Design and Development of Automatic Pneumatic Braking System

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Abstract – Vehicle accidents are ubiquitous in recent years. This is often thanks to heavy increase in population of vehicles, because of its high demand. They pose a significant threat to life and property. A system must be designed to attenuate the consequences of those accidents. The aim of the resent study is to style a tool which may successfully scan the environment during driving and apply brake to avoid front collision of the vehicle, together with extension of bumper. The technology of pneumatics plays a serious role within the field of automation and modern machine shops and space robots. The aim is to style and develop a sway system based intelligent electronically controlled automotive bumper activation and automatic braking system is named automatic bumper system. Ultrasonic sensor provided on the forepart of the vehicle detects the presence of the obstacle. The utilization of pneumatic system can encourage be useful in automation thanks to its simplicity and easy operation. So, the aim is to style and develop a system supported automatic control of auto. So, we aim to style "Automatic Pneumatic Braking System".

Key Words: Ultrasonic sensor, automation, braking system, pneumatic system, bumper

1. INTRODUCTION

Driving may be a common activity for many of the people. The quantity of vehicles is increasing day by day. Now a days, the technology possesses vast changes which leads increase in speed. The speed plays a significant role to keep up time for extended distances. But this speed also getting a significant problem for causes of road accidents. The common braking isn't sufficient for avoidance of accidents when driver isn't active. Further improvement needs to be drained braking system so as to brake a vehicle when driver isn't ready to brake i.e., it's going to need automatic braking system. This automatic braking system allows the vehicle to brake without support of the driving force. The main target of the ultrasonic braking system is that, vehicles should automatically brake when the sensors sense the obstacle. This is often a technology for automobiles to sense an imminent forward collision with another vehicle or an obstacle, and to brake the vehicle accordingly, which is finished by the braking circuit. This method includes two ultrasonic sensors viz. ultrasonic wave emitter and ultrasonic wave receiver. The ultrasonic wave emitter provided ahead portion of an automatic braking system vehicle, producing and emitting ultrasonic waves in a very predetermined distance ahead of the vehicle. Ultrasonic

wave receiver is additionally provided before portion of the vehicle, receiving the reflected ultrasonic wave signal from the obstacle. The reflected wave (detection pulse) is measured to urge the gap between vehicle and also the obstacle. The DC gear motor is connected to the wheels of car and power input is given thereto from Arduino Board. Then PIC microcontrollers accustomed control the servo motor supported detection pulse information and therefore the servomotor successively automatically controls the braking of the vehicle. Thus, this new system is meant to resolve the matter where drivers might not be able to brake manually exactly at the desired time, but the vehicle can stop automatically by sensing the obstacles to avoid an accident. In order to scale back the emission levels, more work goes on for the modification of engine work functions and every one. There are several types of braking mechanism systems that will only are often applicable mechanically, to maneuver the ideology more deep and brief the automated braking system are going to be more sufficient and satisfactory additionally to mechanical braking system. In present generation, number of vehicles are coming into existence with newer technologies for implementation of human comfort and other conditioning. To increase the ideology in a very briefer manner and to require the step in numerous way. May automatic braking system would fulfil the methods of extension of technical existences.

1.1 Objective

The objective of this project is to style the automated braking system so as to avoid the accident. To develop a security vehicle braking system using ultrasonic sensor and to style a vehicle with less human attention to the driving.

This project is critical to be attached to each vehicle. Mainly it's used when drive the vehicles in dark. Mostly the accident occurred within the getting dark because of long travel the motive force may get tired. Therefore the driver may hit the front side vehicle or road side trees. By using this project the vehicle is stopped by automatic braking system. So we will avoid the accident.

1.2 Scope

The scope of this project is to develop a system during which an ultrasonic sensor detects the obstacle and to process the output from the ultrasonic sensor to drive the servomotor as an actuator. Vehicles can automatically brake thanks to obstacles when the sensor senses the obstacles.

The main target of this project is designing an automatically braking system which will help us control the braking system of a vehicle. The automatically braking system also must work with an ultrasonic sensor, which produce sound pulse by a buzzer. The ultrasonic wave is generated from a transmitter and sends to a receiver.
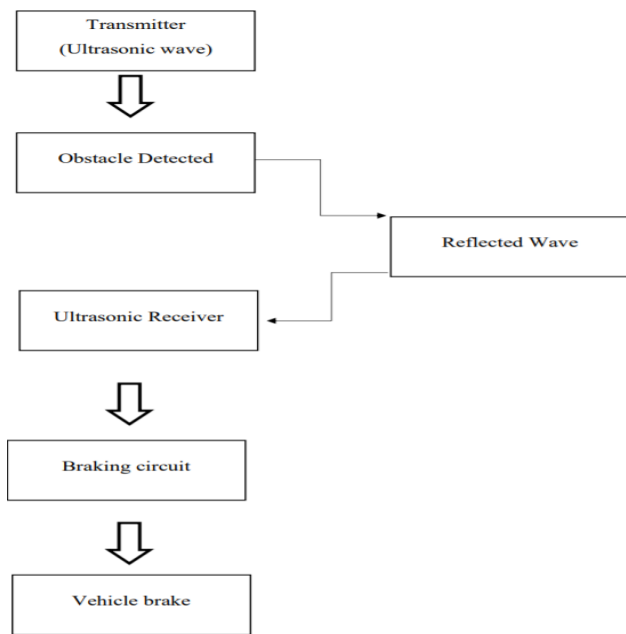
1.2 Methodology

Chart-1 : Block Diagram

2. HARDWARE COMPONENTS

Table -1: List of Components

Components	Nos.
Gear DC motor	1
Pneumatic single acting cylinder	2
Solenoid valve	1
Relay	1
Pressure gauge	1
Coupling	4
Pedestal	2
Wheel	4
Disc brake	1
Slider	2
Pu pipe	5
Battery	2
Air tank	1
Ultrasonic sensor	1
Chain	1
Sprocket	2

2.1 DC Motor

DC geared motors are essentially a DC shunt motor which has been specially designed for low inertia, symmetrical rotation and smooth low-speed characteristics. Geared motor may be a motor with a closed feedback system during which the position of the motor are going to be communicated back to the feedback circuit within the motors. Geared motors are formed from four different elements: a DC motor, a position-sensing device (a potentiometer), a gear reducing part and a sway unit. All of those components work together to form the motor to simply accept control signals that represent the required output of the motor shaft and power the DC motor until its shaft is turned to the proper position. The shaft in geared motors doesn't rotate as DC Motor Air Tank gauge 5x3 Valve + Relay Chain and Sprocket Single acting cylinder 12V Battery freely as those in regular DC motors; it's only able to rotate around 200 degrees in both directions. The position sensing device during a geared motor determines the rotation of the shaft and thus the way the motor has to turn so as to gain the required position. The sliding mode control is strong to plant uncertainties and insensitive to external disturbances. It's commonly accustomed get good dynamic performance of controllable systems. Even then, the chattering phenomena thanks to the finite speed of the switching devices can affect the system behavior significantly. Besides, the sliding control needs the knowledge of mathematical model of the system with bounded uncertainties. Reduced chattering is also achieved without sacrificing robust performance by combining the attractive features of fuzzy control with SMC.

2.2. Pneumatic Single Acting Cylinder

Pneumatic Cylinders sometimes referred to as air cylinders are mechanical devices which use the ability of propellant to provide a force during a reciprocating linear motion. Like Hydraulic Cylinders, pneumatic cylinders use the stored P.E. of a fluid, during this case compressed gas, and convert it into mechanical energy because the air expands in a trial to achieve air pressure. This air expansion forces a piston to maneuver within the desired direction. The piston may be a disc or cylinder, and also the connecting rod transfers the force it develops to the thing to be moved. Single-acting cylinders (SAC) use the pressure imparted by compressed gas to form a drive in one direction, and a spring to return to the house position. More often than not, this sort of cylinder has limited extension thanks to the space the compressed spring takes up. Another downside to SACs is that a part of the force produced by the cylinder is lost because it tries to push against the spring. Thanks to those factors, single acting cylinders are recommended for applications that need no quite 100mm of stroke length.

The cylinder could be a Single acting cylinder one, which suggests that the atmospheric pressure operates forward and spring returns backward. The air from the compressor is tried and true the regulator which controls the pressure to required amount by adjusting its knob. A pressure gage is

attached to the regulator for showing the road pressure. Then the compressed gas is saw the one acting 3/2 solenoid valve for supplying the air to at least one side of the cylinder.

Specification of single acting cylinder

Material: standard

Size: Ø16 x 80 mm

Quantity: 2 nos.

2.3. Solenoid Valve

A solenoid valve is an electrically controlled valve. The valve features a solenoid, which is an electric coil with a movable ferromagnetic core (plunger) in its centre. In the rest position, the plunger closes off a small orifice. An electric current through the coil creates a magnetic field. The magnetic field exerts an upwards force on the plunger opening the orifice. This is the basic principle that is used to open and close solenoid valves.

Solenoid valves are used in a wide range of applications, with high or low pressures and small or large flow rates. These solenoid valves use different operating principles that are optimal for the application. The three most important ones are explained in this article: direct acting, indirect acting, and semi-direct acting operation.

2.4. Relay

A relay is an electrically operated switch. It consists of a group of input terminals for one or multiple control signals, and a group of operating contact terminals. The switch may have any number of contacts in multiple contact forms, like make contacts, break contacts, or combinations thereof. Relays are used where it's necessary to manage a circuit by an independent low-power signal, or where several circuits must be controlled by one signal. Relays were first utilized in long distance telegraph circuits as signal repeaters: they refresh the signal coming in from one circuit by transmitting it on another circuit. An Electromagnet plays a significant role within the working of a relay. It's a metal which doesn't have magnetic property but it are often converted into a magnet with the assistance of an electrical signal. We all know that when current passes through the conductor it acquires the properties of a magnet. So, when a metal winded with a copper wire and driven by the sufficient power supply, that metal can act as a magnet and might attract the metals within its range.

2.5. Pressure Gauge

Pressure measurement is that the analysis of an applied force by a fluid (liquid or gas) on a surface. Pressure is usually measured in units of force per unit of expanse. Many techniques are developed for the measurement of pressure and vacuum. Instruments wont to measure and display pressure in an integral unit are called pressure meters or pressure gauges or vacuum gauges.

2.6. Wheel

A wheel may be a circular block of a tough and sturdy material at whose center has been bored a circular hole through which is placed an axle bearing about which the wheel rotates when a flash is applied by gravity or torque to the wheel about its axis.

2.7. Disc Brake

Brake may be a computer which inhibits motion, slowing or stopping a motion object or preventing its motion. Brake is usually applied to rotating axles or wheels, but may take other form like the surface of a moving fluid. Disc brakes generate an implausible amount of stopping power, usually way more than is critical to adequately stop a road bicycle. This enables the rider to use much less force to the lever before the bike involves a halt. Less hand strength ends up in a decrease in muscle fatigue, especially on longer descents.

2.8. PU Pipe

Pu tubes- Polyurethane Tubing's are very flexible in nature. The pu tube has rubber tube like resilience and suppleness. Polyurethane tube is fitted with the variability of tube fittings like Push-On Fittings (instant tube fittings) or push-in-type fittings, brass or aluminum type fittings.

2.9. Battery

A battery could be a device consisting of 1 or more electrochemical cells with external connections for powering electrical devices like flashlights, mobile phones, and electric cars. When A battery is supplying power, its positive terminal is that the cathode and its negative terminal is that the anode. The terminal marked negative is that the source of electrons which will flow through an external circuit to the positive terminal. When electric battery is connected to an external electric load, a redox reaction converts high-energy reactants to lower-energy products, and also the free-energy difference is delivered to the external circuit as power.

2.10. Chain and Sprocket

A chain and sprocket drive may be a variety of power transmission during which a roller chain engages with two or more toothed wheels or sprockets, employed in engines as a drive from crankshaft to camshaft. Chain and sprocket drives are the foremost common final drive system in motorcycles, atiny low front and bigger rear roulette linked by a roller chain. A sequence and sprocket drive is a method of conveying power to the wheels of a vehicle.

2.11. Sensor

A sensor is a device that maps an environmental attribute to a quantitative measurement. Each sensor is predicated on transduction principle which is conversion of energy from one form to a different form. There are two important terms associated with any sensor –

• Target Angle – This term refers to the 'tilt response' limitations of a given sensor. Since the ultrasonic waves reflect off the target object, target angles indicate acceptable amounts of tilt for a given sensor.

• Beam Spread – This term refers to the most angular spread of the ultrasonic waves as they leave the transducer.

2.12. Ultrasonic Sensor

Ultrasonic Sensor Ultrasonic ranging and detecting devices use high frequency sound waves called ultrasonic waves to detect presence of an object and its range. Normal frequency range of human ear is roughly 20Hz to twenty, 000Hz. Ultrasonic sound waves are sound waves that are above the range of human ear, and thus have frequency above 20,000Hz. An ultrasonic sensor necessarily consists of a transducer for conversion of 1 kind of energy to a different, a housing enclosing the ultrasonic transducer and an electrical connection. These sensors are of two types:

• Ultrasonic Transmitter – Before transmitting the ultrasonic wave, there's part which is ultrasonic wave generator that functions to get ultrasonic wave. In this part, there's timing instruction means for generating an instruction signal for intermittently providing ultrasonic waves. This signal will send to an ultrasonic wave generator for generating ultrasonic waves supported the instruction signal from said timing instruction means (transform electricity into sound wave). After ultrasonic wave was produced, ultrasonic transmitter transmits the ultrasonic waves toward a paved surface to search out the obstacle. The range that obstacle detected is depends on the range of ultrasonic sensors that used.

• Ultrasonic Receiver – If the ultrasonic wave detects the obstacle, it'll produce a reflected wave. An ultrasonic receiver is employed for receiving the ultrasonic waves reflected from the paved surface to come up with a reception signal. There's ultrasonic transducer that may transform back the wave to power. This signal amplified by an amplifier. The amplified signal is compared with reference signal to detect components within the amplified signal thanks to obstacles on the paved surface. The magnitude of the reference signal or the amplification factor of the amplifier is controlled to take care of a relentless ratio between the typical of the reference signal and also the average of the amplified signal.

Table -2: Specifications of Ultrasonic Sensor

Working Voltage	Dc 5 v
Working Current	15mA
Working Frequency	40Hz
Max Range	3m
Min Range	2cm
Measuring Angle	15 degree
Trigger Input Signal	10uS TTL pulse
Echo Output Signal	Input TTL lever signal and the range in proportion
Dimension	45 X 20 X 15mm

3. Sensing and Control Unit

The Sensing and Controlling unit, is that a part of this method which senses the item or obstruction before of the car, measures the gap and therefore the approaching velocity and so sends necessary signals to controller and pneumatic system and hence to the automated Braking Unit. Its components incorporates microcontroller atmega 328p, Servo motor, Ultrasonic Transducer and an influence source to stay the system running. The Microcontroller atmega328p is coded by a software called Arduino 1.6. Ultrasonic sensors work by emitting sound waves at a frequency too high for humans to listen to. They then await the sound to be reflected back, calculating distance supported the time required. This is often almost like how radar measures the time it takes a nonparticulate radiation to return after hitting an object.
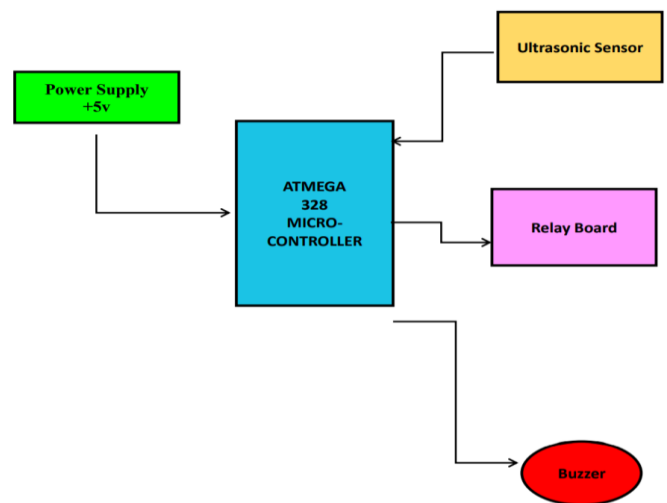
Chart-2: Circuit Diagram

3.1 Working of circuit

Now when an object is sense by ultrasonic senor it sends signals to the circuit and buzzer starts ringing simultaneously the signal is received by the microcontroller and it gives command to solenoid valve , when solenoid valve is activated the air from air tanks flow through pu pipes and 5/3 valve which is connected so single acting cylinder starts expanding so the disc brake is applied , now the buzzer will be activated until the object is there in the path once the path is clear the car will activate to run after 5 sec.

3.2 ATMEGA 328P

ATMEGA328P is high performance, low power controller from Microchip. ATMEGA328P is an 8-bit microcontroller supported AVR RISC architecture. It's the foremost popular of all AVR controllers because it is employed in ARDUINO boards. The ATmega328/P provides the subsequent features: 32Kbytes of In-System Programmable Flash with Read-While-Write capabilities, 1Kbytes EEPROM, 2Kbytes SRAM, 23 general purpose I/O lines, 32 general purpose working registers, Real Time Counter (RTC), three flexible Timer/Counters with compare modes and PWM, 1 serial programmable USARTs , 1 byte-oriented 2-wire Serial Interface (I2C), a 6- channel 10-bit ADC (8 channels in TQFP and QFN/MLF packages) , a programmable Watchdog Timer with internal Oscillator, an SPI port, and 6 software selectable power saving modes. The Idle mode stops the CPU while allowing the SRAM, Timer/Counters, SPI port, and interrupt system to continue functioning. The Power-down mode saves the register contents but freezes the Oscillator, disabling all other chip functions until the subsequent interrupt or hardware reset. In Power-save mode, the asynchronous timer continues to run, allowing the user to take care of a timer base while the remainder of the device is sleeping. The ADC Noise Reduction mode stops the CPU and every one I/O modules except asynchronous timer and ADC to reduce switching noise during ADC conversions. In Standby mode, the crystal/resonator oscillator is running while the remainder of the device is sleeping. This enables in no time start-up combined with low power consumption. In Extended Standby mode, both the most oscillator and also the asynchronous timer still run. By executing powerful instructions in an exceedingly single clock cycle, the device achieves throughputs approaching 1 MIPS per MHz, balancing power consumption and processing speed. As of 2013 the ATmega328 is often utilized in many projects and autonomous systems where a straightforward, low-powered, low-cost micro-controller is required.
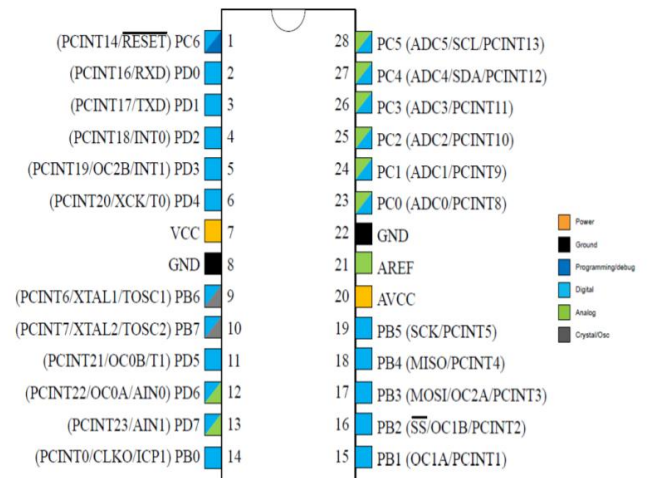

Figure-1: Pin Diagram of ATMEGA 328P

3.3. Pin Description

VCC

Digital supply voltage.

GND

Ground.

Port B (PB7:0) XTAL1/XTAL2/TOSC1/TOSC2

Port B is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for every bit). The Port B output buffers have symmetrical drive characteristics

With both high sink and source capability. As inputs, port B pins that are externally pulled low will source current if the pull-up resistors are activated. The Port B pins are tri-stated when a reset condition becomes active, whether or not the clock isn't running. Reckoning on the clock selection fuse settings, PB6 is used as input to the inverting oscillator amplifier and input to the inner clock operating circuit. Counting on the clock selection fuse settings, PB7 will be used as output from the inverting oscillator amplifier.

If the inner calibrated RC oscillator is employed as chip clock source, PB7..6 is employed as TOSC2..1 input for the asynchronous Timer/Counter2 if the AS2 bit in ASSR is set.

Port C could be a 7-bit bi-directional I/O port with internal pull-up resistors (selected for every bit). The PC5.0 output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, Port C pins that are externally pulled low will source current if the pull-up resistors are activated. The port C pins are tri-stated when a reset condition becomes active, whether or not the clock isn't running.

PC6/RESET

If the RSTDISBL fuse is programmed, PC6 is employed as an input pin. If the RSTDISBL fuse is unprogrammed, PC6 is employed as a reset input. An occasional level on this pin for extended than the minimum pulse length will generate a reset, whether or not the clock isn't running.

Port D is an 8-bit bi-directional I/O port with internal pull-up resistors (selected for every bit). The port D output buffers have symmetrical drive characteristics with both high sink and source capability. As inputs, port D pins that are externally pulled low will source current if the pull-up resistors are activated. The port D pins are tri-stated when a reset condition becomes active, whether or not the clock isn't running.

AVCC

AVCC is that the supply voltage pin for the A/D converter, PC3:0, and ADC7:6. It should be externally connected to VCC, whether or not the ADC isn't used. If the ADC is employed, it should be connected to VCC through a low-pass filter. Note that PC6..4 use digital supply voltage, VCC.

AREF

AREF is that the analog reference pin for the A/D converter.

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1ADC7:6 (TQFP and QFN/MLF Package Only)

In the TQFP and QFN/MLF package, ADC7:6 function analog inputs to the A/D converter. These pins are powered from the analog supply and function 10-bit ADC channels.

4 Working principle and designing

The compressed gas from the compressor at the pressure of 5 to 7 bar is more established a pipe connected to the Solenoid valve with one input. The Solenoid Valve is actuated with Control Timing Unit. The Solenoid valve has two outputs and one input. The air getting in the input goes out through the 2 outputs when the timing control unit is actuated. Thanks to the high atmospheric pressure at the underside of the piston, the atmospheric pressure below the piston is over the pressure above the piston. So these moves the connecting rod upwards which move up the trouble are, which is pivoted by control unit. This force acting is passed on to punch/rivet which also moves downwards. The circuit is to transmit the Ultrasonic rays. If any obstacle is there in a very path, the ultrasonic rays reflected. This reflected ultrasonic rays are received by the receiver circuit is named "ultrasonic receiver". The ultrasonic receiver circuit receives the reflected ultrasonic rays and giving the control signal to the negative feedback circuit. If the solenoid valve is activated, the compressed gas passes to the only Acting

Pneumatic Cylinder. The compressed gas activates the pneumatic cylinder and moves the connecting rod. If the piston moves forward, then the breaking arrangement activated. The breaking arrangement is employed to interrupt the wheel gradually or suddenly thanks to the piston movement. The breaking speed is varied by adjusting the valve is named "Flow Control Valve". In our project, we've got to use this breaking arrangement in one Wheel as a model. The compressed gas drawn from the compressor in our project. The compressed gas flow through the Polyurethane tube to the flow control valve. The flow control valve is connected to the solenoid valve as mentioned within the circuit diagram.

Calculation:

Abbreviations and Acronyms

DBraking = Braking distance

μ = coefficient of friction

g = acceleration due to gravity

V = Velocity before applying brakes

v = final velocity

u = initial velocity

a = acceleration

s = braking distance

F= Force

Units

DBraking = m = Meters

v = final velocity = m/sec =meter/sec

u = initial velocity= m/sec =meter/sec

a = acceleration = m/ =meter/sec2

s = braking distance = m= meter

F= Force = N = Newton

Total stopping distance = Human perception distance + human reaction distance

+braking distance + distance covered in 1msec

Braking distance,

$$DBraking = \frac{v2}{2 \, X \, \mu \, X \, g}$$

m .... (1)

Where, V = Velocity before applying brakes

μ = coefficient of friction = 0.7 (for dry surfaces)

g = acceleration due to gravity (9.81)

DBraking = Braking distance,

DBraking =

$(4.167)2$

$2 X0.7X9.81$

= 1.26 m

Here the human perception time and human reaction time are equal to "zero"

Because it is an automatic braking system.

Total stopping distance = 1.26 m

Total braking distance = 1.26

Bumper actuation length = 1.26 +0.100 = 1.36 m,

Hence the sensors sensing range is set at 1.5 m

IMPACT FORCE CALCULATION

Mass of the vehicle = 22 kg

Velocity of the vehicle = 15km/h = 4.167m/sec

Braking distance = 1.26 m

By motion equation 2as = v

$2 – u$

2 .... (2)

Where, v = final velocity

u = initial velocity

a = acceleration

s = braking distance

$2 × a ×1.26 = 0 – 4.167^2$

a = - 6.89 m/sec2

Force, F = mass× acceleration ...... (3)

= 22× (-6.89)

F= 151.58 N

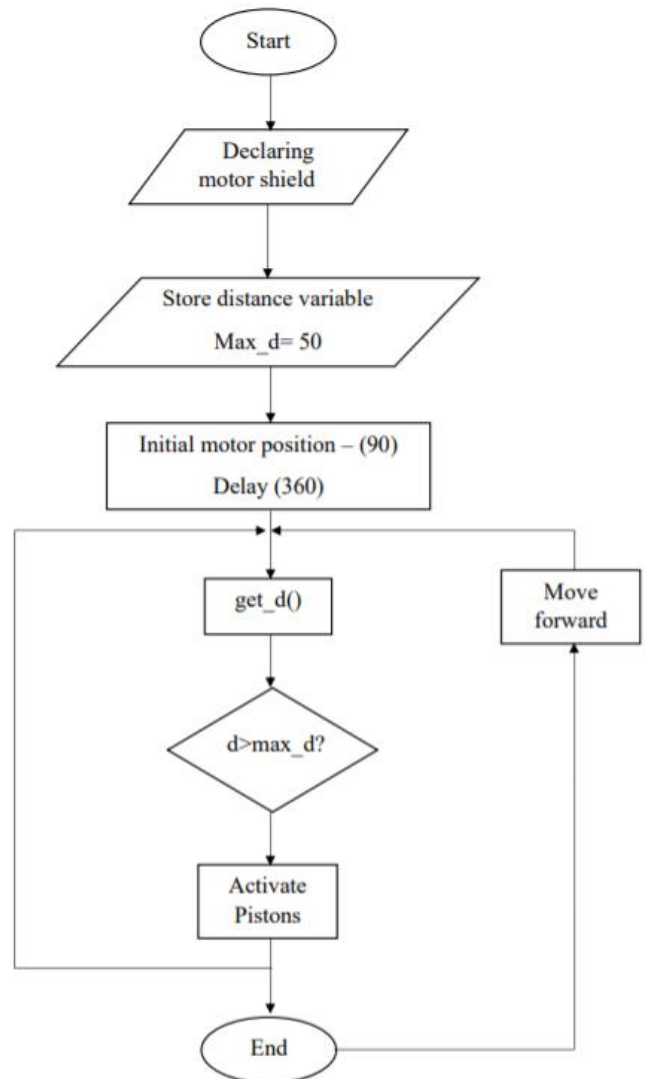**Chart-3:** Flowchart

CONCLUSION

We have successfully completed the fabrication of automatic braking system model prototype and this project presents the implementation of an Automatic Braking System for Forward Collision Avoidance, intended to use in vehicles where the drivers may not brake manually, but the speed of the vehicle can be reduced automatically due to the sensing of the obstacles. It reduces the accident levels and tends to save the lives of so many people. By doing this project practically we gained the knowledge about working of automatic braking system, pneumatic system and with this future study and research, we hope to develop the system into an even more advanced speed control system for automobile safety, while realizing that this certainly requires tons of work and learning, like the programming and operation of microcontrollers and the automobile structure. Hence we believe that the incorporation of all components in Automatic Braking System will maximize safety and also give

such system a bigger market space and a competitive edge in the market.

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