saya berharap projek ini boleh dikategorikan kepada penyelidikan dan pembangunan reka bentuk oleh pelajar mekatronik menarik..

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF SYMBOLS

π : 3.142

° : Degree

Pps : Pulse/second

µs : Micro second

ms : Mili second

V : Voltage

A : Amphere

LIST OF ABBREVIATIONS

DC	: Direct Current
U2781A	: USB Modular Product Chassis
U2701A	: USB Modular Oscilloscope
U2352A	:USB Modular DAQ
U2901A	:DAQ Terminal Block
E3631A	: Triple Output DC Power Supply
FYP	:Final Year Project
FKP	:Faculty of Manufacturing
UMP	:University Malaysia Pahang
ULN	:Upper Limits of Normal
IC	: Integrated Circuit
LED	: Light Emitting Diode
rpm	: radius per minit

CHAPTER 1

INTRODUCTION

1.1 INTRODUCTION

This chapter describes the background of railroad inspector, problem statement of this project, the objectives of research, scope of the research, significant of research and expected result for this project.

1.2 BACKGROUND OF STUDY

Transport is a key necessity for specialization that allows production and consumption of products to occur at different locations. Transport has throughout history been a spur to expansion as better transport leads to more trade. Economic prosperity has always been dependent on increasing the capacity and rationality of transport. But the infrastructure and operation of transport has a great impact on the land and is the largest drainer of energy, making transport sustainability and safety a major issue. In Malaysia, the rail transport occupies a prominent position in providing the necessary transport infrastructure to sustain and quench the ever-burgeoning needs of a rapidly growing economy. Today, Malaysia possesses the fifth largest railway network in the world and development to make the trains as the main transportation become true.

In era for development train as a main transportation, one horrific accident was report by BERNAMA which 2 person passenger was killed in train accident. According to us, incident at about 3:45 pm Wednesday, leaving KTM for services between the city and the east coast of the southern sector breakdown. In the incident,

a locomotive driver, Yahya Osman, 40, died at the scene due to severe injuries and nine wounded mild outpatient treatment Tuanku Ja'afar Hospital here and one of them admitted. During the incident, a train with eight carriages carry 258 passengers travelling from Butterworth, Penang to Singapore.

Figure 1.1: Horrific Accident [1]

On this tragedy, two cranes from Gemas and Falim depot, Ipoh used to work on that. Carriages issued Seremban will be pulled into the station. Both the victim, Chong Wah Sin, 42, who was injured in the left toe and back of the body as well as a woman Chia Lian Heng, 73, was injured in the head, respectively warded at the hospital 4B and 8B.

Another case was record by Green Blog with their title "Tragedy Back To Village" which incident occurred at 6:45 am at the Kampung Sungai Yu between Kuala Lipis and Gua Musang Station when the Express Wau from Kuala Lumpur to Tumpat in the journey took nearly 1,000 passengers aboard the 14 carriages to go home to celebrate Aidilfitri in the village. Reliable two-class passenger coaches and wagons bed nearly 100 passengers boarded at the back of the front carriages disconnected from the connection, causing it to skid before it overturned on the hillside.

Figure 1.2: Two carriages derailed in Kampung Sungai Yu, Gua Musang [2]

A total of 11 passengers were injured, eight more severe, including a wound in the face while the other two broken arms and a broken hip, and was rushed to Merapoh Health Center for treatment. From that, one smart step have to done quickly to avoid this problem will not happen again.

The interesting statement for both this resource is the accident stems from railroad problem which the train out from the railroad. According to the resource, two major problem that always have been face is crack and loosening bolt on railroad. These conditions of railroad always occur because the temperature on railroad always changes between hot and cold. From that, the microstructure of railroad also changed to brittle and easy to crack and loosening bolt.

Table 1.1: Condition of railroad that can cause accidents [3]

Figure 1.3: Loosening bolt

Figure 1.4: Crack on railroad

Figure 1.5: Non-junction on track

Figure 1.6: Serious crack on railroad

Cracks in rails have been identified to be the main cause of derailments in the past, yet there have been no cheap automated solutions available for testing purposes. Hence, owing to the crucial repercussions of this problem, design on implementing an efficient and cost effective solution suitable for large scale application. Since the railway was invented, rail maintenance had always been a problem crack or damage rail could lead derailment.

The principal problem has been the lack of cheap and efficient technology to detect problems in the rail tracks and of course, the lack of proper maintenance of rails which have resulted in the formation of cracks in the rails and other similar problems caused by anti-social elements which jeopardize the security of operation

of rail transport. In the past, this problem has lead to a number of derailments resulting in a heavy loss of life and property.

High safety standards required in the management of railroad lines demand the inspection of railway wheels directly after production in order to detect the presence of surface cracks and bolt loosening that could seriously affect the integrity of the railway, and therefore passenger's safety.

1.3 PROBLEM STATEMENT

Defect in railroad track are responsible for several incidents every year resulting in injuries, fatalities, infrastructure cost, environment damage, loss of use, etc. This case was expose by newspaper, internet, blog, radio, etc which according to us, they was record that the problem stems from railroad. As a result, there is a continuous need for inspection and maintenance of these track, with human inspectors are performing track inspection. Reveals the mind for several kilometer just for checking the defect on railroad is not easier jobalthough their effort is very thorough, the process can be extremely tedious, demanding, and time consuming. It also can provide negligence during checking process and the effect is there are several defect on railroad is failed to detect.

The purpose of this project is to design an autonomous robot platform which travel on railroads tracks and will identify defect on railroad track. Cracks in rails have been identified to be the main cause of in the past, yet there have been no cheap automated solutions available for testing purposes. Hence, owing to the crucial repercussions of this problem, design an efficient and cost effective solution suitable for large scale application. The system can be implemented in the long run to facilitate better safety standards and provide effective testing infrastructure for achieving better results in the future.

1.4 RESEARCH OBJECTIVES

To design of a working autonomous robot on following:

i. To develop system for detect crack

By identify the crack on railroad, the future accident can be prevent better safety standards and provide effective testing infrastructure for achieving better results in the future.

ii. To develop the system that gives a warning of surface crack to prevent possible future accident.

The principal problem is has been the lack of cheap and efficient technology to detect problems in the rail track. This system is more unique, environmental friendly, inexpensive material and component, and the best thing is there no company that has been develop this system.

iii. To build working of railroad inspector

System must be working perfectly to detect defect on railroad especially crack because this is major that have been face by train railroad department.

1.5 RESEARCH QUESTION

There are several techniques to solve this issue that depend on the situation.

i. How to detect the defect on railroad track

There are several technique for solve this issue as used by sophisticated country like United State(US), Japan, Britain, German, China, etc. which they are develop various technique like Ultrasonic inspection, Eddy Current technique, Laser checking and Magnetic Particle Inspection (MPI). All of this technique has their own pro and

contra thus the development on this technique always continues repeatedly.

ii. What are the system that used to detect defect on railroad

By using the components that already available, one system that known as ultrasonic system. The theory behind ultrasonic ranging is quite simple. Typically a short ultrasonic burst is transmitted from the transmitter. When there is an object in the path of the ultrasonic pulse, some portion of the transmitted ultrasonic wave is reflected and the ultrasonic receiver can detect such echo. By measuring the elapsed time between the sending and the receiving of the signal along with the knowledge of the speed of sound in the medium, the distance between the receiver and the object can be calculated. This system need to combine with other technology from Agilent.

1.6 SCOPE OF RESEARCH

The scope is depend the system of autonomous robot that will be develop.

i. To choose the suitable electronic items for build up the autonomous robot

Electronics component have their own characteristics for designing circuit process to avoid this component is burn out during attach on the circuit

ii. To recognize all autonomous robot application and limitation and also to define their classifications

The autonomous robot has their own limitation than other sophisticated system that develops by other country.

iii. To choose the suitable design for build up the autonomous robot

The design of autonomous robot should be taken in terms of dimension of robot, it because the circuit, battery and motor will be place on it platform.

1.7 SIGNIFICANT OF RESEARCH

After this project has been done, all of the knowledge could be apply either in scientifically. In addition, when something knowledge that most of us have then apply into several application it would give us a lot of good implications such as to create a self-confidence. Other than that, by invention may give a lots of attraction to ourselves compared just learning the theoretical of some knowledge. There are several principle and theory that involve with my autonomous robot like knee voltage, semiconducting material doped with impurities to create a p-n junction, forward and reverse bias concept.

1.8 DEFINITION OF TERM

Railroad is a permanent way, is the structure consisting of the rails, fasteners, sleepers and ballast (or slab track), plus the underlying sub grade. A road composed of parallel steel rails supported by ties and providing a track for locomotive-drawn trains or other wheeled vehicles. Transportation system made up of metal rails which is designed to allow trains to maneuver on the tracks from one location to the next. The most recognized railroad system is Amtrak, which travels throughout the United States and Canada. Most railroads with heavy traffic use continuously welded rails supported by sleepers (ties) attached via base plates which spread the load. A plastic or rubber pad is usually placed between the rail and the tie plate where concrete sleepers are used.

Inspector is most generally, an organized examination or formal evaluation exercise and critical appraisal involving examination, measurement, testing, gauging, and comparison of materials or items. An inspection determines if the material or item is in proper quantity and condition, and if it conforms to the applicable or specified requirements. In engineering activities inspection involves the

measurements, tests, and gauges applied to certain characteristics in regard to an object or activity. The results are usually compared to specified requirements and standards for determining whether the item or activity is in line with these targets.

Railroad Inspector is an autonomous robot that functions for detect the defect on railroad with automatically and sent data to USB Modular Oscilloscope U2701A. This robot was using ultrasonic sensor for detect the defect and travel from one station to other station for checking process. Simultaneously, this autonomous robot will stop from one station to other station for charging process before continue the checking process. High pulse on oscilloscope is meaning defect on railroad was detected.

1.9 EXPECTED RESULT

The expected result for developed system used for surface defect detection on railway wheels based on transmit and receive ultrasonic system that guide by Agilent technology. The circuit will be check by Agilent equipment to check the output from the circuit and give the maximum protection for the robot with this system it is possible to on-line detect the surface on railway wheels. The presented system is as a part of technology on inspection line and can be easily modified for special desired industrial applications. The department of railroad the significance and quality of data information. After the device being implemented, the department of railroad track can be easier to define the crack on railroad and it can be save the money to hire the worker to make the checkup of railroad problem. It also can be safety purpose and reduce the time of inspection.

1.10 LAYOUT OF THESIS

The overall content of this proposal will consist of five chapters. The first chapter is discussing about the introduction of the topic followed by the theory and literature review will be in chapter two. Discussion and explanation of the research methodology for all the methods and the components that require that require for mechanical design will be in chapter three. In chapter four, the content are about the

results and discussion for the project. Last but not least, the conclusion and recommendation for the project will be in chapter five.

CHAPTER 2

LITERATURE REVIEW

2.1 INTRODUCTION

This chapter to describe the literature review research for final year project on journal, book and internet sources. The resources need to record to ensure that resources are properly taken as a reference. More accident was report by newspaper, television, radio, blog and the rate of increase in more serious cases reported. However, the train accident and incident rate in railroad yards far exceeds the rates across the entire railroad industry (Reinach and Gertler, 2002). Train accidents include collisions and derailments that involve the operation of on-track equipment and that meet certain reporting thresholds set by the Federal Railroad Administration (FRA, 2003).

Train incidents include employee injuries that involve the movement of on-track equipment and that meet certain reporting criteria (FRA, 2003). In fact, worsen the human error in the detection of defects in rail can invite consequences on the passenger train. In fact, human error in industrial environments and transportation systems is much more complicated to decode than simply blaming the operator. As Reason (1997, p. 126) notes, ". . . human error is a consequence not a cause. Errors . . are shaped and provoked by upstream workplace and organizational factors. Identifying an error is merely the beginning of the search for causes, not the end . . . Only by understanding the context that provoked the error can we hope to limit its recurrence."

2.2 WHAT IS RAILROAD INSPECTOR

Railroad inspector is an autonomous robot for detect defect on railroad and sent coordinate location in longitude on phone and latitude for prevent the future accident with automatically. Defect on railroad will happen the corrugation does not compromise rolling safety, but has an adverse effect on track element and rolling stocks by increasing noises emissions, loading and fatigue (Bohmer and Klimpel, 2002). Its occurrence is increasing on high speed passenger lines, mixed and heavy haul railways and can lead to expensive rail grinding in the attempt to remove it, premature removal of the rails and complete rail failure.

Nowadays, maintenance issues are becoming overwhelming because of the increase of operating loads, traffic, and high-speed trains. Therefore, maintenance means prevention of catastrophic rail failure to avert loss of rolling material as well as of lives. Since 1923 with the invention of the car inspection for detect rail flaw have been the most common way to inspect railroads (Abbaszadeh, 2003).

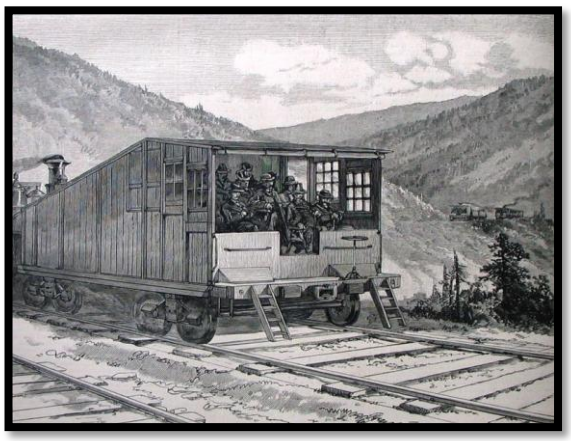

Figure 2.1: An Inspection Car on the Pennsylvania Railroad [4]

2.3 WHAT IS ULTRASONIC SYSTEM

There are several technique for detect defect on railroad that depend on situation and form structure condition on earth. Developed foreign country have develop various technique and modern for solve this issue. One of the most popular methods is ultrasonic inspection which this system is common technique in the rail industry in many foreign countries. Ultrasonic techniques scan railhead through ultrasonic beams and detect the return of reflected or scattered energy using ultrasonic transducers (Erazo, Baumert and Ladwig, 2004). It is a relatively well understood technique and was thought to be the best solution to crack detection. According toD.E. Bray, 1976 state that the ultrasonic non-destructive inspection has been significant contributor to the invention of railway accident for a number of years.

Ultrasonic frequencies, i.e. frequencies above 20 kHz, as these are rare in nature and thus the sensors are not disturbed. Moreover, man hears no such high frequencies. Incidentally, they are also completely harmless, because the sound energy is extremely small. Industrial ultrasonic sensors operate at frequencies of approximately 80-400 kHz, depending on what characteristics the sensor shall have (Evans, 2010). The greater the required measuring distance is, the lower frequencies must be used. Few creatures also make use of ultrasound for guidance. These are mainly the dolphin (in water) and the bat (in the air, as our sensors). Both have bad organs of sight and send ultrasonic waves up to 200 kHz *(*Symons, 1985). In addition, also other creatures can hear frequencies above 20 kHz although they probably don’t have a benefit for their orientation.

Few creatures also make use of ultrasound for guidance. These are mainly the dolphin (in water) and the bat (in the air, as our sensors). Both have bad organs of sight and send ultrasonic waves up to 200kHz.In addition, also other creatures can hear frequencies above 20 kHz although they probably don’t have a benefit for their orientation:

Table 2.1: Group of frequency

Category	Frequency
Man	20kHz
Gog	50kHz
Cat	60kHz
Grasshopper	95kHz

The dolphin transmits and receives ultrasonic waves in water in order to detect obstacles and beasts of prey. Since the acoustic impedance of water is about 3000 times higher than that of air, both waves generated by animal as well as by technique reach much farer in water than in air. For the bat living in air it is more difficult. Its high-frequency sound waves do not extend so far. But it also has the most advanced ultrasonic location system. The high frequency enables it to get a very fine local resolution. The ultrasonic cries of bats are produced in the larynx and emitted through the mouth to the outside(Schmidtke, 1994). When the emitted waves meet a flying body, e.g. a small prey animal, they are reflected and returned to the ears, which serve as a sound signal receiver. The hearing organs of bats must have an amazingly good sound analysis capability.

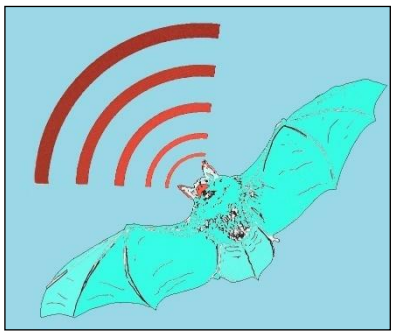

Figure 2.2: Ultrasonic that beam from bat [5]

It is believed that due to only microsecond short differences in time of sound flight between the left and right ear they are able to get a three-dimensional acoustic image. Therefore a bat can orient itself with their ears in the absolutely dark, as we do with our eyes at daylight. As engineers we need to give us once more defeated by nature.

2.4 WORKING OF ULTRASONIC SYSTEM

The ultrasonic system refers to any application of sound waves higher in frequency than the human audible range. The amplitude of the reflections and their arrival times indicate the presence, the location and the severity of the damage (Clark, 2004). Music and common sounds that are considered pleasant are typically 12 kHz or less, while some humans can hear frequencies up to 20 kHz. Ultrasonic waves consist of frequencies greater than 20 kHz and exist in excess of 25 MHz

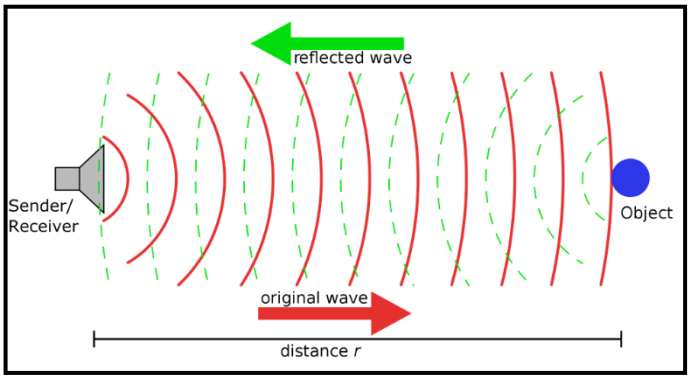

Figure 2.3: Ultrasonic technique [6]

Although, ultrasonic testing is capable of inspecting the whole railhead (Marais and Mistry, 2003).Within nondestructive test, ultrasonic waves give the ability to see through solid material and detect surface or internal flaws without affecting the material adversely.

2.5 ADVANTAGE OF THE ULTRASONIC SYSTEM

The currently existing technical solutions offered by many companies in the detection of cracks in rails involve periodic maintenance coupled with occasional monitoring usually once a month or in a similar timeframe. However possesses the inherent advantage of facilitating monitoring of rail tracks on a daily basis during nights when the usual train traffic is suspended. The simplicity of idea and the easy-availability of the components make the project ideal for implementation on a large scale with very little initial investment. The simplicity of our project ensures robustness of operation and also the design has been carefully modified to permit rugged operation. Another disadvantage that can be attributed to the conventional commercially available testing equipment is that they are heavy which poses a practical limitation.

However, this important disadvantage has been rectified in project as the design is simple and sensible enabling the device to be easily portable. According to Mc Carthy (2007), the stability of sloped land areas and the potential for failure, or landslide, is a concern where movement of existing or planned slope would have an effect on the safety of people and properties or the usability and the value of the area. While designing the mechanical parts of the robot, due consideration has been given to the variable nature of the tracks and the unique challenges posed by the deviations in the Malaysia scenario.

2.6 APPLICATION

The modern Railroad Inspector are suitable used in Malaysia especially the company that which makes the train as transport in Malaysia like Kenderaan Tanah Melayu (KTM) which this system is inexpensive electronic component, unique and effective. Important for these companies to take early steps to ensure passenger safety is fully guaranteed and this thing will convince people to continue to choose the train as the main transport for long distance travel.

CHAPTER 3

METHODOLOGY

3.1 INTRODUCTION

Before build the device the first thing do is measure the distance of the railway, length between the tracks, sensitivity of ultrasonic system. After that, check the signal output using the Agilent equipment like oscilloscope. By using this equipment, we can measure the input and output voltage and ampere to give maximum protection for autonomous robot. Then we get the equipment for ultrasonic sensor and Arduino Uno system and fix it to the body of device.

3.2 CONCEPT OF RAILROAD INSPECTOR

The concept of Railroad Inspector like autonomous robot which this system fully automatic control by programming. The surface to support the platform must be flat for easier to locate the component. Dimension platform of the robot is important to support the track, circuit, battery, motor driver and two DC gear motor that locate below the platform robot. This DC gear motor was synchronize to control the robot speed.

Figure 3.1: Concept of Railroad Inspector [7]

This robot will travel from one station to another station for checking process without using man power. This robot also will stop automatically from one station to other station for charging process before continue the checking railroad process. From this concept, the detection defect on railroad and repairing process will be easily besides saving their own time.

3.3 DESIGN OF RAILROAD INSPECTOR

A sketch is a quickly executed freehand drawing that is not intended as a finished work. In general, sketching is a quick way to record an idea for later use. Architect's sketches primarily serve as a way to try out different ideas and establish a composition before undertaking a more finished work, especially when the finished work is expensive and time consuming.

Today, the mechanical of the drafting task have largely been automated and accelerated through the use of computer. CATIA (Computer Aided Three-dimensional Interactive Application) is a multi-platform CAD/CAM/CAE commercial software suite developed by the Before start sketch using CATIA software, one discussion between supervisor has been done to select the best sketching from 5 different concepts with taking a few of term such as design, cost, easy to constructed, material, aerodynamic and anything else.

Table 3.1: Differences between the designs

Advantages	Disadvantages
Environmentally friendly	Moderation in term of speed
Modern design	
More stable to carry the load like circuit, battery and DC motor	
Inexpensive material and component	
Moderation of costs needed	
High arts in term of designation	
Attractive and more unique toward to the customer request	
Low maintenance needed	

Measurement will be determined according to load that need to support, dimension of dc motor, connection the circuit and battery 12 volt for trigger dc motor. It is important to avoid the robot that will be design is not bigger and not to small, also it can reduce the load that support by robot to ensure it will move smoothly. Also that, wide space for put the circuit is important to avoid from short circuit when the wire will contact each other. Safety need to be considering while the design because short circuit can damage the other electric component like dc motor.

CATIA is the leading software solution used to develop a broad range of products across the world. It is used to design, simulate, analyze, and manufacture products in a variety of industries including aerospace, automotive, consumer goods, and industrial machinery, just to name a few. By sketch using CATIA software, we can transform the idea that draft using hand to 3D dimension. 3D systems such as CATIA will produce the geometry of the part, the technical drawing comes from user defined views of the part. Any orthographic, projected and section views are created by the software. There is no scope for error in the production of these views. The main scope for error comes in setting the parameter of first or third angle projection, and displaying the relevant symbol on the technical drawing.

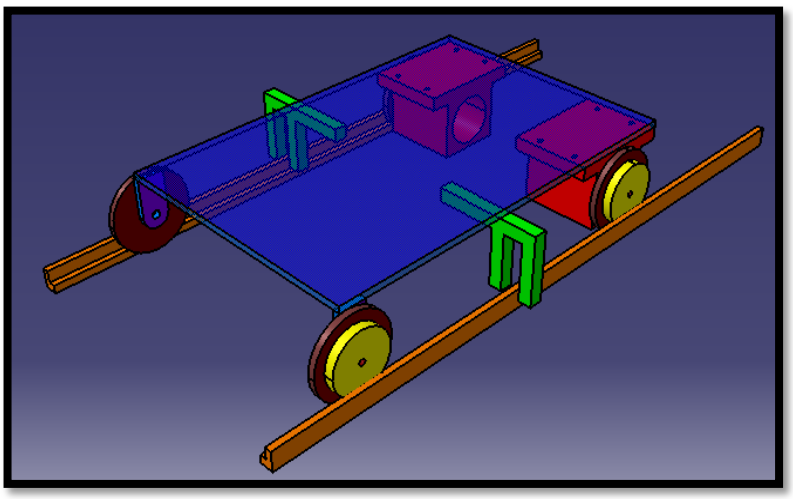

Figure 3.2: Design concept model for Railroad Inspector

3D dimension allows individual parts to be assembled together to represent the final product. Buildings, Aircraft, ships and cars are modeled, assembled and checked in 3D before technical drawings are released for manufacture. Developing this project using CATIA, the designer did not have to design every single new part whenever the customer request of their own requirement. There is lots of advantage in this field such as the cost and time can be reducing on product designing. After finished assemble all the part, we can see the result which a robot is created that simulate by 3D dimension.

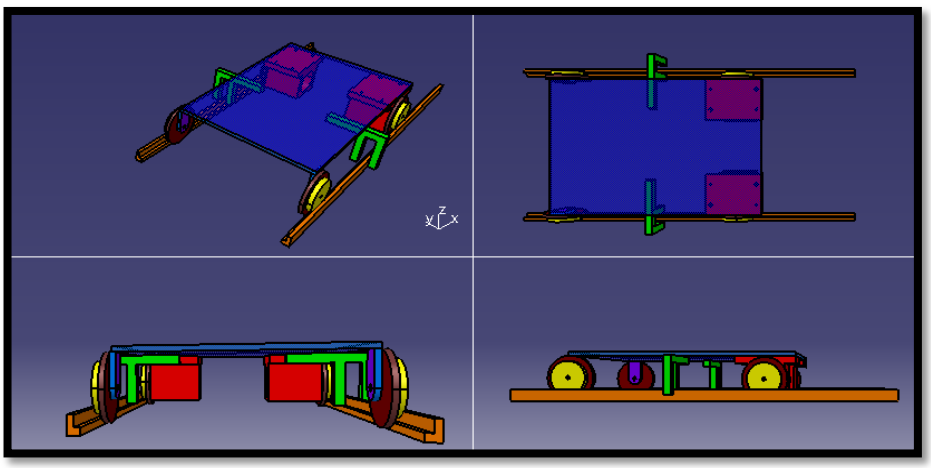

Figure 3.3: Multi view model of Railroad Inspector

Design autonomous robot using CATIA requires patience cause by using this software, we need to put more detail specification to build part by part before we assemble the part. If we put the wrong value, this part with other part cannot be match and of course, we have problem to during assemble. From that, we can convert the car with other shape like wireframe, shading, shading with material and many more. The function is we can see roughly inside the autonomous robot and it will produce the idea how we can install the other component like dc motor below the robot.

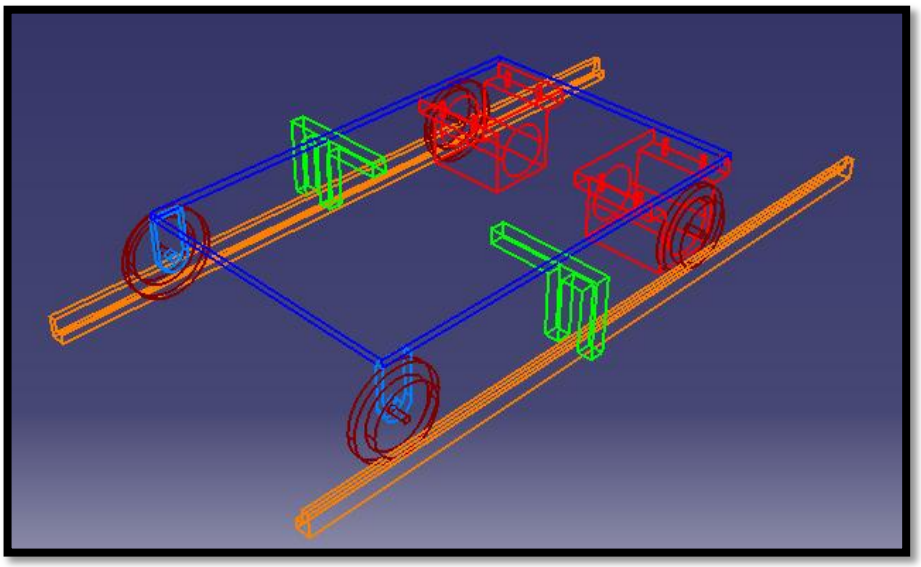

Figure 3.4: Model of Railroad Inspector in wireframe diagram

3.4 BLOCK DIAGRAM

Block diagram will be guide my autonomous robot for connection between platform is U2701A Modular oscilloscope and other component that involve like DC Gear motor, Ultrasonic sensor, motor driver, Arduino UNO, and E3631A DC Power Supply.

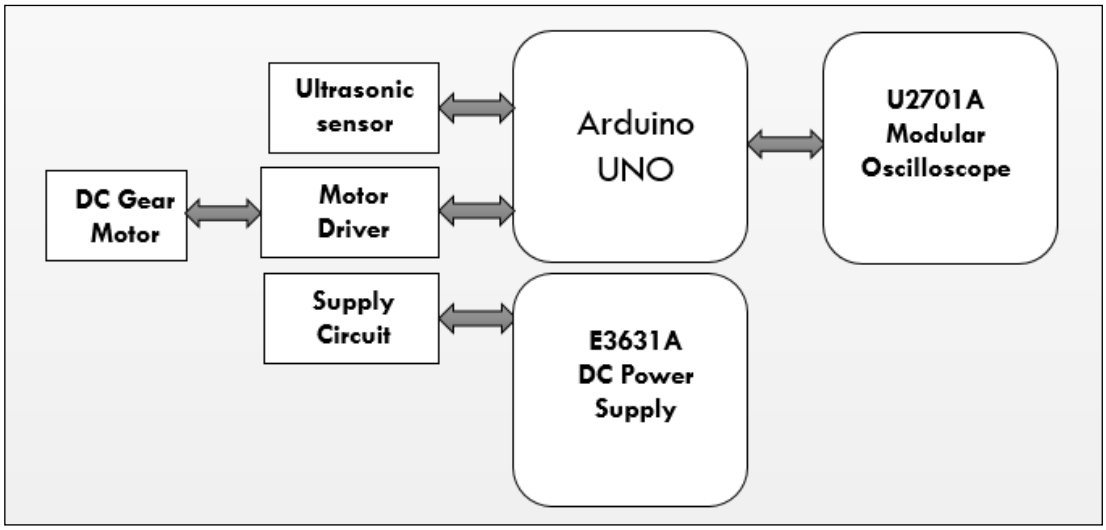

Figure 3.5: Block diagram of railroad inspector

For on this project, Agilent technology is the platform that I need to program using their own software. Ultrasonic sensor will attach on this platform to give feed back if defect on railroad was detect. Motor driver will contact with DC motor for control process from one station to other station. From one station, the motor will be ON until the robot reaches the second station, the motor will OFF to stop it. The purpose is to charge the autonomous robot for next checking process beside for checking if the robot faces the problem.

The autonomous robot will start from one station to other station with automatically. The system must be in good condition to avoid the robot stuck or not function during the checking railroad process. Especially battery, charging process is need from one station to other station that depend on how length the railroad that the robot need to travel. During process checking the railroad, the platform just gives feedback when the system was detecting defect on railroad. If the systems do not have feedback from system, it means no defect on railroad.

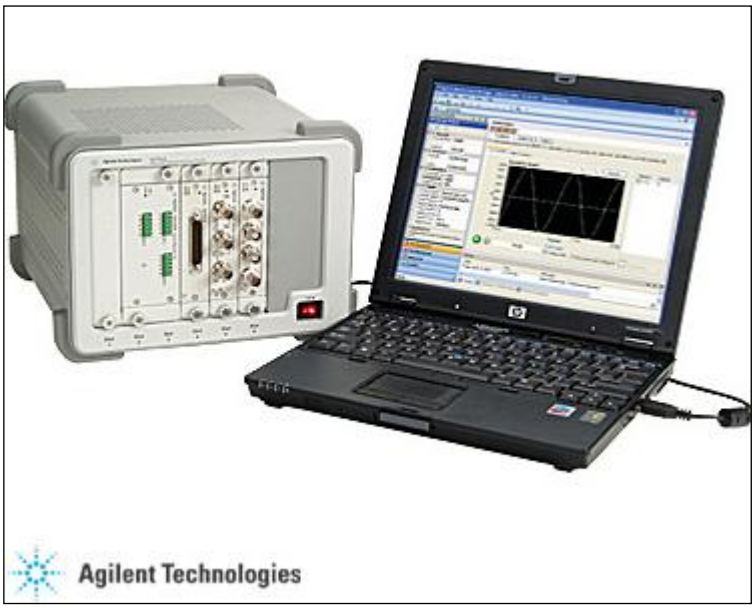

Figure 3.6: Platform of Railroad Inspector [8]

Until the end process the autonomous not detect defect on railroad, it will stop on next station for charging process before continue checking process. But if the robot was detecting defect on railroad, robot will automatically sent signal to U2701A USB Modular Oscilloscope for analysis the graph. Benefit of this equipment which data can be save and record for long period. It suitable because this autonomous robot need to travel from one station to other station. Feedback from this system will show on the PC which engineer need to analysis the graph to determine condition of defect.

3.5 Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328 (datasheet). It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features

the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

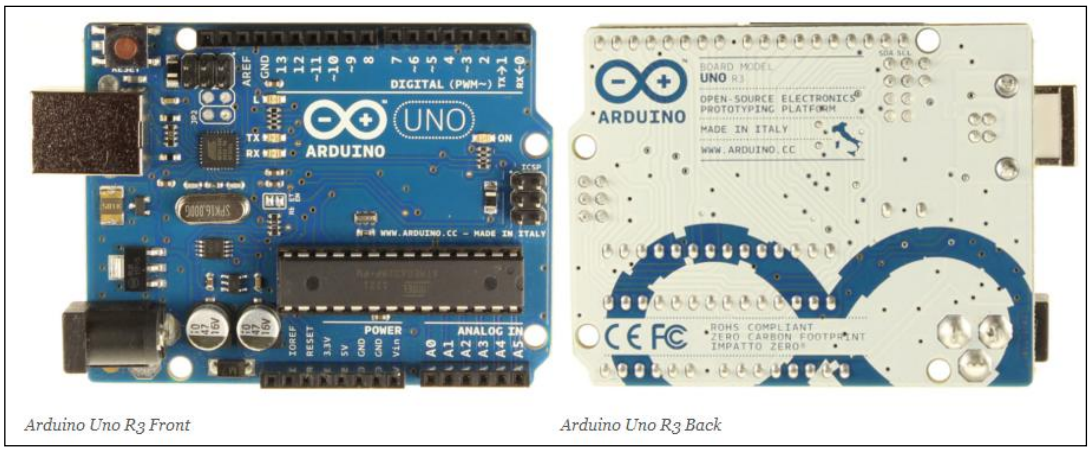

Figure 3.7: Arduino Uno [9]

Revision 2 of the Uno board has a resistor pulling the 8U2 HWB line to ground, making it easier to put into DFU mode. Revision 3 of the board has the following new features: 1.0 pinout: added SDA and SCL pins that are near to the AREF pin and two other new pins placed near to the RESET pin, the IOREF that allow the shields to adapt to the voltage provided from the board. In future, shields will be compatible both with the board that use the AVR, which operate with 5V and with the Arduino Due that operate with 3.3V. The second one is a not connected pin that is reserved for future purposes. Stronger RESET circuit. Atmega 16U2 replace the 8U2.

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform; for a comparison with previous versions, see the index of Arduino boards.

3.6 Ultrasonic sensor

3.6.1 Introduction

The HC-SR04 ultrasonic sensor uses sonar to determine distance to an object like bats or dolphins do. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package. From 2cm to 400 cm or 1” to 13 feet. It operation is not affected by sunlight or black material like Sharp rangefinders are (although acoustically soft materials like cloth can be difficult to detect). It comes complete with ultrasonic transmitter and receiver module.

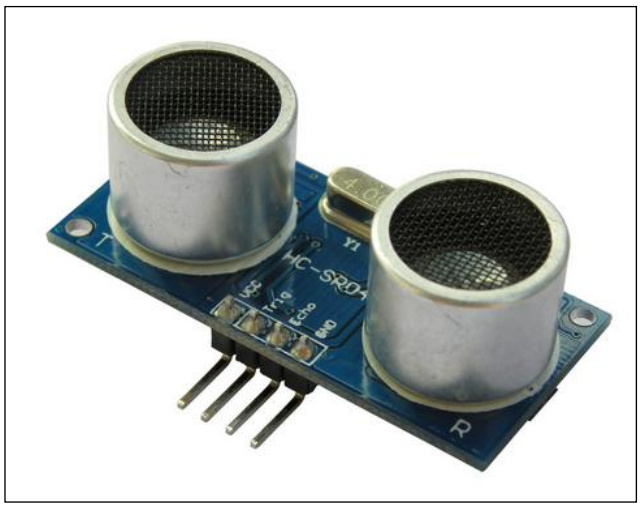

Figure 3.8: Ultrasonic sensor [10]

Table 3.2: Ultrasonic sensor specification

Specification	Detail
Power supply	+5V DC
Quiescent Current	<2mA
Working Current	15mA
Effectual Angle	<15°
Ranging Distance	2cm – 400 cm/1" - 13ft
Resolution	0.3 cm

Measuring Angle	30 degree
Trigger Input Pulse width	10uS
Dimension	45mm x 20mm x 15mm

3.6.2 Operation

To start measurement, Trig of SR04 must receive a pulse of high (5V) for at least 10us, this will initiate the sensor will transmit out 8 cycle of ultrasonic burst at 40kHz and wait for the reflected ultrasonic burst. When the sensor detected ultrasonic from receiver, it will set the Echo pin to high (5V) and delay for a period (width) which proportion to distance. To obtain the distance, measure the width (Ton) of Echo pin.

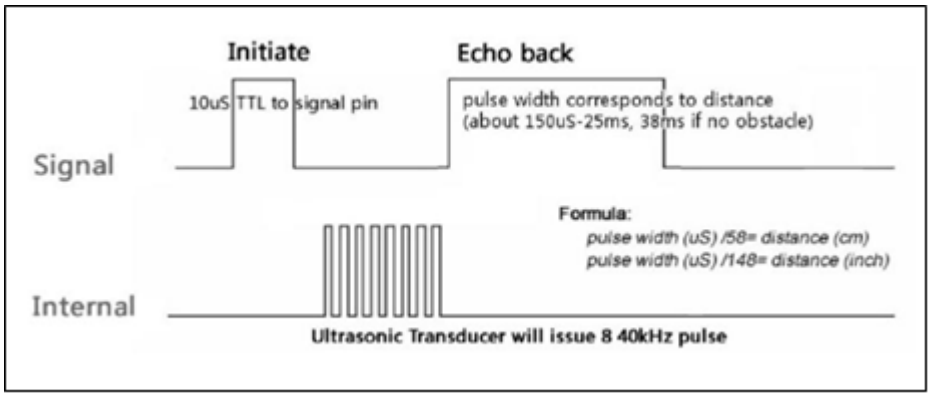

Figure 3.9: Working principle of ultrasonic sensor [11]

Time = Width of Echo pulse, in uS (micro second)

- Distance in centimeters = Time / 58
- Distance in inches = Time / 148
- Or utilize the speed of sound, which is 340m/s

3.7 DC Gear Motor

The suitable motor will be choosing for carried load to make sure railroad can be run smoothly. Wheel on railroad need to turning carefully to avoid burr after machining to not disturb travel. Right specification while choosing the dc gear motor not only allows the system to work properly but it could indirectly support if there is an increase in the number of components.

Figure 3.10: DC Gear Motor [12]

Table 3.3: DC Gear Motor specification

Specification	Detail
Supply	12Volt
Output power	1.1 watt
Rate speed	12rpm
Rated current	410mA
Rated torque	1176mNm

With the specifications that meet the requirements, choosing of this type of motor is important to make sure the system is run perfectly. Sometime, it can prevent friction between two interfaces between wheel and track. Friction that happen will some extent interfere the system for detect defect on railroad.

3.8 LCD Display

Arduino LCD Keypad Shield or navigation shield which come with 6 momentary push button for menu navigation and also a 2×16 LCD. It only required plugging and using with Arduino main board and there no soldering or fly-wiring are required. LCD display which is pin-4, 5, 6,7,8,9. For LCD data, it use pin-4, 5, 6, 7, while for the RS and Enable pin, it use pin-8 and 9.

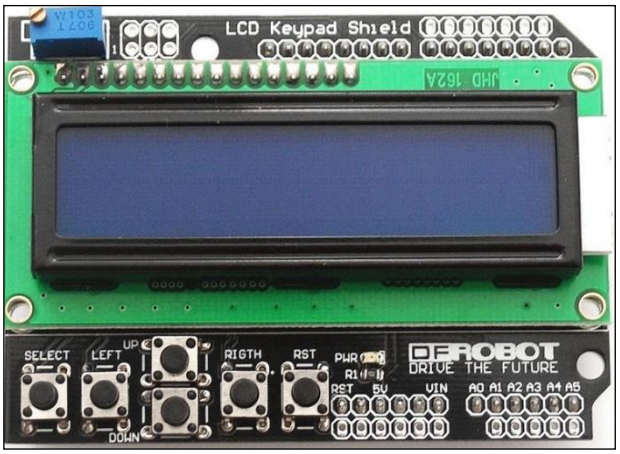

Figure 3.11: LCD Display [13]

The Arduino-LCD Keypad Shield are operate in 4-bits mode. To ease user, Arduino Team have prepared the <LiquidCrystal.h> file which we only require to modified and change the pin using only.

3.9 Motor Driver

A motor driver is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A driver might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults.

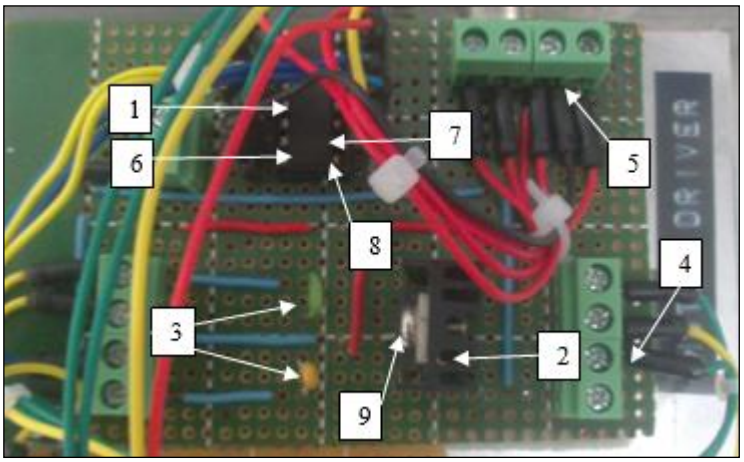

Figure 3.12: Motor driver

Table 3.4: Component for build motor driver

Number	Component
1	L293D
2	Heat sink
3	Capacitor 0.5µF and 0.1 µF
4	Supply 12 Volt
5	Supply 9 Volt
6	To dc gear motor 1
7	To dc gear motor 2
8	From Arduino Uno
9	LM7805

For build this motor driver, it must include several electronic component and most importantly is L293D which this this driver will be sent Pulse Width Modulation (PWM) for trigger DC Gear Motor. Need to careful during do the wiring for L293D because this driver so sensitive and easy to burn out. Check also voltage that supply and not more than 12Volt and install heat sink on this driver to reduce heat while it operation.

3.10 Agilent Electronic Instrument

Install the computer using AMM (Agilent Measurement Manager) software before use this equipment to interface between two of this device. Select carefully Operation System (OS) on PC to avoid technical problem during launch the system. AAM is a bundled software that comes with the standard purchase of a USB modular DAQ, USB modular instrument or the 27811A USB modular product chassis.

Figure 3.13: U2781A [14]

Figure 3.14: U2701A [15]

Figure 3.15: E3631A [16]

Table 3.5: Features of Agilent Instrument

Component	Types	Features
USB Modular Product Chassis	U2781A	▪ Multiple instrument synchronization ▪ High-speed USB 2.0 ▪ Internal and external 10 MHz reference clock ▪ SSI/Star trigger bus synchronization between external trigger source and modules
USB Modular Oscilloscope	U2701A	▪ High sampling rate up to 500 Msa/s, enables accurate measurements analysis ▪ Up to 32 MB large memory ▪ Fast Fourier Transfer (FFT) and waveform math functions enables easy waveform calculation
Triple Output DC Power Supply	E3631A	▪ Output 1 : 0 to 6V, 0 to 5A ▪ Output 2 : 0 to 25V, 0 to 1A ▪ Output 3 : 0 to -25V, 0 to 1A

3.11 Flow Chart of Circuit Testing Process

Flow chart circuit testing is important to ensure the system is perfectly done before it will install on autonomous robot to avoid difficulties if the system does not work. It will easier process to check connection of the component like Ultrasonic sensor, Arduino UNO, LCD Display, and motor driver.

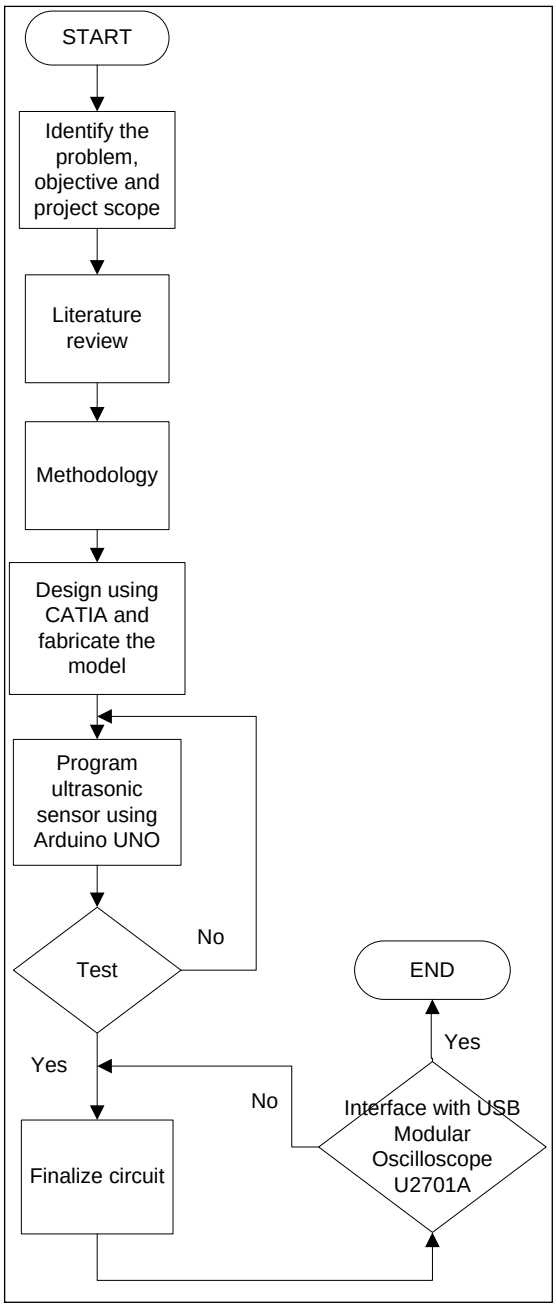

Figure 3.16: Process of testing of Railroad Inspector

The process will start by testing the circuit before install to the autonomous robot. By using the flow chart, it will guide me to manage the testing circuit process. Install the main device which Ultrasonic sensor and Arduino Uno is important to detect defect on railroad before sent signal to platform for next process. After design using CATIA software, fabricate the model of railroad inspector involve with sophisticated machine like milling and turning to fabricate the model. Material that involve is aluminum because the special characteristic like non-corrosion. Connection wiring between the circuit must be done carefully because ultrasonic sensor very sensitive and it easy to burn out. Check positive and negative terminal before 'On' the supply is important to avoid short circuit on Arduino UNO, Ultrasonic sensor and motor driver. After circuit already finalize, sent signal to USB Modular Oscilloscope U2701A to check signal from Arduino UNO.

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3.12 PROCESS FLOW CHART

Process flow chart is important to guide for explanation process how railroad inspector detect defect on railroad.

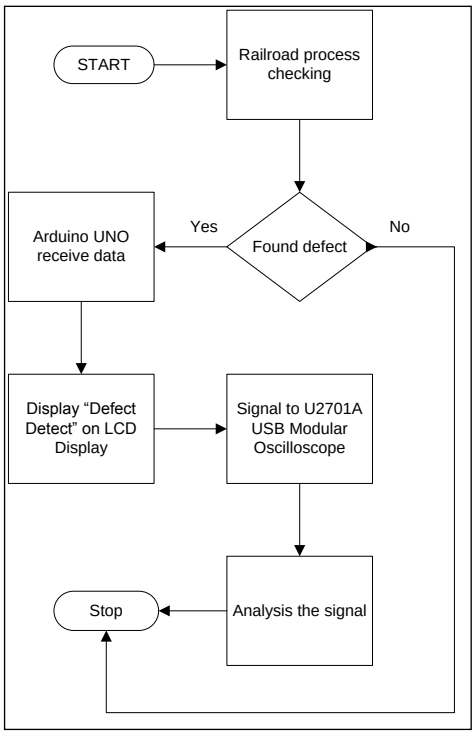


Figure 3.17: Flow chart of checking process system

The core is proposed the crack detection scheme basically consists of an ultrasonic sensor assembly that functions as the railroad defect detector. Pair of sensor is install on the railroad inspector to find defect on railroad. Signal from this sensor will sent to Arduino Uno next process to display condition of track. Track in normal condition, LCD Display will display “No Defect” and if not, “Defect Detect” will display on LCD Display. From that, signal from Arduino Uno will sent to U2701A USB Modular Oscilloscope for analyze the signal.

Signal from this equipment oscilloscope will analysis by engineer to determine the condition of track. If the signal from produce ‘HIGH’ pulse or ‘1’, that mean system was detect defect on railroad and if the system was not detect defect on track, signal from oscilloscope just produce ‘LOW’ pulse or ‘0’.

CHAPTER 4

RESULT AND DISCUSSION

4.1 INTRODUCTION

Before build the model of autonomous robot, sketch that design by CATIA software need to print out to avoid error part during assembles the mechanical part. There are several machines that involve which is band saw, turning, milling, drilling and grinding to make every part more accurate and precise to make the part will match with other part.

4.2 DEVELOPMENT OF HARDWARE DESIGN

Development of hardware design consist three stage which it start from design, build and assemble the mechanical part. Aluminum is the best thing to make this prototype because it light weight and non-corrosion.

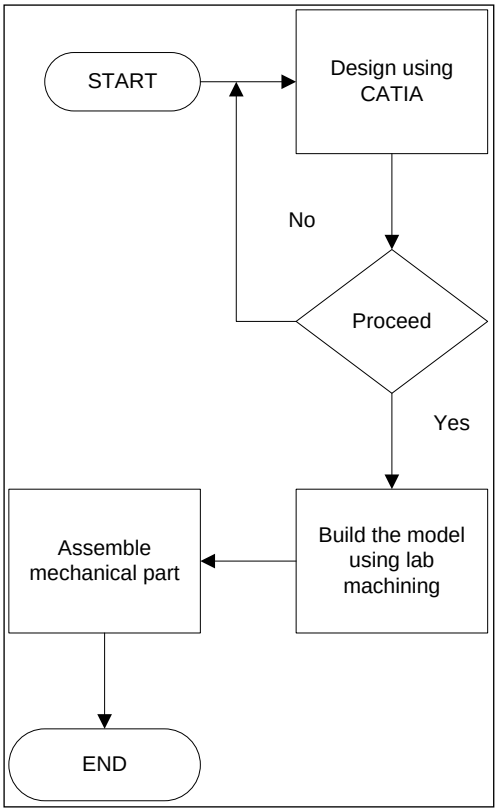


Figure 4.1: Development of hardware design

Railroad inspector is divide by several mechanical and electrical part which is this item consist their own function. However, this system is fully depend on the Agilent equipment to see the result when defect on railroad was detect.

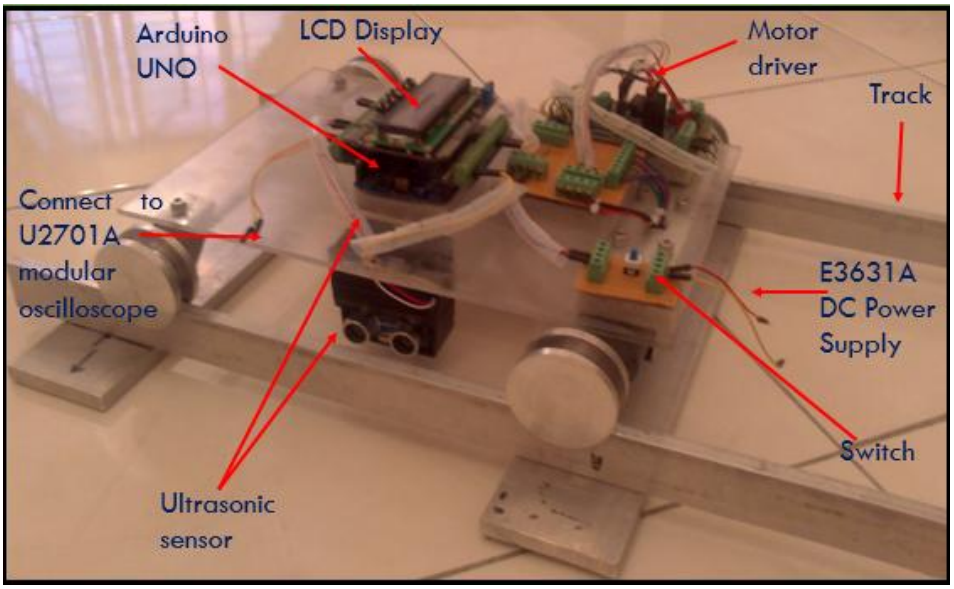


Figure 4.2: Railroad Inspector

Table 4.1: Railroad Inspector specification

Item	Function
Ultrasonic sensor	Sent data to DAQ Terminal Block when receive signal from LED-LDR system
Arduino Uno	Receive signal from ultrasonic sensor and sent signal to U2701A
U2701A	Display on signal from Arduino Uno to determine condition of track
E3631A	Supply voltage to main system specially for DC gear Motor
DC Gear Motor Driver	Control the speed of railroad inspector to stop from one station to other station for charging process
DC Gear Motor	For movement of railroad inspector
Wheel	Allow the autonomous robot move on the railway
Switch On / Off	Cut off supply from power supply
Battery 9 Volt	Supply the voltage to autonomous robot

Assemble the railroad inspector with the track is important to check the system is function or not when defect on railroad was detect. It also to check the autonomous robot is match with the track or not.

4.3 DEVELOPMENT OF CIRCUIT

Build the circuit need to be careful to avoid the component and circuit is burn out. Express SCH software already measure the output input voltage or ampere when circuit already design. It also easier to edit or replace the component on the circuit for testing process.

4.3.1 COMPONENT AND EQUIPMENT

Using ultrasonic system, the basic component that list is important to trigger the system when defect on railroad was detect. However, ultrasonic sensor is that one sensitive component which is need to be careful during install to the circuit.

Table 4.2: Component for build the system

Component	Quantity
Ultrasonic sensor	2
IC L293D	1
Arduino UNO	1
LCD Display	1
Capacitor 5µF and 1µF	2
Resistor 45Ω, 1kΩ and 2.5kΩ	4
Switch on/off	1
Supply voltage 9V and 12V	1
Cytron DC Gear Motor	2
Heat sink	1
Voltage regulator L293D	1

4.3.2 ELECTRICAL CIRCUIT

Datasheet will be guided during design electrical circuit which is easier for us to check pin connection. By using datasheet, it can avoid this component from burnout.L293D are quadruple high-current half-H drivers. The L293D is designed to provide bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V. This devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications.

Figure 4.3: L293D [17]

All inputs are TTL compatible. Each output is a complete totem-pole drive circuit, with a Darlington transistor sink and a pseudo-Darlington source. Drivers are enabled in pairs, with drivers 1 and 2 enabled by 1,2EN and drivers 3 and 4 enabled by 3,4EN. When an enable input is high, the associated drivers are enabled and their outputs are active and in phase with their inputs.

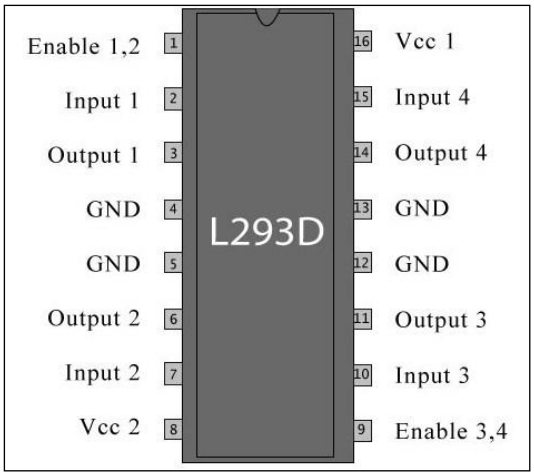


Figure 4.4: Pin connection for L293D [18]

When the enable input is low, those drivers are disabled and their outputs are off and in the high-impedance state. With the proper data inputs, each pair of drivers forms a full-H (or bridge) reversible drive suitable for solenoid or motor applications. On the L293, external high-speed output clamp diodes should be used for inductive transient suppression. A VCC1 terminal, separate from VCC2, is provided for the logic inputs to minimize device power dissipation. The L293D are characterized for operation from 0°C to 70°C.

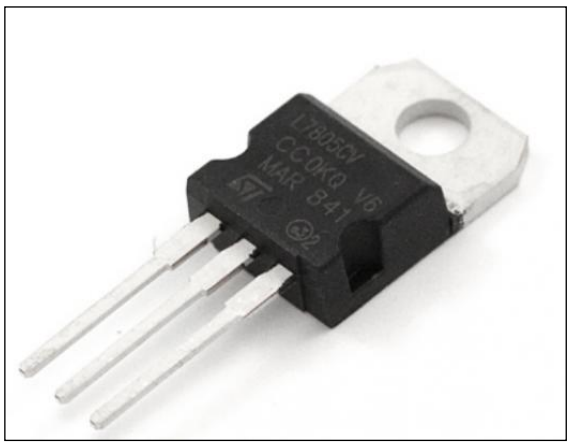


Figure 4.5: LM 7805 [19]

A LM7805 Voltage Regulator is a voltage regulator that outputs +5 volts. An easy way to remember the voltage output by a LM78XX series of voltage regulators is the last two digits of the number. A LM7805 ends with **"05"**; thus, it outputs 5 volts. The **"78"** part is just the convention that the chip makers use to denote the series of regulators that output positive voltage. The other series of regulators, the LM79XX, is the series that outputs negative voltage.

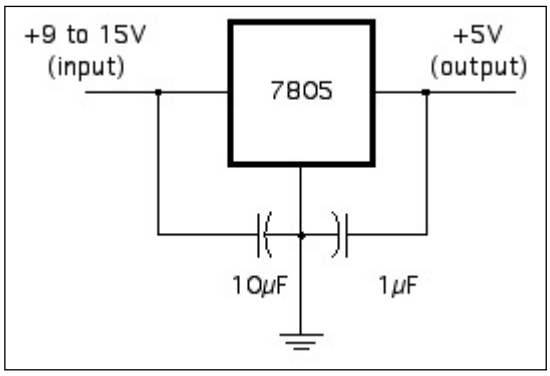


Figure 4.6: Pin connection of LM 7805 [20]

The LM7805, like most other regulators, is a three-pin IC. **Pin 1** (Input Pin): The Input pin is the pin that accepts the incoming DC voltage, which the voltage regulator will eventually regulate down to 5 volts. **Pin 2** (Ground): Ground pin establishes the ground for the regulator. **Pin 3** (Output Pin): The Output pin is the regulated 5 volts DC.

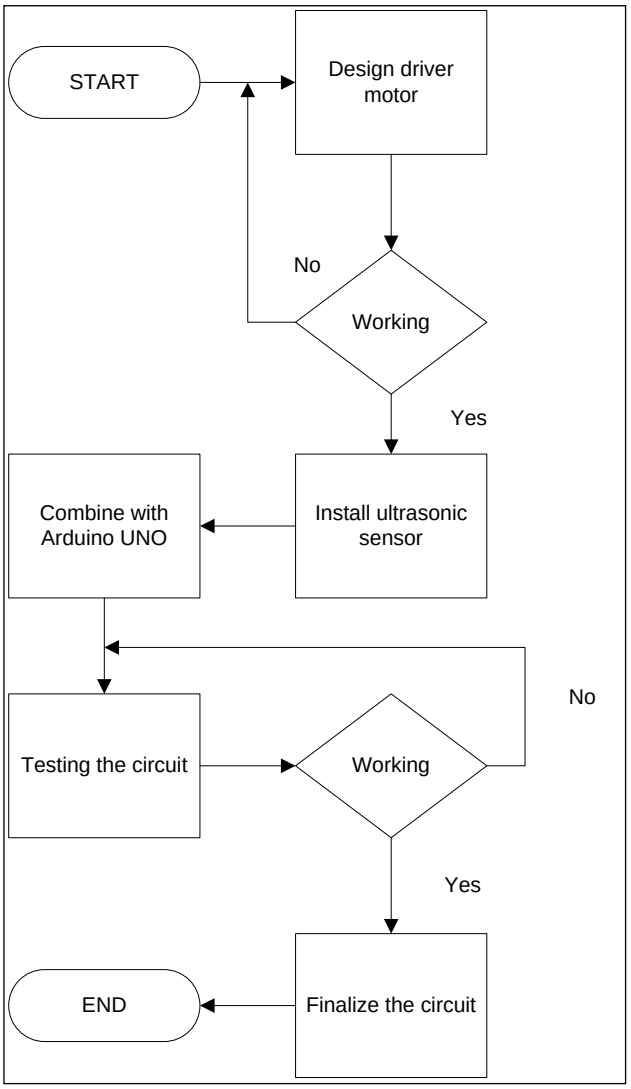


Figure 4.7: Flow chart of electrical circuit

4.4 DEVELOPMENT OF PROGRAMMING

The ATmega328 on the Arduino Uno comes preburned with a boot loader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol. Rather than requiring a physical press of the reset button before an upload, the Arduino Uno is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2/16U2 is connected to the reset line of the ATmega328 via a 100 µ farad capacitor.

When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the boot loader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

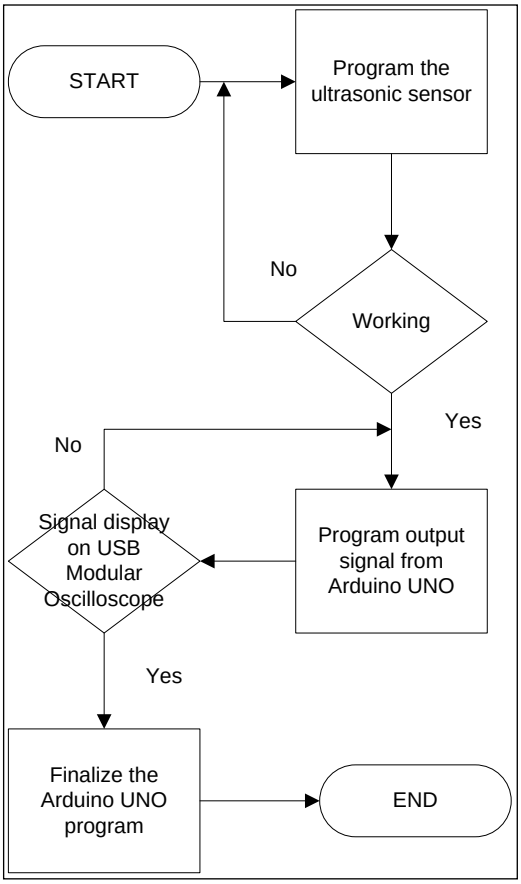


Figure 4.8: Flow chart to program ultrasonic sensor

4.5 SYSTEM DETECT DEFECT ON RAILROAD

System fully depend on efficient of ultrasonic sensor to give feedback when defect on railroad was detect. Both of this sensor will install on right and left of track to determine condition of railroad. If this component failure to detect defect, whole the system will not function automatically. Install the ultrasonic sensor must in correct location where transmit and receive not be interrupt by other part. Limit for

this sensor for detect defect must be at least 2cm from railroad. If location in wrong place which below than 2cm, sensor will failure to detect defect on railroad.

If the system not detect defect on railroad, LCD Display will display “No Defect” to show that railroad in normal condition and no defect was detect on track. It mean train is allowed through this track and simultaneously it can prevent future accident.

Figure 4.9: No defect on track

However, if system was detect defect on railroad, LCD Display will display “Defect Detect” to reminder engineer that defect on railroad was detect. Technical Department is responsible to repair railroad to avoid the train accident. At the same time, train did not allowed using trough this track until troubleshoot on railroad is finished.

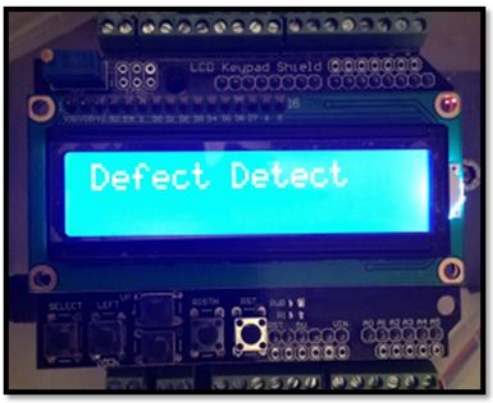


Figure 4.10: Defect detect on track

Simultaneously, Arduino Uno will sent signal to U2701A USB Modular Oscilloscope to record and save data to determine location defect on railroad. It will make easier the department to send technician fort troubleshoot the problem. From the graph, channel 1 is right track and channel 2 is left track. Digital signal that sent from Arduino Uno will be sent to U2701A USB Modular Oscilloscope to record and save data. On this oscilloscope, it read voltage which it measure 5Volt or 'HIGH' pulse when system was detect defect on track.

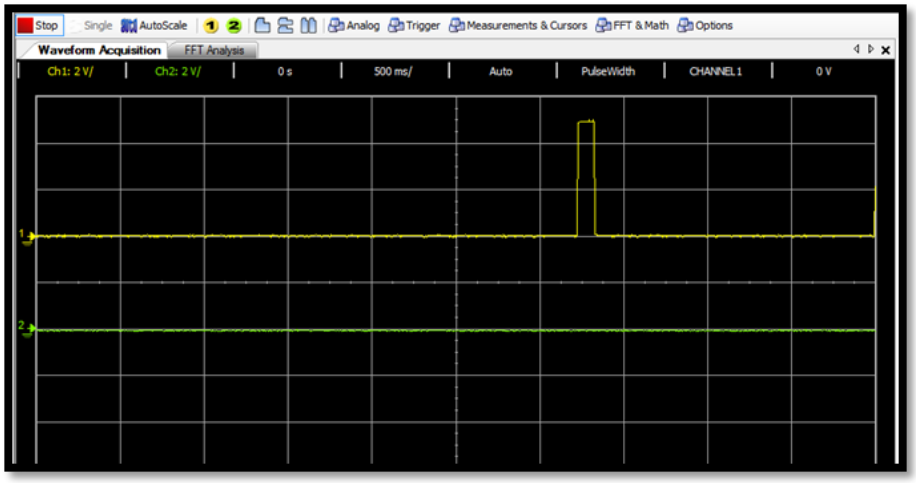


Figure 4.11: Display condition on track

It produce like a spike for easier the engineer determine the condition of track and constant voltage which 0Volt or 'LOW' pulse indicate that there are no defect on railroad to allowed the train using this track.

4.6 DISCUSSION

From the result, spike that produce from U2701A show the condition of track which defect on railroad was detect by system. Other than that, digital signal from Arduino Uno that sent to U2701A will record and save for be a reference and guide for engineer to determine condition of track. However, the system cannot detect small crack which this sensor has their own limit. It can detect 0.3cm difference depth on metal which is value of crack on track must be more than 0.3cm. Follow the literature review, small crack like 0.2cm can invite to train accident.

One of effective system need to design and build to ensure the system can detect small crack and become more precise to ensure the autonomous robot working perfectly. System also should be can record and save for long time period because in reality world, track of railroad can be reach to hundred kilometers from one station to other station. With this method, it will make railroad inspector become more efficient autonomous robot to detect defect on railroad other than fully automatic, portable, environmentally friendly, modern and unique and maintenance needed.

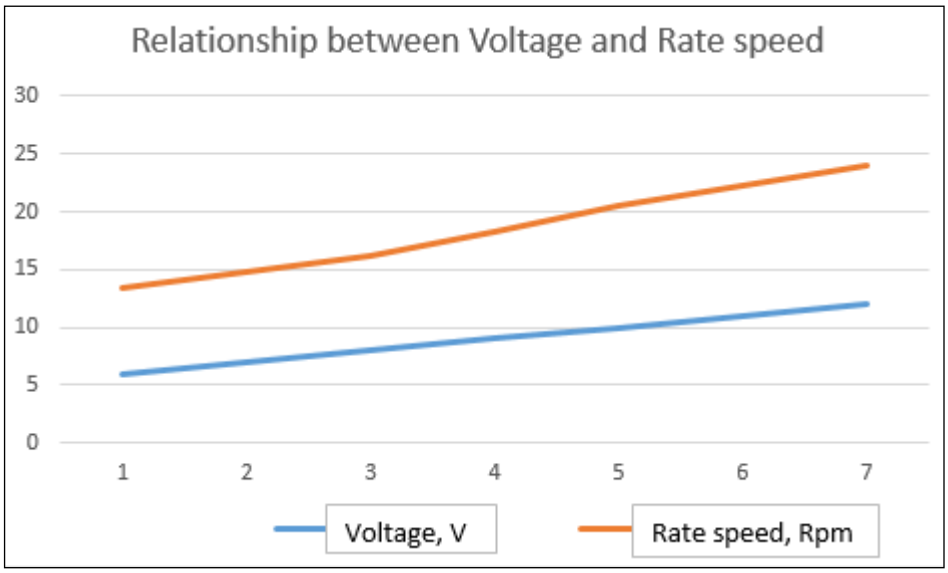


Figure 4.12: Graph voltage versus rate speed

From the graph (see **figure 4.12**), it clearly show that voltage proportional with rate speed which if voltage is increase, rate speed also increase. Maximum voltage for this type of dc motor is 12Volt where rate speed can be reach to 12Rpm. However, this system do not need higher rate speed but moderately because the ultrasonic sensor have their own limit. Reflect from transmitter to receiver has their own limitation or the system will not detect defect on railroad.

Second one, the graph (see **figure 4.13**) state that if ampere, (A) was increase, torque speed, (T) also increase which is both of this element always proportional with others. Carefully during increase the ampere because in can cause dc gear motor burn out. The suitable current for run this system is about 1.1 Ampere which the

autonomous robot in normal condition where railroad inspector not too fast and not too slow.

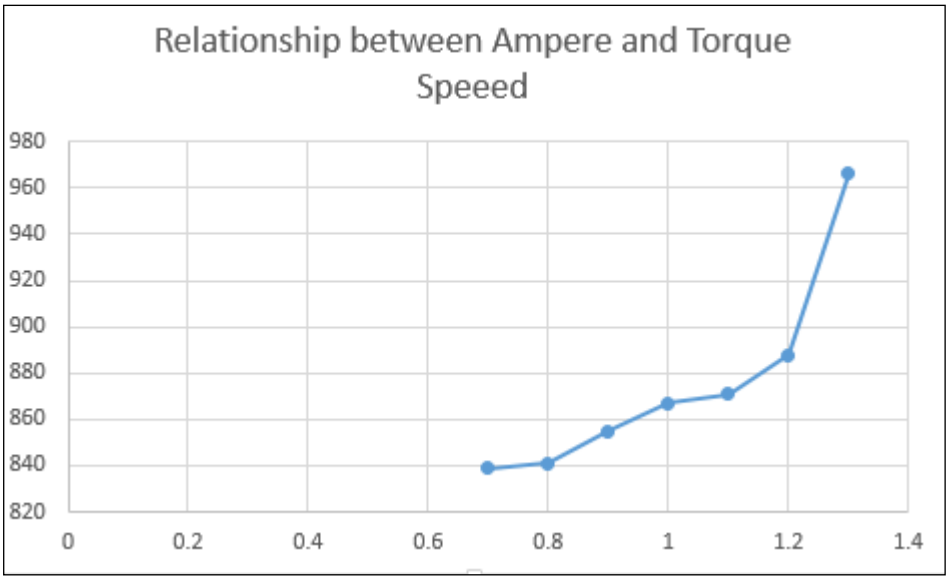


Figure 4.13: Graph ampere versus torque speed

CHAPTER 5

CONCLUSION AND RECOMMENDATION

5.1 INTRODUCTION

This chapter will summarize the outcome or discussion of the autonomous robot project and recommendation for the future development. The summarized outcome of the project is based on the result and achievement that has been discussed in chapter four. Upon the completion of the project, it can be concluded that the objective and the scope of research the project have successfully met as stated in chapter one, such as to find the design fundamental for basic of railroad model. Railroad Inspector is an autonomous robot which this robot can be travelling from one station to other station for collect to determine defect on railroad. By using Agilent Electronic instrumentation, it easier the process to determine condition of track.

5.2 CONCLUSION

As a conclusion, there are some loopholes in designing railroad inspector where the system should be modified so that the system becomes more efficient and effective. Though at a high cost to do the modification, but it is worth it for very effective results. In paced world of technology, there are some advanced countries such as U.S. and German laser sensor technology as the main medium for a development.

5.2 RECOMMENDATION

Overall, this project was a success with the majority of the system is perfectly working. There is still opportunity for refinement on some aspects of the system and after critical thinking the following improvements are suggested to anyone who would want to upgrade the system. Effective sensor can be used to replace ultrasonic sensor for make sure the system is working perfectly. Laser is the best sensor to replace ultrasonic sensor because it more effective and quietly precise which it can detect 0.001cm differences of depth than ultrasonic sensor. Light of sun or other light like lamp and sold on is not affected to this sensor because laser that beam from this sensor has their own criteria.

Figure 5.1: Laser sensor [21]

The light source of the sensor is infrared laser of wavelength 785nm with laser class 1 safety. Scan area is 240º semicircle with maximum radius 4000mm. Pitch angle is 0.36º and sensor outputs the distance measured at every point (683 steps). Laser beam diameter is less than 20mm at 2000mm with maximum divergence 40mm at 4000mm.

Table 5.1: Specification of laser sensor

Specification	Detail
Power source	DC 5V (from USB port)

Accuracy	0.001cm differences of depth
Limitation	Scanning range up to 5.6 meters
Scanning area	240 degree
Scan time	100 ms/scan
Weight	160 gram
Dimension	15mm(W) x 27mm(D) x 70mm(H)

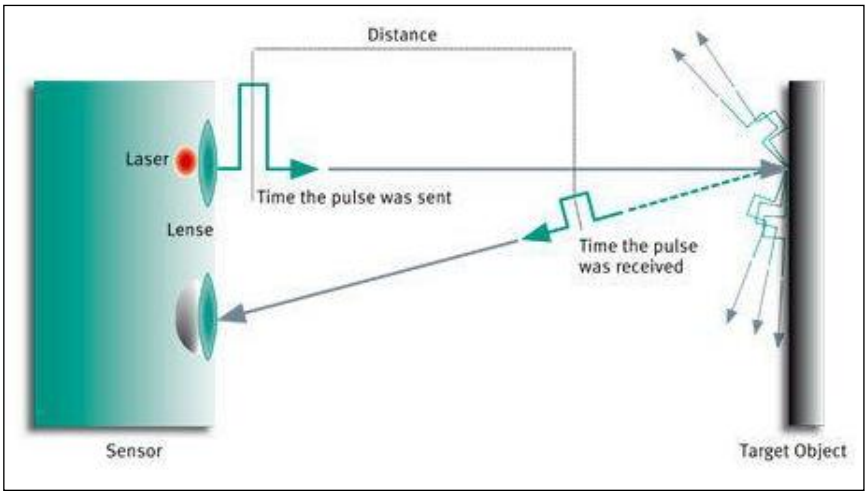


Figure 5.2: Principle working of laser sensor [22]

Principle of distance measurement is based on calculation of the phase difference, due to which it is possible to obtain stable measurement with minimum influence from object's color and reflectance. By using this type of sensor, small crack on track can be detected and simultaneously it can prevent future accident. Through the price is expensive but it very effective and suitable use to detect defect on railroad.

Also those, by using USB Modular DAQ (U2352A) can be to replace USB Modular Oscilloscope (U2701A) because this instrument can be save and record for long period than U2701A. It comes bundled with the Agilent Measurement Manager (AMM) software for quick set up and data logging. Simplifying this further is the command logger function offered in the Agilent Measurement Manager that allows capturing of configuration commands that can be easily converted to snippets of

VEE code. Other supported languages are VB, C++, and C#. To use this instrument, it need to connect with DAQ Terminal Block (U2901A) which this instrument will sent data to U2352A either analog or digital signal. Pin 68 need to connect with ground to avoid short circuit happen on this instrument and to prevent U2352A from ruinous.

Figure 5.3: U2352A [23]

The U2352A offers multifunction capabilities in a module. It can be used like a digital multimeter in polling mode. It can be transformed to be a simple scope using the continuous mode with simple triggering capabilities. No matter if it is used as a standalone module or when plugged into a U2781A USB modular instrument chassis, the synchronization and triggering capabilities allow great flexibility in making the desired measurements. The digital IO channels allows for closed loop control through connections to switches, relays and solenoids. The burst mode enables the U2352A to simulate simultaneous analog input acquisition.

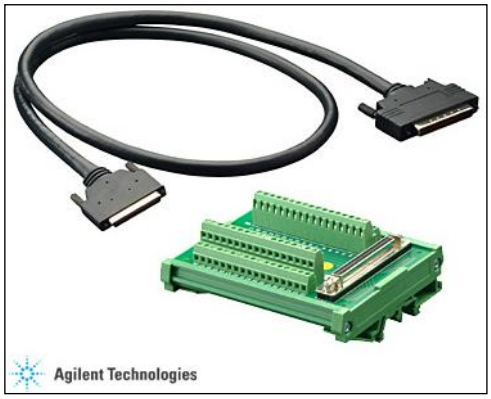


Figure 5.4: U2901A [24]

The U2901A is a terminal block and SCSI-II 68-pin connector with 1 meter cable or 2 meter cable that can be used conjunction with the U2352A Series. It consist 68 pin 22-34 and 56-68 for digital signal, then 1-68 for analog signal.

Figure 5.5: Interface instrument between U32352A, U2901A and PC [25]

When the ultrasonic detect defect on railroad, signal will sent to Arduino Uno before to display on LCD Display before sent to U2901A. From U2901A, signal will sent to U2352A for record and save data. This instrument can save and record for long time period for collect data from one station to other station. It make easier the engineer for determine location defect on railroad for troubleshoot the problem. It also can count how much defect on railroad from one station to other station for easier the department to spare part to bring on location.

By using this technique, railroad inspector can travel for more kilometers for checking railroad process. It fully using robot and prevent reveals the mind for several kilometer just for checking the defect on railroad is not easier jobalthough their effort is very thorough, the process can be extremely tedious, demanding, and time consuming. It also can provide negligence during checking process and the effect is there are several defect on railroad is failed to detect.

REFERENCES

1. Abbazasdeh (December, 2003). "Looking for flaws in all the right places.Railway Age"*Mechanisim, Physics and Mathematics vol. 203*. No.12. pp. 29–31.
2. Reinach and Gertler (Mei, 2002). "Science on particle industry" *Technology and Science* pp. 58-65
3. D.E. Bray (September, 1976). "Method of detect system deposing and edge enhancement Signal Process" *Sensor and Instrumentation at Industry* pp. 88 - 114.
4. Clark (July, 2004) "Progress in world of science" *Mechanics Properties* v. 43 pp. 218-245.
5. Erazo, Baumert and Ladwig (November, 2004). "Application of ultrasonic sensors in the process industry, measurement science and technology"*Creation of Frequency* pp. 73-78
6. Federal Railroad Administration (FRA, 2003). "Rules and Act Department of Railroad" Reason pp. 578-685
7. Bohmel and Klimpel (March, 2002). "Technique for determine crack on metal" *Material, Engineering and Properties*Press. ISBN 0703753071 pp. 215-219
8. Evans (October, 2010). "Programming for Arduino" *Arduino Programming* pp. 165-171
9. Symons (August, 1985). "Human and Sensitivity of Frequency**"** *Psychology and Human Fact* pp. 147-151
10. Schmidtke (February, 1994) "Animal and Human Sensor"*Compass of Universe* Press. ISBN 0521845270 pp. 155-167
11. Marais and Mistry (June, 2003) "Ultrasonic Sensor" *Advance in Mechanical Engineering* pp. 165-171 (2003)
12. Mc Carthy (July, 2007) "Amplitude, Frequency and Reflection" *Frequency and Desibel* pp. 247-251
13. Mr.Azman Ibrahim (3 May 2008) "Accident of Train" *Bernama.com*
14. Mr.Shahdan omar (August 2010) "Tragedy back to village" *http://greenboc.blogspot.com*

15. J. Callaway (September 2007) “Guide for Agilent Instrument” *http://www.unitest.com/meas_eq/gifs/u2701a_1.jpg*
16. George Fox University (August 2001) “Setup Power Supply” http://engr.georgefox.edu/Equipment/E3631A
17. GarageLab (May 19, 2012) “L293D H Bridge DC Motor Controller with Arduino” *http://garagelab.com/profiles/blogs/tutorial-l293d-h-bridge-dc-motor-controller-with-arduino*
18. Jeremy Armin (October 2001) “pin connection L293D” *http://obliblog.wordpress.com/2012/05/30/control-motor-arduino-l293d-chip/*
19. Stephanie K.Gillick (January 2006) “lm7805 function and characteristics” *http://www.robotgear.com.au/Product.aspx/Details/397-Voltage-Regulator-5V-LM7805*
20. Datasheet.com (June 1995) “LM7805 datasheet” *http://www.alldatasheet.com/datasheet-pdf/pdf/139342/FCI/LM7805.html*
21. PanasonicUSA.com (August 2004) “Low cost, M18 laser sensors that are suitable for basic laser applications” *http://pewa.panasonic.com/automation-controls/sensors/laser-sensors/m18-l/*
22. Southtechline.com (March 2009) “High speed laser sensor principle” *http://news.thomasnet.com/fullstory/High-Speed-Laser-Sensors-enable-2D-measurement-818030*
23. See Kan Tai (October 2001) “Specification of Agilent Instrument U235x, U23xx”*http://www.acquitek.com/agilent/u2352a-usb-modular-data-acquisition.html*
24. G.Kallay Young (February 2002) “U2901A pin connection” *http://www.newark.com/agilent-technologies/u2901a/cable-assembly-terminal-block/dp/32M0132*
25. A. Paul Hillmanton (July 2006) “Agilent USB Modular Instrument” *http://www.testequity.com/static/98/*

APPENDIX A

PROGRAMMING FOR ARDUINO UNO

```
#include "Ultrasonic.h"
#include <LiquidCrystal.h>
LiquidCrystal lcd(8, 9, 4, 5, 6, 7);
Ultrasonic ultrasonic1 (2,3);
Ultrasonic ultrasonic2 (12,13);
int signalU1 =A0;
int signalU2 =A1;
void setup() {
lcd.begin(16, 2);
lcd.setCursor(0, 0);
//lcd.print("checking progress");
 pinMode(signalU1, OUTPUT);
 pinMode(signalU2, OUTPUT);
delay(1000);
}

void loop()
{
//ultrasonic 1 program code
  if (ultrasonic1.Ranging(CM)>=3.0){
      lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Defect Detect ");
    lcd.setCursor(0, 1);
     digitalWrite(signalU1, HIGH);
    delay(100);
    digitalWrite(signalU1, LOW);
  }

//ultrasonic 2 program code
 else if(ultrasonic2.Ranging(CM)>=3.005){
```

```
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("Defect Detect 1");
lcd.setCursor(0, 1);
digitalWrite(signalU2, HIGH);
delay(100);
digitalWrite(signalU1, LOW);
}

else if ((ultrasonic1.Ranging(CM)<3.0)&& (ultrasonic2.Ranging(CM)<3.005))
{
lcd.clear();
lcd.setCursor(0, 0);
lcd.print("No Defect");
digitalWrite(signalU1, LOW);
digitalWrite(signalU2, LOW);
delay(100);
}


delay(1000);
}
```

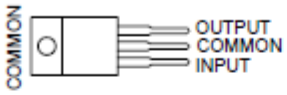
APPENDIX B

DATASHEET OF LM7805

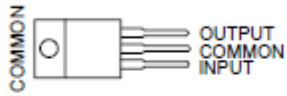
SLVS055J – MAY 1976 – REVISED MAY 2003

- 3-Terminal Regulators
- Output Current up to 1.5 A
- Internal Thermal-Overload Protection
- High Power-Dissipation Capability
- Internal Short-Circuit Current Limiting
- Output Transistor Safe-Area Compensation

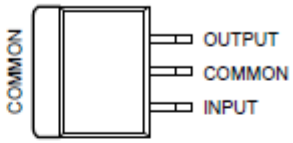
KC (TO-220) PACKAGE
(TOP VIEW)



KCS (TO-220) PACKAGE
(TOP VIEW)



KTE PACKAGE
(TOP VIEW)



description/ordering information

This series of fixed-voltage integrated-circuit voltage regulators is designed for a wide range of applications. These applications include on-card regulation for elimination of noise and distribution problems associated with single-point regulation. Each of these regulators can deliver up to 1.5 A of output current. The internal current-limiting and thermal-shutdown features of these regulators essentially make them immune to overload. In addition to use as fixed-voltage regulators, these devices can be used with external components to obtain adjustable output voltages and currents, and also can be used as the power-pass element in precision regulators.

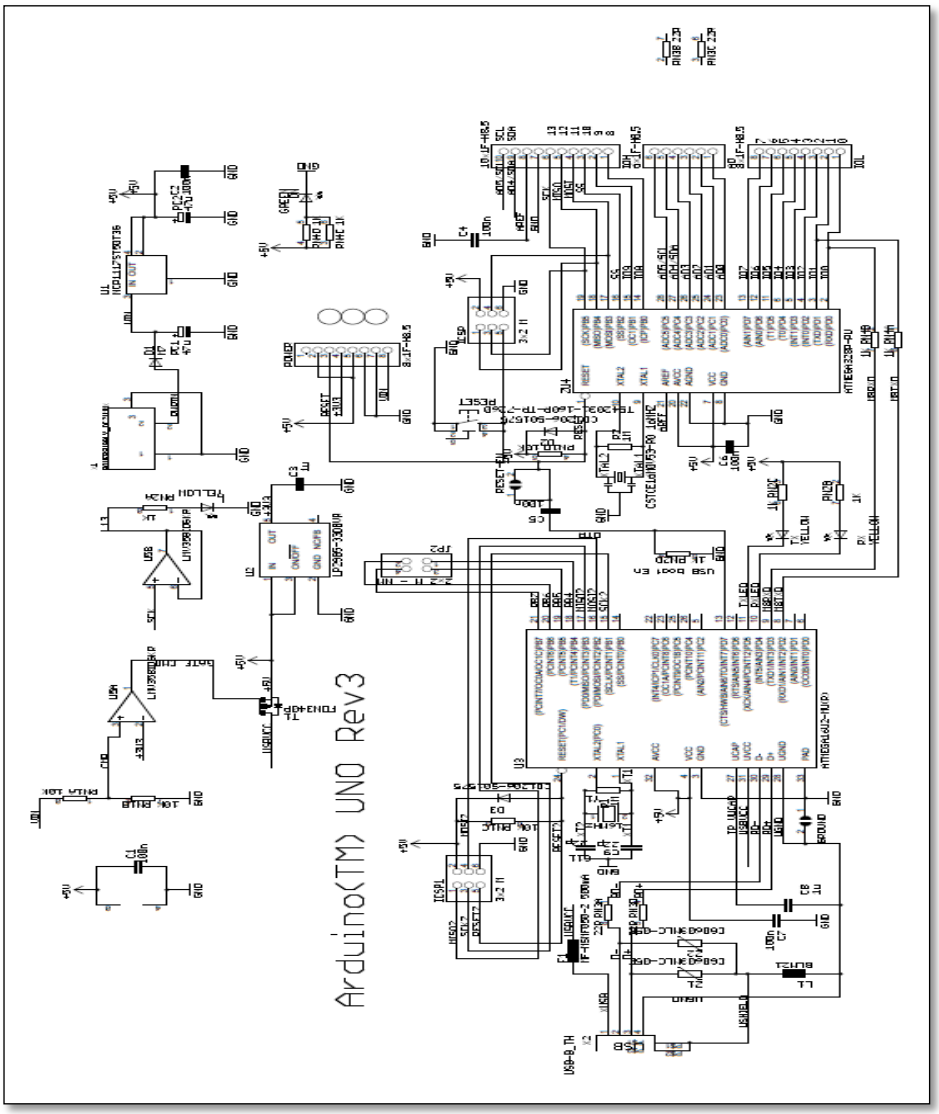
ORDERING INFORMATION

T_J	$V_{O(NOM)}$ (V)	PACKAGE†		ORDERABLE PART NUMBER	TOP-SIDE MARKING
0°C to 125°C	5	POWER-FLEX (KTE)	Reel of 2000	μA7805CKTER	μA7805C
		TO-220 (KC)	Tube of 50	μA7805CKC	μA7805C
		TO-220, short shoulder (KCS)	Tube of 20	μA7805CKCS	
	8	POWER-FLEX (KTE)	Reel of 2000	μA7808CKTER	μA7808C
		TO-220 (KC)	Tube of 50	μA7808CKC	μA7808C
		TO-220, short shoulder (KCS)	Tube of 20	μA7808CKCS	
	10	POWER-FLEX (KTE)	Reel of 2000	μA7810CKTER	μA7810C
		TO-220 (KC)	Tube of 50	μA7810CKC	μA7810C
	12	POWER-FLEX (KTE)	Reel of 2000	μA7812CKTER	μA7812C
		TO-220 (KC)	Tube of 50	μA7812CKC	μA7812C
		TO-220, short shoulder (KCS)	Tube of 20	μA7812CKCS	
	15	POWER-FLEX (KTE)	Reel of 2000	μA7815CKTER	μA7815C
		TO-220 (KC)	Tube of 50	μA7815CKC	μA7815C
		TO-220, short shoulder (KCS)	Tube of 20	μA7815CKCS	
	24	POWER-FLEX (KTE)	Reel of 2000	μA7824CKTER	μA7824C
		TO-220 (KC)	Tube of 50	μA7824CKC	μA7824C

† Package drawings, standard packing quantities, thermal data, symbolization, and PCB design guidelines are available at www.ti.com/sc/package.

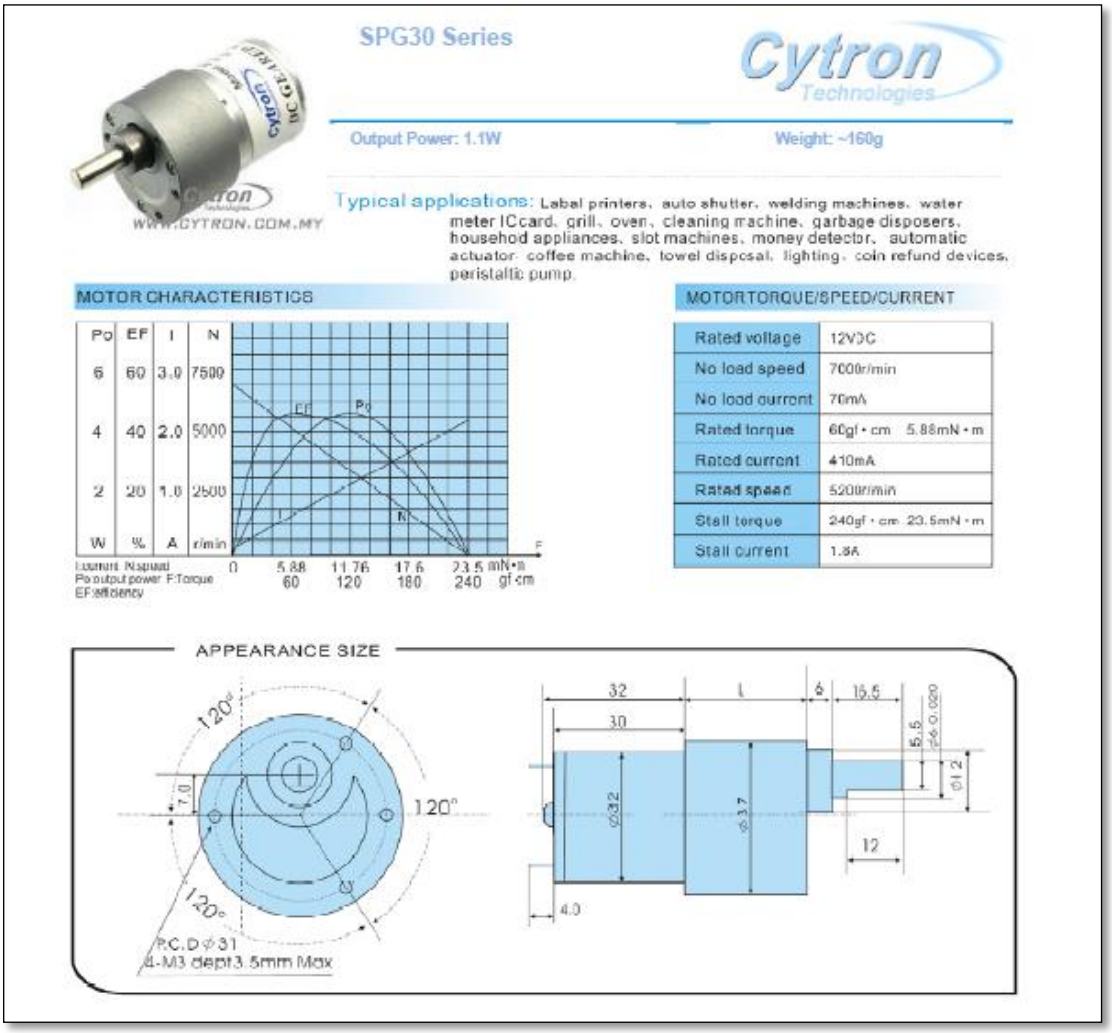
APPENDIX C

ARDUINO UNO CIRCUIT



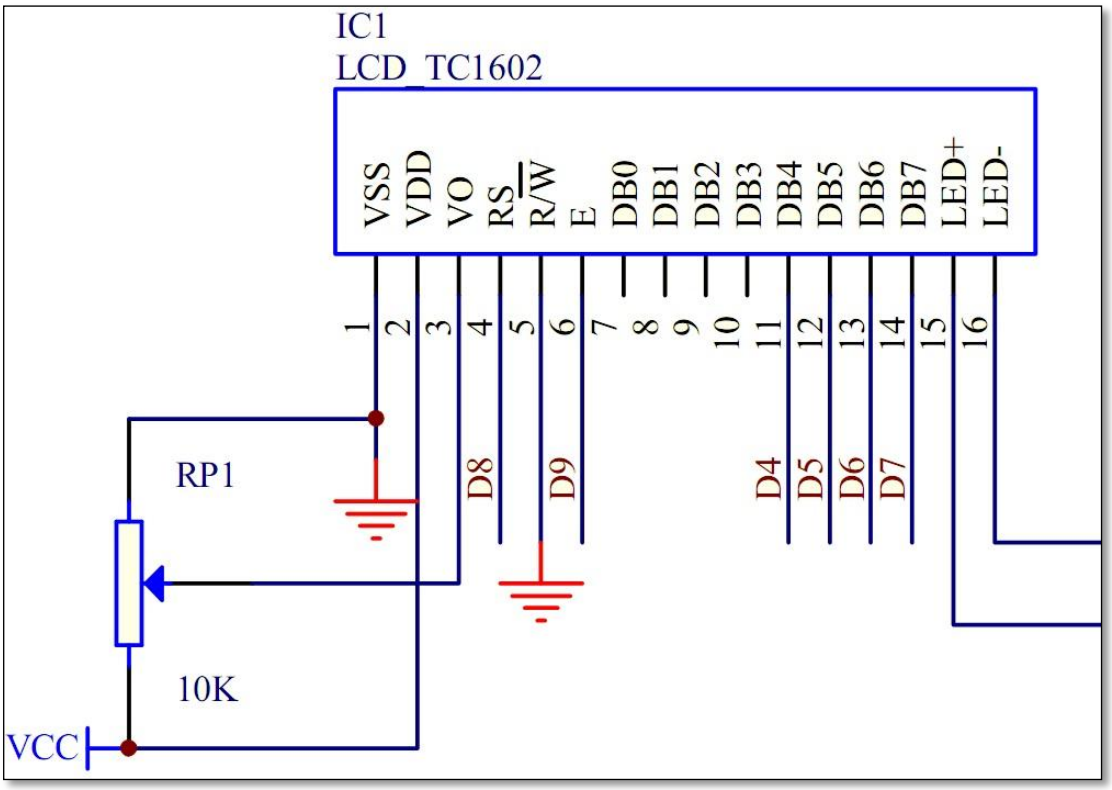
APPENDIX D

DC GEAR MOTOR SPECIFICATION



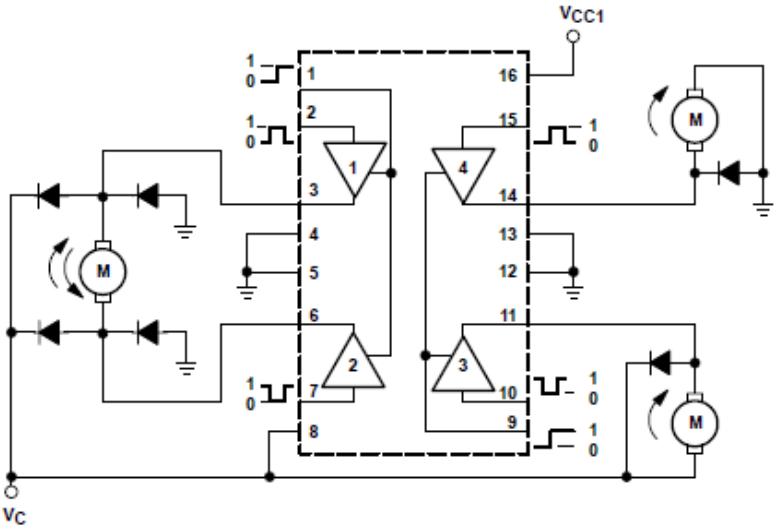
APPENDIX E

LCD DISPLAY PIN CONNECTION



APPENDIX F

L293 BLOCK DIAGRAM



NOTE: Output diodes are internal in L293D.

TEXAS INSTRUMENTS AVAILABLE OPTIONS

T_A	PACKAGE
	PLASTIC DIP (NE)
0°C to 70°C	L293NE L293DNE

APPENDIX G

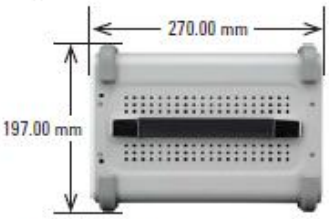
U2781A DATASHEET

Product outlook and dimensions

Front view

Rear view

Top view



Standard shipped accessories

- Power cord
- USB extension cable
- L-Mount kit (used with modular product chassis)
- Agilent Automation-Ready CD-ROM (contains the Agilent IO Libraries Suite)
- Agilent U2781A USB Modular Product Chassis Quick Start Guide
- Agilent USB Modular Products Reference CD-ROM
- Functional Test Certificate

Product characteristics and general specifications

REMOTE INTERFACE
- Hi-Speed USB 2.0*
- USBTMC-USB488[5]

POWER CONSUMPTION
- 400 VA maximum
- Installation Category II

OPERATING ENVIRONMENT
- Operating temperature from 0 °C to +55 °C
- Operating humidity at 15% to 85% RH (non-condensing)
- Altitude up to 2000 meters
- Pollution Degree 2
- For indoor use only

STORAGE COMPLIANCE
–20 °C to 70 °C

SAFETY COMPLIANCE
Certified with:
- IEC 61010-1:2001/EN 61010-1:2001 (2nd Edition)
- USA: UL61010-1: 2004
- Canada: CSA C22.2 No.61010-1:2004

EMC COMPLIANCE
- IEC/EN 61326-1 1998
- CISPR 11: 1990/EN55011:1991, Class A, Group 1
- Canada: ICES-001:1998
- Australia/New Zealand: AS/NZS 2064.1

ACOUSTIC EMISSION
- Sound pressure level: 45.5 dB(A)
- Sound power level: 56.6 dB(A)

SHOCK AND VIBRATION
Tested to IEC/EN 60068-2

DIMENSION (W × D × H)
270.00 mm × 271.20 mm × 197.00 mm (with bumpers)

WEIGHT
3.7 kg (without any modules slotted in)

WARRANTY
Three years for U2781A
Three months for standard shipped accessories

APPENDIX H

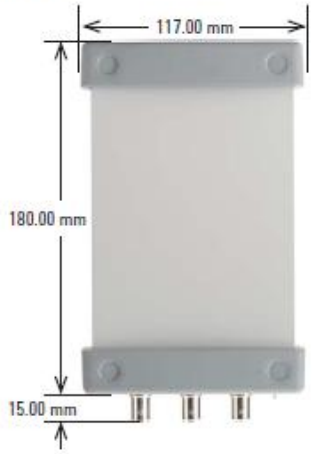
U2701A DATASHEET

Product outlook and dimensions

Front view

Rear view

Top view



Standard shipped accessories

- 12 V, 2 A AC/DC Power adapter
- Power cord
- USB Standard A to Mini-B interface cable
- 2 x 10:1 Passive probe 150 MHz 1.2m, N2862A (only applicable for U2701A)
- 2 x 10:1 Passive probe 300 MHz 1.2m, N2863A (only applicable for U2702A)

Product characteristics and general specifications

REMOTE INTERFACE
- Hi-Speed USB 2.0*
- USBTMC 488.2 Class device

POWER CONSUMPTION
- +12 VDC, 2 A
- Installation Category III

OPERATING ENVIRONMENT
- Operating temperature from 0 °C to +50 °C
- Operating humidity at 20% to 85% RH (non-condensing)
- Altitude up to 2000 meters
- Pollution Degree 2
- For indoor use only

STORAGE COMPLIANCE
- Storage temperature from –20 °C to 70 °C
- Storage humidity at 5% to 90% RH (non-condensing)

SAFETY COMPLIANCE

Certified with:
- IEC 61010-1:2001/EN 61010-1:2001 (2nd Edition)
- USA: UL61010-1: 2004
- Canada: CSA C22.2 No.61010-1:2004

EMC COMPLIANCE
- IEC 61326-1:2002/EN 61326-1:1998+A2:2001+A3:2003
- Canada: ICES-001:2004
- Australia/New Zealand: AS/NZS CISPR 11:2004

SHOCK AND VIBRATION

Tested to IEC/EN 60068-2

IO CONNECTOR

BNC connector

DIMENSION (W × D × H)

Module dimension:
- 117.00 mm × 180.00 mm × 41.00 mm (with bumpers)
- 105.00 mm × 175.00 mm × 25.00 mm (without bumpers)

WEIGHT
- 534 g (with bumpers)
- 482 g (without bumpers)

WARRANTY

One year for U2701A/U2702A

Three months for standard shipped accessories

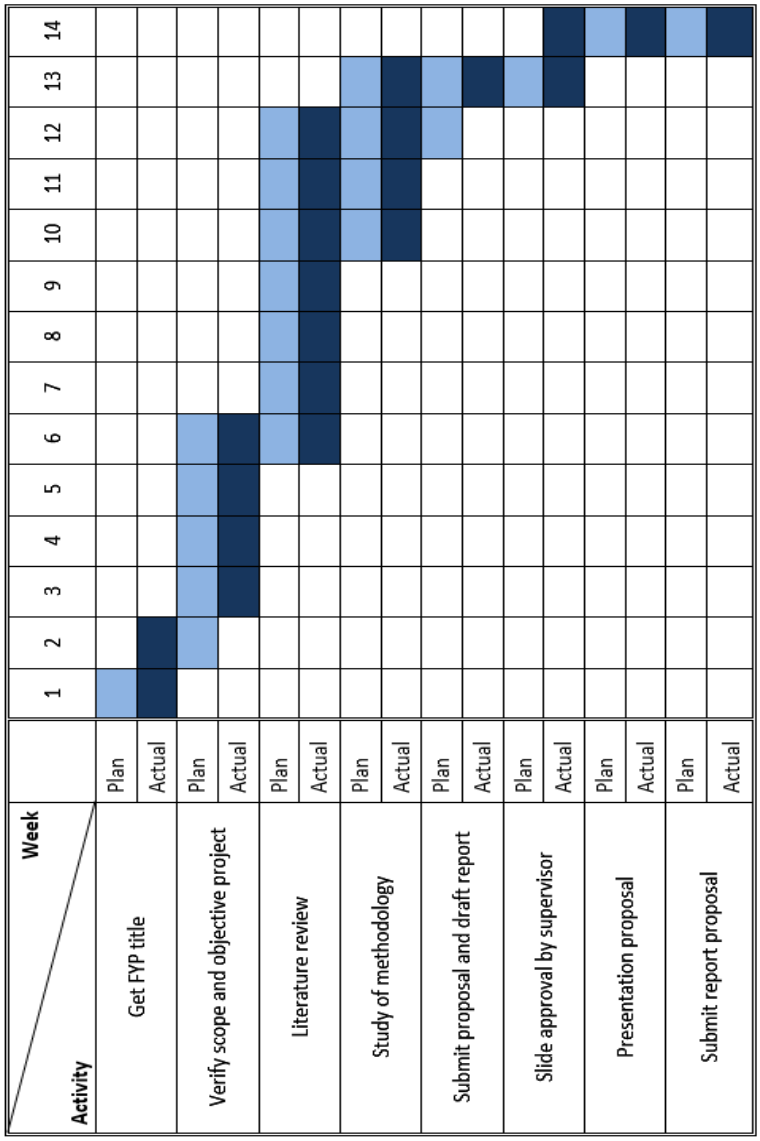
APPENDIX I

U2352A SPECIFICATION

Model Number	U2351A	U2352A	U2353A	U2354A
Analog Input				
Resolution	16 bits, no missing codes			
Number of channels	16 SE/8 DI (software selectable/ch)			
Maximum sampling rate	250 kSa/s		500 kSa/s	
Scan list memory	Up to 100 selectable channel entries			
Programmable bipolar input range	±10 V, ±5 V, ±2.5 V, ±1.25 V			
Programmable unipolar input range	0 to 10 V, 0 to 5 V, 0 to 2.5 V, 0 to 1.25 V			
Input coupling	DC			
Input impedance	1 GΩ / 100 pF			
Operational common mode voltage range	±7.5 V maximum			
Overvoltage protection	Power on: Continuous ±30 V, Power off: Continuous ±15 V			
Trigger sources	External analog/digital trigger, SSI/Star Trigger[1]			
Trigger modes	Pre- trigger, delay-trigger, post-trigger and middle-trigger			
FIFO buffer size	Up to 8 MSa			
Analog Output				
Resolution	16 bits	N/A	16 bits	N/A
Number of channels	2	N/A	2	N/A
Maximum update rate	1 MSa/s	N/A	1 MSa/s	N/A
Output ranges	0 to 10 V, ±10 V, 0 to AO_EXT_REF, ±AO_EXT_REF[2]	N/A	0 to 10 V, ±10 V, 0 to AO_EXT_REF, ±AO_EXT_REF[2]	N/A
Output coupling	DC	N/A	DC	
Output impedance	0.1 Ω Typical	N/A	0.1 Ω Typical	N/A
Stability	Any passive load up to 1500 pF	N/A	Any passive load up to 1500 pF	N/A
Power on state	0 V steady state	N/A	0 V steady state	N/A
Trigger sources	External analog/digital trigger, SSI/Star Trigger[1]	N/A	External analog/digital trigger, SSI/Star Trigger[1]	N/A
Trigger modes	Post-trigger and delay-trigger	N/A	Post-trigger and delay-trigger	N/A
FIFO buffer size	1 channel: Maximum 8 MSa 2 channels: Maximum 4 MSa/ch	N/A	1 channel : 8 MSa 2 channels : Maximum 4 MSa/ch	N/A
Function generation mode	Sine-wave, square-wave, triangle, sawtooth and noise waveform	N/A	Sine-wave, square-wave, triangle, sawtooth and noise waveform	N/A

APPENDIX J

GANTT CHART FOR FYP 1



APPENDIX K

GANTT CHART FOR FYP 2