DESIGN AND DEVELOPMENT ON AUTOMATED PNEUMATIC BUMPER DRIVEN BY BRAKE ACTUATION

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DESIGN AND DEVELOPMENT ON AUTOMATED PNEUMATIC BUMPER DRIVEN BY BRAKE ACTUATION

ABSTRACT

The key concern of this project is the design and development of the technology of pneumatics which plays a major role in the field of automation, modern machine shops and space robots. The aim is to develop a control system based on intelligent and electronically controlled pneumatic bumper and braking system. This project consists of ultrasonic transmitter and receiver circuit, control unit, solenoid valve, pneumatic bumper system and pneumatic braking system. The ultrasonic sensor senses the obstacle closer to the vehicle (within 4-7 feet), then the control signal is given to the pneumatic bumper as well as pneumatic braking system simultaneously. This bumper and braking system is activated only when the vehicle speed is above 40-50 km per hour. This vehicle speed is sensed by the ultrasonic sensor and it is given to the control unit. The control unit controls the solenoid valve so that the pneumatic bumper and braking system is actuated.

MENGKAJI DAN MEMBANGUNKAN TEKNOLOGI PNEUMATIC BERDASARKAN SISTEM BUMPER PNEUMATIK DAN SISTEM KAWALAN BREK YANG BIJAK DAN ELEKTRONIK

ABSTRAK

Kebimbangan utama projek ini adalah untuk mengkaji dan memajukan teknologi pneumatik yang memainkan peranan utama dalam bidang automasi, kedai mesin moden dan robot ruang. Tujuannya adalah untuk membangunkan sistem kawalan berdasarkan sistem bumper pneumatik dan sistem kawalan brek yang bijak dan elektronik. Projek ini terdiri daripada litar pemancar dan penerima ultrasonik, unit kawalan, injap solenoid, sistem bumper pneumatik dan sistem brek pneumatik. Sensor ultrasonik merasakan penghalang dekat dengan kenderaan (dalam jarak 4-7 kaki), maka isyarat kawalan diberikan kepada bumper pneumatik serta sistem brek pneumatik secara serentak. Sistem bumper dan brek ini diaktifkan hanya apabila kelajuan kenderaan melebihi 40-50 km sejam. Kelajuan kenderaan ini dirasakan oleh sensor ultrasonik dan ia diberikan kepada unit kawalan. Unit kawalan mengawal injap solenoid supaya sistem bumper pneumatik dan brek digerakkan.

ACKNOWLEDGEMENTS

I hereby want to say thanks to University of Malaya for giving me an opportunity to carry out this research which definitely will improvise my technical career in future. Very importantly, I also want to thank my supervisor **Assoc. Prof. Dr. Farazila Binti Yusof**, who have provided a great supervisory work and given lots of useful feedback during the progression of my project. His advice, guidance and supports are deeply appreciated by me. I would have not successfully completed this project without his help. Next I would like to express sincere gratitude to my friends and engineers for helping and guiding me in the process of getting a better understanding of my project requirements and also getting basic information for my project. Last but not the least, many thanks to my family members and friends as well who directly or indirectly have helped me to complete the report.

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CHAPTER 1: INTRODUCTION

The achievement of automation can be via robotics, pneumatics, computers, hydraulics, etc., among all the listed sources, a medium of attraction for less expensive automation is formed from pneumatics. It is also important to note that economy as well as simplicity are the major benefits of all pneumatic systems. Hence, in mass production, an essential role is being played by Automation. The roles played are:

- To ensure mass production achievement.
- To ensure the reduction of man-power.
- To make sure that the plant's efficiency is increased.
- To ensure work load reduction.
- To ensure reduction in the cost of production.
- To ensure reduction in the time taken to produce.
- To ensure reduction of the material handling.
- To help in reduce workers' fatigue.
- To ensure the achievement of a good quality of product.
- To lessen the process of Maintenance.

1.1 Pneumatic system

With regards to the performance of mechanical works, for a long time now, a vital role has being played by Pneumatics as a technology. Also, it has being made use of in developing automated solutions. There is a similarity between the hydraulic system and the Pneumatic system, however the use of compressed air is replaced with hydraulic fluid in these systems. Furthermore, a system can be referred to as pneumatic if it uses compressed air for the control and transmission of energy. These systems are made use of in diverse industries to a large extent. They are provided via a compressor of air. Air

is being sucked in by the compressor from the atmosphere and then get stored in a receiver which is also called a high pressure tank. The air that has been compressed then gets supplied to the system via different valves and pipes.

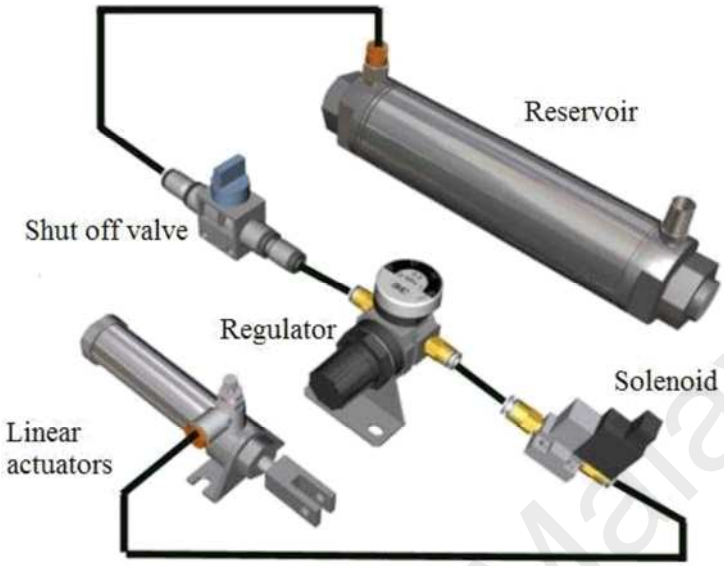

Figure 1.1: Basic pneumatic system

The term ‘Pneuma’ refers to air. The overall idea of Pneumatics is the use of compressed air in performing a work. Moreover, compressed air can be referred to as the air obtained from the atmosphere that has been lessened in volume via compression, hence leading to its increase in pressure. It is also utilized as a medium of working which is usually from a pressure of 6 kg/sq mm to 8 kg/sq mm. A maximum force of about 50 kN could be developed in order to use pneumatic systems. It is important to state that the controls’ actuation can be done manually, that is could be either electrical actuation or pneumatic. The air that has been compressed is majorly used to perform work via acting on a vane or piston. However, such kind of energy is utilized by diverse aspects of the steel industry.

1.2 Problem Statements

Rigorous efforts are made by researchers and vehicle manufacturers to improve the efficiency on improving automated breaking system in order to minimize accident made by human. One of the method used is to develop a control system based on intelligent and electronically controlled pneumatic bumper and braking system. However, many studies conducted focus mainly on autonomous emergency braking systems.

1.3 Objective

The proposed system consists of an Ultrasonic sensor, this sensor senses the obstacle in above 4 to 7 feet when the vehicle runs above 40-50 km per hour and also its sense the obstacle in the wide area of the path within the distance it can sense the obstacle so as to control the bumper and braking mechanism.

1.4 Scope of the Project

The scope of the project is to compare the existing system and propose a new system. As a conclusion, the overall design and fabrication, are analysed and upgrading is done for the overall pneumatic system's efficiency.

1.5 Components of pneumatic system

The movement and force for majority of the pneumatic systems is being provided by air motors, pneumatic cylinders and rotatory actuators and this is used to hold, move, form and process materials. In operating and controlling of these actuators, additional pneumatic constituents needs to be in place such as, units of air service for compressed air preparation and valves for pressure control, direction as well as flow of the actuators movement. There are two major sections by which a fundamental pneumatic system is

consisted of. They are: 1) compressed production of air, transportation and system of distribution, 2) compressed system for the consumption of air.

The major constituents of the production of the compressed air, transportation as well as the system of distribution comprises electric-motor and centre for motor control, compressor of air, pressure switch, storage tank, auto-drain, check-valve, pressure-gauge, dryer of air, air-lubricator, pipelines, filters, and diverse kinds of valves.

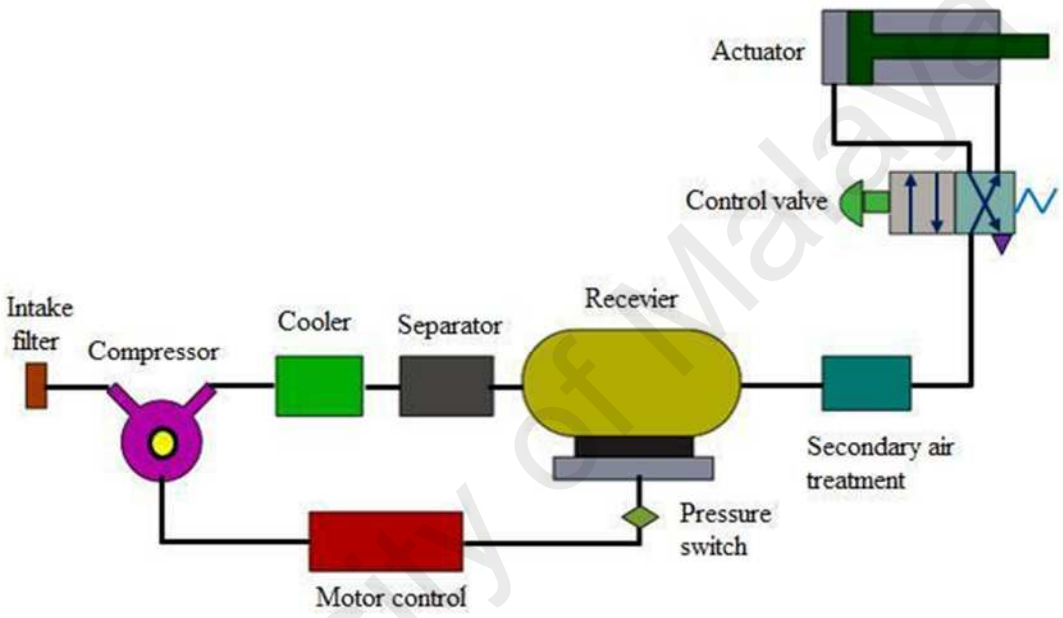

Figure 1.2: Main components of pneumatic system

1.5.1.1 Intake filter

The purpose of an intake filter which is also referred to as an air filter is for the filtering out of contaminants from the air.

1.5.1.2 Compressor

An air compressor is responsible for the conversion of a combustion or an electric motor's mechanical energy into the compressed air's potential energy. Different kinds of compressors are being made use of in the systems of compressed air.

A compressor that is used for generating compressed air is chosen based on the preferred maximum pressure of delivery and the needed air-flow rate. However, in compressed air systems, the kinds of compressors therein are:

i) Piston or reciprocating compressors
    a) Single stage or double stage piston compressor
    b) Diaphragm compressor
ii) Rotary compressors
    a) Sliding vane compressor
    b) Screw compressor
iii) Centrifugal compressors
iv) Axial flow compressors

1.5.1.3 Electric motor

The transformation of electric energy into mechanical energy is done by an electric motor. It can also be used for the driving of the air compressor.

1.5.1.4 Receiver

The air receiver serves as a storage place for the compressor's obtained compressed air. The aim of the air-receiver is to ensure smoothness in the compressor's pulsating flow. Also, it serves as an aid to the air for cooling and condensing the present moisture.

1.5.1.5 Cooler and separator

In order to ensure that the pneumatic system is being operated satisfactorily, there is need for cleaning and drying the air. This is because air in the atmosphere is humid in nature and is contaminated with smoke and dust. Such particles could lead to the wearing of the system components and corrosion might be caused by the presence of moisture. Therefore, to be able to get rid of such impurities, air treatment is very

important and a necessity. In the course of the operation of compression, there is an increase in the temperature of the air.

1.5.1.6 Secondary air treatment

Air treatment can be split into three phases. The 1st phase deals with the prevention of large-sized particles from getting into the air compressor via an intake-filter. The air that escapes out of the compressor might be humid in nature and might also have a high temperature. In the 2nd phase, treatment of the compressed air from the compressor occurs. In this phase, there is a reduction of the compressed air's temperature via the use of a cooler and a dryer is used to dry the air. Furthermore, a system for air-drying could be absorption type, refrigeration type, adsorption type, or a kind that makes use of semi-permeable membranes. There is also the provision of an in-line filter for purpose of removing any existing contaminant particles. Such treatment is referred to as basic treatment of air. However, in the 3rd phase, also referred to as the secondary process for air treatment, additional filtering is conducted.

1.5.1.7 Lubricator

The lubrication of a cylinder's moving parts as well as the valves is of much essentiality in a pneumatic system. Due to this, compressed lubricators of air are utilized before the pneumatic equipment. A fine oil mist is being introduced into the compressed air by the lubricator. This however assists in lubricating the system's moving components of which application is being made by the compressed air. About 20-50 centistokes of kinematic viscosity is being agreed to be the accurate grade for oil lubrication.

1.5.1.8 Control valve

Control valves are used for the control, regulation, and monitoring of the flow of direction, pressure, and others. A control valve's key function is the maintenance of

continuous down-stream pressure in the air-line, not minding the variances in the upstream pressure. As a result of the compressed air-flow's high velocity, there exists a dependent flow of pressure drop in the midst of the load (application) and the receiver. Therefore, the receiver's pressure is continuously kept at a higher point than the pressure of the system. In the site of the application, in order to keep it fixed, there is a regulation of the pressure. Three mediums for the controlling of local pressures exists and they are provided thus. The 1st method ensures that air is being vented into the atmosphere regularly by the load. Hence the airflow to the load is being restricted by the pressure-regulator, thereby regulating the air-pressure. For this kind of pressure-regulation, some minimal flow is needed for the regulator to be operated. However, if the load is a type that is dead-end and does not draw any air, the receiver's pressure will rise to a quite high pressure. Such kinds of regulators are referred to as: 'non-relieving regulators', due to reason being that there must be a flow of air via the load. In the 2nd type, the load is seen as a dead-end load. Nevertheless, in order to ensure reduction in pressure, there is a venting of air to the atmosphere by the regulator.

1.5.1.9 Actuators

Actuators like motors and air-cylinders are used for obtaining the needed movements of pneumatic system's mechanical elements. Actuators refer to output devices that ensures energy conversion from a compressed air to the needed kind of motion or action. Generally, pneumatic systems are used in different industries to move and grip operations. Those operations are being executed via the use of actuators. Typical pressure of hydraulic cylinders is around 100 kg/sq mm, while that of pneumatic cylinders is approximately 10 kg/mm^2.

1.5.2 Advantages of pneumatic system

Pneumatic systems are extensively used in diverse industries to drive automatic machines. Hence, these systems have many advantages, some of which have been explained below:

a) **High effectiveness:** An unrestricted supply of air exists in the atmosphere for the production of compressed air. Furthermore, it is possible to easily store items in big volumes. The usage of compressed air is not limited by distance, due to the fact that it can be easily transported via pipes. After its usage, the air that is compressed can be directly released to the atmosphere without having the need to process.

b) **High durability and reliability:** The components of the pneumatic system are of much durability and are not easy to damage. Furthermore, they are much more reliable and durable when put in comparison with electromotive components.

c) **Simple design:** Designs of the components of pneumatic systems are of relative simplicity. Hence, they are more appropriate to use in easy-going automated control systems. With operational speeds that are of continuous variability and simplicity, a choice of movement like angular movement of rotation or linear movement are available.

d) **Safety aspects:** Unlike electro-motive systems, there is a higher level of safety with the pneumatic systems, this is due to reason being that they have the ability to work in an environments that is flammable without instigating explosion or fire outbreak. Not only that, also pneumatic system's overloading only results to operation termination or sliding. The components of the pneumatic system doesn't get

overheated or burned when being overloaded unlike an electromotive system's components.

e) **Environmental friendly:** The production of pollutants does not occur during the operation of a pneumatic system. Also, these systems maintain a neat environment and undergo appropriate treatment of air exhaust which could be installed for the cleaning of room standards. Hence, pneumatic systems have the ability to perform well in environs with a high level demand of neatness/cleanliness. One of such examples is integrated circuits lines of production.

1.5.3 Limitations of pneumatic system

Even though a lot of benefits are being possessed by pneumatic systems, yet they still have numerous limitations. Such limitations are presented below:

1. **Relatively low accuracy** – Due to reason being that the powering of pneumatic systems are done with force enacted by the compressed air, hence the compressed air's operational volume determines their operation. Knowing well that when air undergoes heating or compression, its volume might change, the system's air supply might also not be accurate which could lead to a reduction in the systems overall accuracy.
2. **Processing required before use** – It is mandatory for compressed air to undergo some processing before it is used, this is to make sure that dust or water vapour are absent. If this is not done, it could cause the pneumatic components to rapidly wear-out because of friction.
3. **Uneven moving speed** – There is a relative unevenness in the moving speeds of a piston because it is very easy for air to be compressed.
4. **Noise** – There is a usual production of noise when the pneumatic components releases air that is compressed.

1.5.4 Applications of pneumatic system

Numerous applications are available for pneumatic systems. Some of such applications are: process equipment's operation, operations of forming, riveting, welding/brazing holdings, fixtures and jigs holdings, spray printing, objects moving and lifting, pneumatic rammers, machine tools, bins and hoppers unloading, chemicals or water, air system valves operation, pneumatic drills and pneumatic presses, etc. Other specific applications are explained below:

- Previously, air brakes on trucks and buses are known to be air-brake systems that are compressed. However, these systems makes use of a kind of friction brake wherein compressed air is being pressed on a piston, and then the pressure is applied to the brake pad which eventually stops the vehicle.
- Pneumatic systems can be the building base for machines that are used for exercise. An air-pressure adjustable resistance can be created by a pneumatic cylinder.
- In the measurement of liquids or gases, pressure sensors are utilized.
- Expandable structures like: bouncy castles, blown-up figures or balloons are being inflated with a gas-air, nitrogen, hydrogen or helium. Also the gas pressure retains the inflation of the structure.
- Compressed air is used to create pneumatic tires so as to form and inflate a tyre's body on either a car, bike or any other vehicle.
- A jack-hammer that is hand-held is a tool which combines both a chisel and a hammer, and compressed air is normally used to power it.

1.6 Pneumatic actuators

Pneumatic actuators are devices which are used to convert the pressure of a compressed air energy into the mechanical energy so as to ensure the performance of

useful work. In other terms, actuators are used for task performance that exerts the needed force at the end of a stroke or they are used for the creation of displacement via the piston's movement. This pressurized air obtained from the compressor is then supplied to the reservoir. Furthermore, the storage-obtained pressurized air is supplied to the pneumatic actuator in order to perform task. The air cylinder is an efficient and easy device which is used to provide straight-line motions or linear thrust with a quick rate of response. Friction losses are low and sometimes exceeds 5 percent (%). They are also appropriate to be used under conditions that excludes the usage of hydraulic cylinders which are at a high ambient temperature of about 200 to 250^{0}C. Actuators can be categorised into three and they are:

a) Linear actuators: These deals with the conversion of pneumatic energy to linear motion.
b) Rotary actuators: They deal with the conversion of pneumatic energy to rotary motion.
c) Actuators to operate flow control valves: They are used for controlling the pressure and flow of fluids like steam, liquids or gases.

1.6.1 Types of pneumatic cylinders /linear actuators

Pneumatic cylinders refer to devices that are used to convert air pressure to linear mechanical motion and force. These cylinders are used mainly for single application purposes like turning, bending, metering, tilting, branching, allocating, ejecting, transferring, stamping, clamping and a lot of other applications. The diverse schemes of classification of pneumatic cylinders are presented as follows:

1. Based on application for which air cylinders are used
    i) Light duty-air cylinders
    ii) Medium duty-air cylinders

iii) Heavy duty-air cylinders

2. Based on the action of the cylinder

   i) Single-acting cylinder

   ii) Double-acting cylinder

3. Based on the movement of the cylinder

   i) Rotating type air cylinder

   ii) Non-rotating type air cylinder

1.6.1.1 Based on the cylinder action

With regards to the action of the cylinder, the cylinders can be classified as double acting and single acting. Cylinders with single acting have a single line of air inlet, while those that are double acting cylinders have dual lines for the inlet of air. The advantages of double acting cylinders over the single acting ones are given below:

i. For single acting cylinders, the compression of air is just fed at one side. Therefore, such cylinders can only work in one direction, however in the case of a double acting cylinder, the air that has been compressed shifts the piston in dual directions so that they can work in the two directions.

ii. In a single acting cylinder, there is a limit in the length of the stroke by the spring's compressed length. However in principle, the length of the stroke is not limited in a double acting cylinder.

iii. In a single acting cylinder, the spring's pressure has to be overcome by air while the piston moves forward and therefore some strength is displaced even before the commencement of the actual piston stoke. However such problem does not occur in a double acting cylinder.

(A) Single acting cylinder

A single acting cylinder only has one port for performing tasks. Moreover the pistons forward motion is achieved through the supply of the compressed air to the port that is working. The piston's return motion is gotten by the spring placed on the cylinder's rod side. A schematic diagram of a single acting cylinder is being depicted in Figure 1.3. Furthermore, single acting cylinders are made use of in situations whereby the exertion of force is needed in just one direction. Examples of such situations are braking, sorting, locking, ejecting, and clamping, among others.

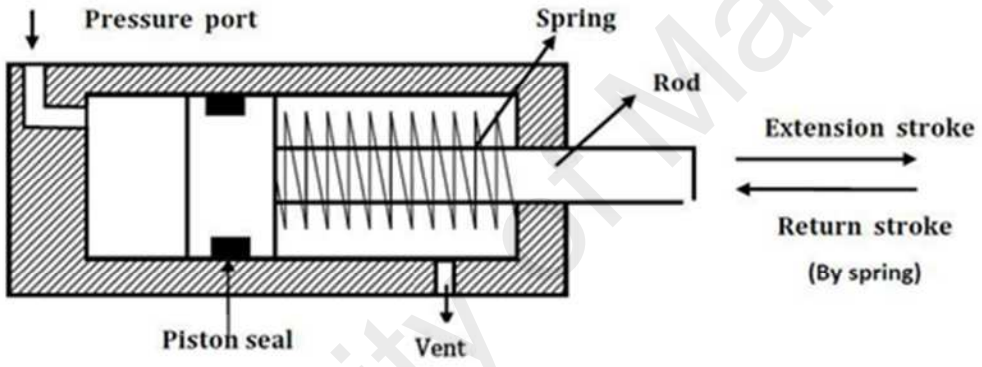

Figure 1.3: Single acting cylinder

(B) Double acting cylinder

A schematic diagram of a double acting cylinder is displayed in Figure 1.4. Double acting cylinders are fortified with dual ports for working, with one at the piston side and the other at the rod side. In order to achieve the cylinder's forward motion, there is an admission of compressed air on the side of the piston and a connection of the rod side to the exhaust also occurs. In the course of a return motion, there is an admission of the supplied air at the rod side whereas the volume of the piston side is connected to the exhaust. Also, an exertion of force occurs by the piston in the course of both return and forward motion of the cylinder. Double acting cylinders are available in diameters from

a few millimetres (mm) to about 300 mm and stroke lengths of a little mm up to around 2 meters.

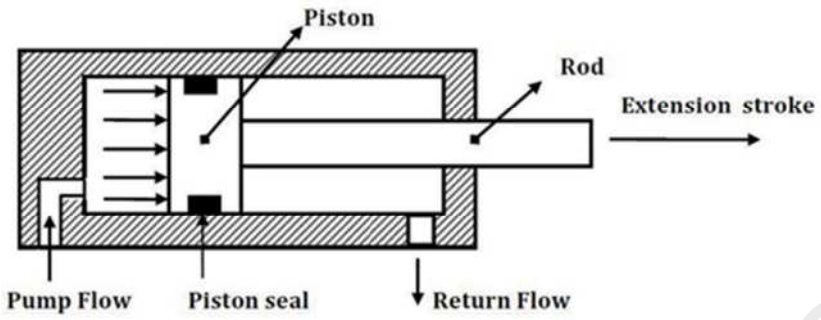

Figure 1.4: Double acting cylinder

1.7 Solenoid valve

A solenoid valve refers to a valve that is controlled electromechanically. A solenoid is being featured by the valve, which is an electric coil that has in its centre a moveable ferromagnetic core, and this core is called the plunger. In the position of rest, a small orifice is closed off by the plunger. Also, a magnetic field is being created by an electric current that flows through the coil. This magnetic field applies force on the plunger, and due to that force, the plunger is being pulled towards the coil's centre so as to open he orifice. This is the basic principle which is used for the opening and closing of the solenoid valves. A solenoid valve is also an electromechanically actuated valve used for the controlling of gases and liquids flow.

Furthermore, one of the most-frequently used control elements with regards to fluidics is solenoid valves. Their duties are the shutting off, releasing, dosage, distribution or mixing of fluids and they are found in several areas of application. They also provide secured and fast switching, long life of service, high reliability, good compatibility medium of used materials, less control of power and compact design.

Figure 1.5: Solenoid valve

1.7.1 Advantages of solenoid valve

- Fast operation
- High reliability
- Long service life
- Compact design

1.7.2 Applications of solenoid valve

a) **Commercial appliances:** Valves are mainly switches, the only difference is that while the mechanical devices are being controlled by the former, the electrical devices are being controlled by the latter. However, hydraulic fluids flow is being controlled by the solenoid valves and they mostly operate at pressures of about 3000 psi. Hence the movement of oil to the rams or actuators is being controlled by the solenoids as well.

b) **Automobile industry:** Solenoid is a vital aspect of the starter system and automobile ignition. In a normal situation, just a little current from the ignition is being received by the starter and an extensively large current is being received from the battery of the car.

c) **Electromechanical solenoids:** These solenoids comprises of an electromechanical inductive coil and are wounded about an armature. Furthermore, the wounding of the coil is for the purpose of enabling the movement of the armature from its mean point and hence making it to become and electromagnet via the inductance of the coil.

1.8 Brake

As a result of a vehicle's motion, there is a dissipation of the kinetic energy in form of heat energy because of friction amidst the moving parts (that is: wheel drum or wheel) and the stationary parts of the vehicle (brake shoes). Therefore, it is a necessity to have braking system in an automobile to enable the vehicle to be able to stop. The application of brakes on the wheels is for the slowing down or stoppage of a vehicle.

1.8.1 Functions of brake

There are two main functions of brakes:

- For slowing down or stopping the vehicle at the possibly shortest time when the need arises.
- For the controlling of the vehicle's speed at bends and also at periods when driving down on a sloppy hill.

1.8.2 Classification of brake

a) Based on the actuation method
   - Foot brake
   - Hand brake

b) Bases on the mode of operation
   - Mechanical brake
   - Hydraulic brake
   - Air brake

- Vacuum brake
- Electric brake

c) Based on the front or rear wheel's action

- Front wheel brake
- Rear wheel brake

d) Based on the braking contract's application method

- Internally expanding brake
- Externally contracting brake

1.9 Sensor

A sensor is referred to as device which is able to detect and respond to some kinds of physical environmental input. Precise input can be heat, moisture, pressure, light, or any other phenomena of an environment. Thus, the output form a general point of view is a converted signal of a readable human display located at the sensor or electronically transmitted via a network for further processing or reading.

1.9.1 Sensor fundamentals

a) **Range**: All kinds of sensors are designed to be able to work via a precise range. These design ranges are normally fixed, and if the go beyond the normal fixed point, it will lead to permanent damage or to a sensor being destroyed. It is therefore normal to make use of transducing elements via just the portion of their range where predictable performance is being provided by them and most times enhanced linearity.

b) **Zero**: In the process of the making of a measurement, it is very important to begin at a datum that is known, and it is also most times convenient to adjust the instruments output to zero at the datum. Hence, this value is one which is ascribed to some definite points in the ranges that are measured.

c) **Zero drift**: There might be variance in the level of signal from the original set value of zero during the working period of the sensor. This initiates an error into the measurement which is equivalent to the varied amount, or 'drift' as it's usually referred to. More so, the drift in zero might be due to changes in temperature, stabilization of electronics, or even the transducer's age or electronic components.

d) **Linearity**: The sensor with the most conveniences for usage is the linear transfer function sensor. In this case, it involves a direct proportion of the output to the input via the overall range, thereby describing a straight line through the output graph slope versus that of the input.

1.9.2 Types of sensor

Diverse kinds of sensors are available to select from and for purpose of the research, the characteristics of a few sensors has been identified below. Also, the comprehension of why and where they are used is also explored.

1.9.2.1 Sound sensor

As the name suggests, this sensor (generally a microphone) is responsible for the detection of sound and hence returns a voltage that is proportional to that of the level of sound. A simple robot could be designed for navigation based on the received sounds. Take for instance a robot that turns to the right for one hand clap and then turns to the left for two hand claps. Fortunately even a complex robot can make use of the same microphone for the recognition of both speech and voice.

1.9.2.2 Proximity sensor

This kind of sensor can detect that a close-by object is present within a known distance, and without contacting any physical object. A proximity sensor's working principle is quite simple. An electromagnetic radiation is being transmitted by a transmitter or an electrostatic field is being created by a transmitter and then the

transmitter analyses the return signal to find out if interruptions exists. There are diverse kinds of proximity sensors and a few of them which are used generally in robots shall be discussed.

a) **Infrared (IR) transceiver**: A beam of IR light is being transmitted by an IR LED and peradventure it discovers an obstacle, the light will simply reflect back, and this light is captured by an IR receiver. However, just a few IR transceivers can be used for the measurement of distance.

b) **Ultrasonic sensor**: Sound waves of high frequency are being generated by these sensors. Echo's that is being received recommends that an object is being interrupted. Also, these ultrasonic sensors can be used for measurement of distance.

c) **Photo-resistor**: Photo-resistor is a light sensor; however, it can still serve the purpose of a proximity sensor. Whenever a sensor has a close proximity with an object, there is a variance in the level of light which in return causes some variations in the photoresistor's resisting power. Such variations can be detected and further processed.

There are numerous diverse proximity sensors types and just a little of them are generally suitable for robots. For instance, "capacitive proximity sensors" are available which detects variance in the capacitance about it. Furthermore, Inductive proximity sensor is able to detect objects and distances via the utilization of magnetic fields.

CHAPTER 2: LITERATURE REVIEW

Some researchers have described that to design and develop a control system that is based on intelligent electronically controlled automotive bumper activation as well as an automatic braking system, it will comprise of IR transmitter and Receiver circuit, and the Control Unit (Chari, 2015). Furthermore, Pneumatic bumper system and pneumatic braking system of the vehicle speed is sensed by the proximity sensor and this signal is given to the control unit, the pneumatic bumper and the braking activation system.

Furthermore, studies on auto brake collision warnings exists in literature (B Mustapha et al., 2012). The Auto Brake can be described as where the area in front of the vehicle is continuously monitored with the help of long range radar and a forward-sensing wide-angle camera fitted in front of the interior rear-view mirror. In a study, a warning and brake support was provided for collisions with other vehicles, both moving and stationary (Coelingh et al., 2007).

Baharuddin Mustapha et al. (2013) Informed that an obstacle detection system is built based on two types of sensors. The system is intended for use by the elderly and people with vision impairment. From their study, results from experiments showed that ultrasonic and infrared sensors have diverse features in terms of measurements of output voltage (Baharuddin Mustapha et al., 2013). It is clearly indicated that ultrasonic sensor gives a linear output characteristic whereas infrared sensor shows a nonlinear output characteristic.

The study of (Mohammad, 2009) described about the amplitude response of infrared (IR) sensors depends on the reflectance properties of the target. Therefore, in order to use IR sensor for measuring distances accurately, prior knowledge of the surface

Ultrasonic (US) sensor can provide the initial information on distance to obtain the parameters for this method.

An original ultrasonic reverse warning system is a new system that can assist drivers while car is braking. It includes ultrasonic emitter and receiver that can produce and receive the ultrasonic waves to determine the distance between car and obstacle. Some researchers designed a system that could assist drivers stop the car automatically, an electronic circuit was constructed (Kim, 2015; Sobers et al., 2009). According to this circuit that was designed, a signal was produced to the braking system of a car based on the distance between the car and obstacle for a safe braking purpose.

CHAPTER 3: EXISTING SYSTEM

3.1 Block diagram of existing system

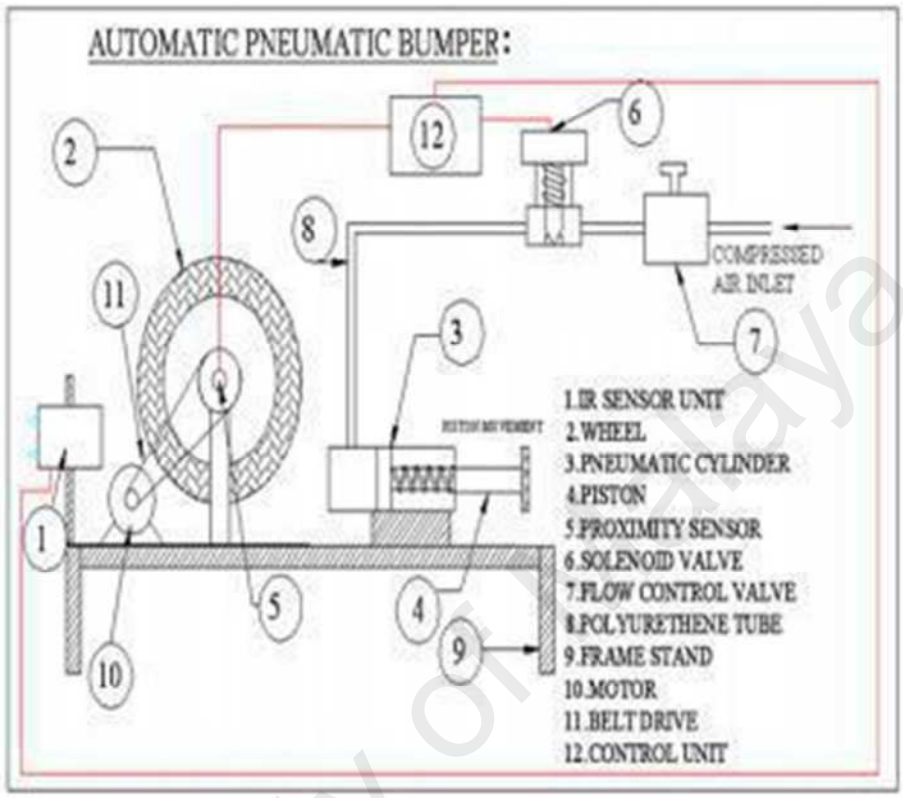

Figure 3.1: Block diagram of existing system

3.2 List of components

- IR Sensor Unit
- Wheel
- Pneumatic Cylinder
- Piston
- Solenoid Valve
- Polyurethane Tube
- Motor
- Belt Drive

3.3 Components description

3.3.1 IR Sensor unit

An infrared sensor is an electronic device that has the ability to emit for purpose of sensing some parts of a surrounding. Furthermore, it can measure the heat of an object as well as detect its motion. These kinds of sensors only measures the radiation of infrared, instead of its emission which is known as passive IR sensor.

Figure 3.2: IR sensor unit

3.3.2 Wheel

A wheel is a circular component with an intention of rotating on an axle-bearing. The wheel is among the major components of the “wheel and axle” which is among the six simple machines. Furthermore, in combination with axles, wheels makes it possible for the easy movement of heavy objects hence, simplifying movement or transportation while backing up a load, or executing labour in machines.

Figure 3.3: Wheel

3.3.3 Pneumatic cylinder

The cylinder is a Single acting cylinder one, meaning that there is a forward operation of the air pressure and a backward return of the spring. Additionally, the obtained air from the compressor flows via the regulator that is responsible for the control of pressure to the needed amount via the adjustment of its knob.

Figure 3.4: Single acting cylinder

3.3.4 Solenoid valve

A solenoid valve is a valve that is operated in an electromechanical manner. This valve is being controlled by a solenoid-based electric current: in the scenario of a valve with dual ports, the flow is switched either on/off; in the situation of a triple-port valve, the outflow is switched amidst the dual outer ports. Numerous solenoid valves can be positioned together on a manifold.

Figure 3.5: Solenoid valve

3.3.5 Motor

An electric motor is an electrical machine which deals with the conversion of electrical energy to mechanical energy. The inverse of such is electrical energy being converted from mechanical energy. The working of a single phase motor is simple.

The main components of the motor rotor and stator winding aids in motor rotation. Winding consists of two parts which are the main winding and the auxiliary winding.

Figure 3.6: Motor

3.4 Existing model

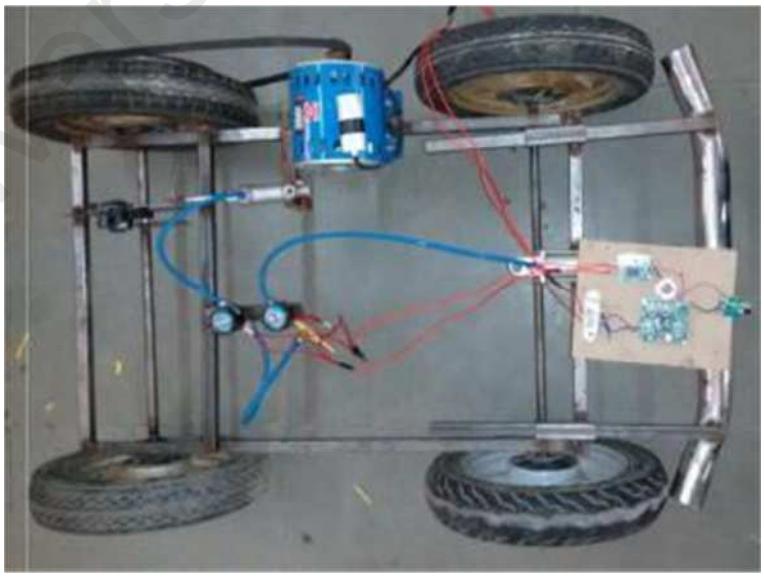

Figure 3. 7: Existing model

3.5 Disadvantage of existing system

- Much sensitivity of its sensor to sunlight and IR lights.
- Weakness to darker colours, such as black.
- Ability to sense only in a narrow direction.
- Time consumption of retraction is more.

CHAPTER 4: PROPOSED SYSTEM AND METHODOLOGY

4.1 Block diagram of proposed system

The following diagram shows the working process of automatic pneumatic braking and bumper system.

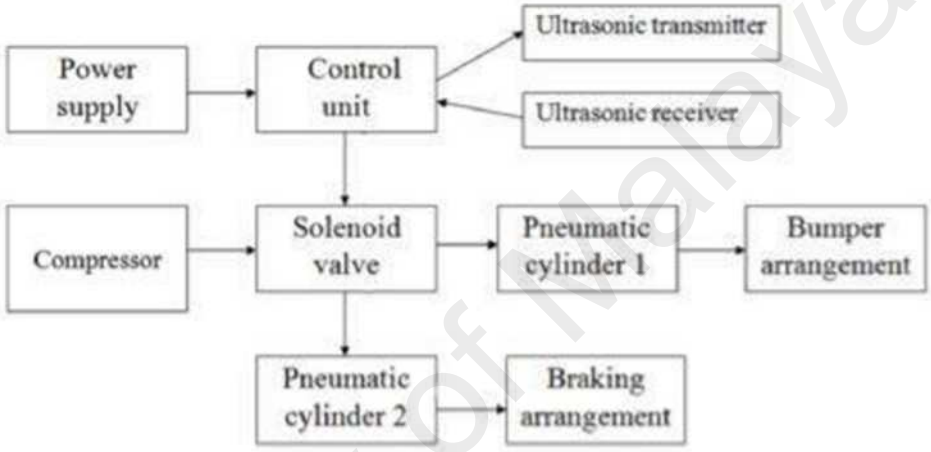

Figure 4.1: Block diagram of proposed system

4.2. List of components

- Ultrasonic sensor
- Solenoid valve
- Pneumatic cylinders
- Bumper arrangement
- Braking arrangement
- Microcontroller

4.3 Description of components

4.3.1 Ultrasonic sensor

A special sonic transducer is used for the ultrasonic proximity sensors, which permits alternate transmission and sound waves reception. Furthermore, there is a reflection via an object of the transducer-emitted sonic waves, this reflection is retrieved back in the transducer. After the emission of the sound waves is done, there would be a switching of the ultrasonic sensor to be able to the receiving mode. It is also important to note that the elapsed time between the reception and emission is proportionate to the object's distance from the sensor. However the possibility of sensing is only amidst the area of detection.

Figure 4.2: Ultrasonic sensor

4.3.2 3/2 Solenoid valve

A 3/2 way solenoid valve comprises of two states for switching and triple ports. In every switching state, 2 out of the 3 ports get connected. However, when the solenoid is activated, there is a switch in the state of the valve and a different connectivity amidst the valves ports get established. The diagram below shows a direct operated 3/2 way valve. Furthermore, in the de-energization state, it is possible for the medium to flow between from the right side port to the port on the top. However, in the energized state, a flow of the medium can occur from the port on the left to the port on the right. This is referred to as a normally closed 3/2-way valve.

Figure 4.3: Solenoid valve

4.3.3 Double acting pneumatic cylinder

Double-acting cylinder (DAC) utilizes the air-obtained force for movement in both retracted and extended strokes. Two ports permits air in, one of which is for the outstroke and the other for the in-stroke. The length of the stroke for this design is however unlimited; but there is more chance of vulnerability to bending and buckling by the piston rod.

Figure 4.4: Double acting pneumatic cylinder

4.3.4 Bumper arrangement

The following figure shows the bumper arrangement in this project. When the obstacle is sensed by the ultrasonic sensor, it will pass the signal to the pneumatic cylinder through the solenoid valve to activate this bumper arrangement.

Figure 4.5: Bumper arrangement

4.3.5 Brake arrangement

In this project the brake is applied in the front wheel. When the bumper is activated, then the signal is passed to the pneumatic cylinder, it will thereafter activate the braking arrangement. The following figure shows the braking arrangement.

Figure 4.6: Brake arrangement

4.3.6 Microcontroller

All needed functions are on a single chip. It is important to note that there is a difference between a microcontroller and a microprocessor, which is a generic-purpose chip used for creating multiple-function computer or device and it needs numerous chips to be able to handle different tasks. A microcontroller is supposed to possess more self-containing and independence, and ought to function as a dedicated, minute computer. This kind of devices are designed typically through the use of CMOS (Complementary Metal Oxide Semiconductor) technology, an effective fabricating technique which uses reduced power and has more immunity to power spikes than other techniques. Also, multiple architectures wherein a microcontroller is seen as an integrated chip which is most times a part of an embedded system. Such microcontrollers includes a RAM, CPU, I/O ports, ROM, and timers just like a conventional computer, however due to reason being that their design is for the execution of just a single precise task for controlling of a single system, they are of more smaller sizes and more simplified to include usage as a normal computer. However, CISC (Complex Instruction Set Computer) is a predominant architecture which permits the microcontroller to include numerous instructions for control that can be executed with just a single macro instruction.

Some use a RISC (Reduced Instruction Set Computer) architecture, which implements lesser instructions, but provides a more simplicity and lesser consumption of power. The earlier generation of controllers were built typically from logic components and were mostly very big. However, in the later times, microprocessors were used and it was possible for controllers to get fitted onto a circuit board.

In many areas microcontrollers have become quite common and they can be found in a number of appliances at home, instrumentation, and computer equipment.

Furthermore, they are used mostly in automobiles, and they have lot of industrial usages, and have grown to become a centric part of the industrial robotics. Microcontrollers do not need a processing power that is significant due to reason being that they are mostly used for the control of an independent process and in executing simple instructions.

4.3.6.1 PIC16F877A

The term PIC, or Peripheral Interface Controller, is the name given by Microchip Technologies to its single – chip microcontrollers. PIC micros have grown to become the most widely used microcontrollers in the 8- bit microcontroller segment. The PIC16F877A CMOS FLASH-based 8-bit microcontroller is upward compatible with the PIC16C5x, PIC12Cxxx and PIC16C7x devices. It features 200 ns instruction execution, 256 bytes of EEPROM data memory, self-programming, an ICD, 2 Comparators, 8 channels of 10-bit Analog-to-Digital (A/D) converter, 2 capture/compare/PWM functions, a synchronous serial port that can be configured as either 3-wire SPI or 2-wire I2C bus, a USART, and a Parallel Slave Port.

Pin configuration and description

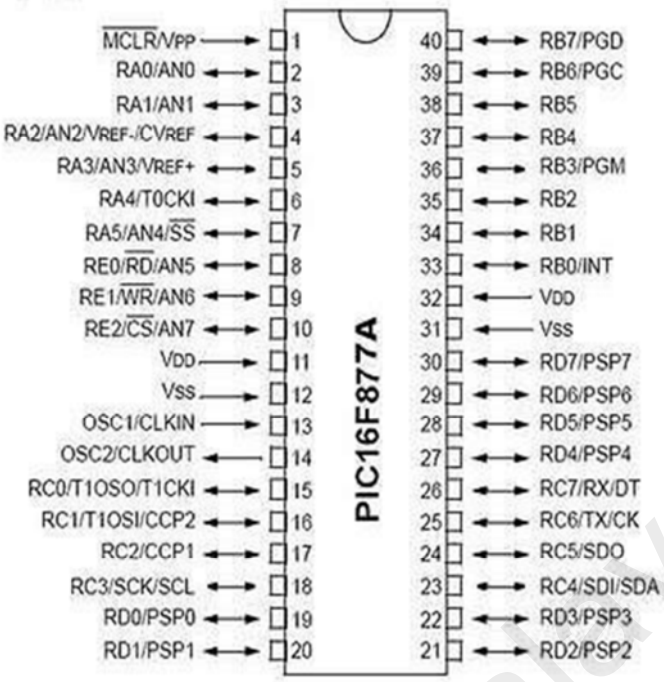

Figure 4.7: Pin diagram of PIC16F877A

4.3.7 Memory organization

In each of the PIC16F87XA devices, three memory blocks exists. There are distinct buses in the Program Memory and Data Memory, this is for the purpose of concurrent accessibility.

4.3.7.1 Program memory organization

A 13-bit program counter is available in the PIC16F87XA devices which has the capability to address an 8K word x 14 bit program memory space. Furthermore, the PIC16F876A/877A devices have 8K words x 14 bits of FLASH program memory, while PIC16F873A/874A devices have 4K words x 14 bits.

4.3.7.2 Data memory organization

The data memory is split into numerous banks which contains the special function registers and the general purpose registers. Additionally, the selected bits of the bank are bits RP1 (STATUS<6>) and RP0 (STATUS<5>).

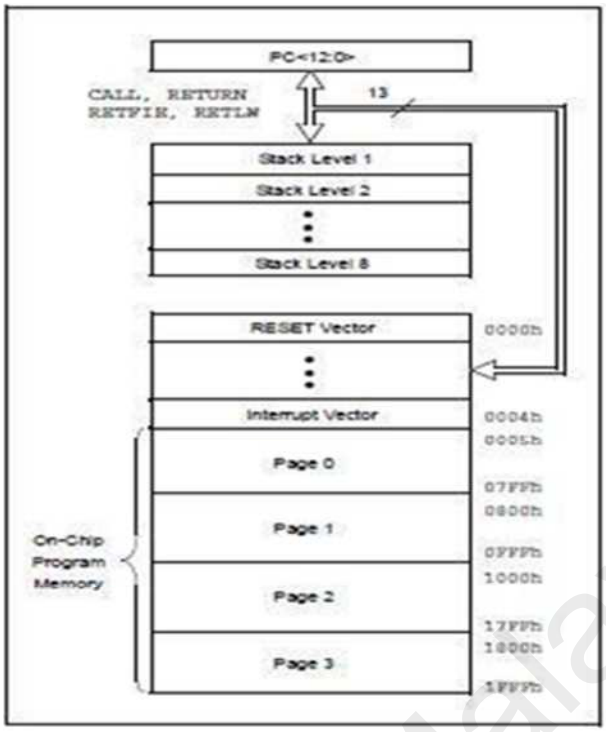

Figure 4.8: Memory organization **of** PIC16F877A

4.4 Working principle

4.4.1 Proposed system

The proposed system consists of an ultrasonic sensor, this sensor senses the obstacle in above 4 to 7 feet when the vehicle runs above 40-50 km per hour and also its senses the obstacle in a wide area of the path within the distance it can sense the obstacle to control the bumper and braking mechanism.

4.4.2 Working principle of automatic pneumatic bumper and brake actuation

If a vehicle speed is above the 40-50 Km per hour, the control unit will activate the ultrasonic sensor unit. The ultrasonic transmitter circuit is to transmit the ultrasonic waves. If any obstacle is detected in a path above 4 – 7 feet distance, the ultrasonic waves would be reflected. This reflected ultrasonic waves are received by the ultrasonic receiver. The ultrasonic receiver circuit receives the reflected ultrasonic waves and gives the control signal to the control circuit. The control circuit is used to activate the solenoid valve. If the solenoid valve is activated, the compressed air passes on to the Pneumatic Cylinder. The compressed air activates the pneumatic cylinder and moves

the piston rod. If the piston moves forward, then the bumper arrangement and braking arrangements are activated. The piston speed is varied by adjusting the flow control valve. We have applied this arrangement in one wheel as a model. The compressed air is drawn from the compressor. The compressed air flows via the Polyurethane tube to the flow control valve. The flow control valve is connected to the solenoid valve. Once the solenoid valve is activated, the bumper and brake are actuated and the vehicle stops.

Figure 4.9: Fabricated model

4.5 Coding

4.5.1 Ultrasonic program

```
unsigned char one,ten,hund,y;
unsigned char value1;
char adc_conv2();
void adc_conv();
void txs(const char *val);
void tx(unsigned char
val1); #define brake RC0
#define engine RC1

void adc_conv()
{
unsigned int one,ten,hund;
unsigned char ones,tens,hunds,x;

CHS0=0;
CHS1=0;
CHS2=0;
GODONE=1;
while(GODONE==1);
                    delay(5000);
                    x=(ADRESL);
 hund=x/100;
                    ten=(x%100)/10;
                    one=x%10;
ones=one+(0x30);
tens=ten+(0X30);
```

```
hunds=hund+(0X30);
lcdcommand(0x86);
ones=one+(0x30);
tens=ten+(0X30);
hunds=hund+(0X30);
lcddat(hunds);
lcddelay(6500);
lcddat(tens);
lcddelay(6500);
lcddat(ones);
lcddelay(6500);


while(1);
}
}
```

4.5.2 LCD program

```
#define rs RE2
#define rw RE1
#define en RE0
//#define output PORTD

void lcdinit();
void lcdcommand(char a);
void lcddat(char b);
void lcdstr(const char

*x); void lcddelay(int i);

void delay(int i);
```

```
void lcdinit()
{
        lcdcommand(0x38);
        lcdcommand(0x0e);
        lcdcommand(0x01);
        lcdcommand(0x80);
}
void lcdcommand(char a)
{
        PORTD=a;
        rs=0;
        rw=0;
        en=1;
        lcddelay(100);
        en=0;
}
void lcddat(char b)
{
        PORTD=b;
        rs=1;
        rw=0;
        en=1;
        lcddelay(100);
        en=0;
}
        while(i--);
}
```

4.6 List of materials

Table 4.1: List of materials

Sl.no	List of materials	Quantity
1	Ultrasonic sensor	1
2	Solenoid valve	1
3	Pneumatic cylinders	2
4	Bumper arrangement	1
5	Braking arrangement	1
6	Wheels	4
7	Motor	1
8	Bearing	4
9	Polyurethane tube and fittings	-

CHAPTER 5: CONCLUSION

This project work has provided us an excellent opportunity and experience, in using my limited knowledge. By use of an ultrasonic sensor in the proposed system, it improves the retraction timing of cylinder actuation, sensing the wide area path instead of narrow path and reduces the wear and tear of belt in the motor and also reduces the speed of the motor when the obstacles was nearer to the vehicle. Thus it overcomes the existing system with IR sensor which results better prevention of accident and also reduces the damage of vehicles and driver. Hence, I conclude that my proposed system will give better result in real time implementation.

CHAPTER 6: COST ESTIMATION

Table 6.1: Cost estimation

Sl.no	List of materials	Price (RM)
1	Ultrasonic sensor	300
2	Solenoid valve	1200
3	Pneumatic cylinders	4000
4	Bumper arrangement	500
5	Braking arrangement	500
6	Wheels	2000
7	Motor	3000
8	Bearing	1000
9	Bluetooth circuit	500
10	Pic microcontroller	1500
11	Polyurethane tube and fittings	200
12	Fabrication	5000
	Total	19700

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