Design & Development of Smart Pneumatic Based Auto Bumper & Braking System

Dr. Mahesh Gaikwad[1], Sahil Shekhar Godase[2], Shreedhar Gulab Kothawale[3], Somnath Shankar Hake[4], Vrushabh Mahesh Mule[5]

[1, 2, 3, 4, 5] Dept of Mechanical Engineering

[1, 2, 3, 4, 5] JSPM's Jayawantrao Sawant College of Engineering Hadapsar, Pune-28

Savitribai Phule Pune University, Pune

Abstract- *The Design & Development of Smart Pneumatic Based Auto Bumper & Braking System is a system designed to prevent accidents by automatically applying the brakes of a car when it is too close to another vehicle or obstacle. The system uses a combination of pneumatic cylinders, ultrasonic sensors, and microcontrollers to detect the distance between the car and the obstacle and apply the brakes when necessary. The system consists of four main components: the pneumatic cylinder, the ultrasonic sensors, the microcontroller, and the braking system. The pneumatic cylinder is responsible for applying the brakes, and the ultrasonic sensors are used to detect the distance between the car and the obstacle. The microcontroller is the brain of the system, receiving input from the ultrasonic sensors and sending output to the pneumatic cylinder to apply the brakes.The braking system is responsible for actually stopping the car. It can be either a traditional hydraulic braking system or an electronic braking system. The braking system is triggered by the microcontroller, which sends a signal to apply the brakes when the ultrasonic sensors detect that the car is too close to an obstacle.*

The system is designed to be simple, reliable, and cost-effective, and it can be installed on any type of car. It is especially useful in situations where the driver may not be able to react quickly enough to prevent an accident, such as in heavy traffic or when driving at high speeds.

The design and development of the Smart Pneumatic Based Auto Bumper & Braking System has been the subject of several research studies, and there is still scope for further research and development in this area. Overall, the system has the potential to significantly improve the safety and efficiency of automobiles, and it could become a standard feature in future car models.

Keywords- Smart Pneumatic System, Auto Bumper, Braking System, Ultrasonic Sensors, Microcontroller, Distance Detection, Safety, Automation, Vehicle Technology.

I. INTRODUCTION

- The Design & Development of Smart Pneumatic Based Auto Bumper & Braking System is a revolutionary approach to improve the safety of automobiles by automatically applying the brakes when the car is too close to an obstacle. The system uses a combination of pneumatic cylinders, ultrasonic sensors, and microcontrollers to detect the distance between the car and the obstacle and apply the brakes when necessary. This system has the potential to significantly reduce the number of accidents caused by driver error or lack of attention.
- In recent years, the number of car accidents has increased significantly due to various reasons, such as distracted driving, fatigue, or even technical malfunctions. Several researchers have focused on developing advanced technologies that can prevent accidents or reduce their impact. One such technology is the Smart Pneumatic Based Auto Bumper & Braking System.
- This system is designed to be a simple, reliable, and cost-effective solution to prevent accidents. It can be installed on any type of car and can work in conjunction with existing braking systems. The system uses ultrasonic sensors to detect the distance between the car and the obstacle and a microcontroller to process the information and send a signal to the pneumatic cylinder to apply the brakes.
- The development of the Smart Pneumatic Based Auto Bumper & Braking System is a complex process that requires expertise in several areas, such as mechanical engineering, electrical engineering, and computer science. Several research studies have been conducted to optimize the design and functionality of the system.
- In this literature review, we will explore the different aspects of the Design & Development of Smart Pneumatic Based Auto Bumper & Braking System, including its components, working principle, advantages, and limitations. The review will also highlight the current state of research in this field and the future prospects for the technology.

II. NEED FOR AUTOMATION

- Automation is a crucial aspect of the Design & Development of Smart Pneumatic Based Auto Bumper & Braking System. The system's primary objective is to automatically detect obstacles and apply the brakes when necessary, without requiring any input from the driver. The automation of the system ensures that the reaction time is fast enough to prevent accidents, which is critical in situations where the driver may not be able to react quickly enough.
- Manual braking systems rely on the driver's ability to perceive and react to obstacles, which can be affected by several factors, such as distractions, fatigue, or impairment. The Smart Pneumatic Based Auto Bumper & Braking System eliminates the need for the driver to react by automatically applying the brakes. This automation can significantly reduce the number of accidents caused by driver error or lack of attention.
- In addition to safety, automation also enhances the efficiency and reliability of the system. The system uses ultrasonic sensors to detect the distance between the car and the obstacle and a microcontroller to process the information and send a signal to the pneumatic cylinder to apply the brakes. Automation ensures that these processes are carried out accurately and consistently, reducing the risk of errors or malfunction.
- Overall, the automation of the Design & Development of Smart Pneumatic Based Auto Bumper & Braking System is essential to its effectiveness and reliability. The system's ability to automatically detect obstacles and apply the brakes when necessary can significantly improve the safety of automobiles and reduce the number of accidents caused by driver error or lack of attention.

III. PROBLEM STATEMENT

- The problem statement of the Design & Development of Smart Pneumatic Based Auto Bumper & Braking System is to address the increasing number of accidents caused by driver error or lack of attention. Despite the advances in vehicle technology and safety measures, accidents continue to occur due to various reasons such as distracted driving, fatigue, or even technical malfunctions.
- The Smart Pneumatic Based Auto Bumper & Braking System aims to provide a simple, reliable, and cost-effective solution to prevent accidents caused by the driver's inability to react to obstacles. The system is designed to detect the distance between the car and the obstacle and automatically apply the brakes when necessary, without requiring any input from the driver.
- The problem statement of the project is to develop a Smart Pneumatic Based Auto Bumper & Braking System that is efficient, reliable, and easy to install on any type of vehicle. The system must be able to accurately detect obstacles, process the information, and apply the brakes in a timely and consistent manner. Additionally, the system must be designed to work in conjunction with existing braking systems and not interfere with their functionality.
- To address these challenges, the project requires a multidisciplinary approach that includes expertise in mechanical engineering, electrical engineering, and computer science. The development of the system must consider various factors such as the type of sensors to be used, the design of the pneumatic cylinder, the programming of the microcontroller, and the integration of the system with the vehicle's existing technology.

IV. OBJECTIVE

The main objective of designing and developing a Smart Pneumatic Based Auto Bumper & Braking System is to enhance the safety and functionality of automobiles. The system is designed to detect obstacles in the path of a moving vehicle and activate the brakes or deploy the bumper to prevent collisions.

The specific objectives of this system can include:

- Accident prevention: The primary objective of the system is to prevent accidents and reduce the risk of injury to passengers and pedestrians.
- Improved vehicle control: The system can improve the control of the vehicle in different driving conditions, such as during sudden stops or emergency maneuvers.
- Increased driver awareness: The system can alert the driver of potential hazards, giving them time to react and prevent collisions.
- Reduced vehicle damage: The system can help to reduce the damage to the vehicle in the event of an accident.
- Increased overall vehicle safety: The Smart Pneumatic Based Auto Bumper & Braking System can improve the overall safety of the vehicle by providing an additional layer of protection against accidents.

V. SCOPE

- The main objective of designing and developing a Smart Pneumatic Based Auto Bumper & Braking System is to enhance the safety and functionality of automobiles. The system is designed to detect obstacles in the path of a

moving vehicle and activate the brakes or deploy the bumper to prevent collisions.

The specific objectives of this system can include:

- Accident prevention: The primary objective of the system is to prevent accidents and reduce the risk of injury to passengers and pedestrians.
- Improved vehicle control: The system can improve the control of the vehicle in different driving conditions, such as during sudden stops or emergency maneuvers.
- Increased driver awareness: The system can alert the driver of potential hazards, giving them time to react and prevent collisions.
- Reduced vehicle damage: The system can help to reduce the damage to the vehicle in the event of an accident.
- Increased overall vehicle safety: The Smart Pneumatic Based Auto Bumper & Braking System can improve the overall safety of the vehicle by providing an additional layer of protection against accidents.

VI. LITERATURE REVIEW

[1]"Design and Development of Smart Pneumatic Based Auto Bumper and Braking System for Cars" by MohdKhairulAzmi bin Md. Azmi, Mohammad Hamzah Hamidon, and Ahmad Kamal Mat Yamin (2016):

This paper discusses the design and development of a Smart Pneumatic Based Auto Bumper and Braking System for Cars. The system uses a microcontroller to control the pneumatic cylinder that applies the brakes. The system also uses ultrasonic sensors to detect the distance between the car and the obstacle. The paper presents the design of the system, the experimental results, and the future scope of the system.

[2] "Development of a Smart Pneumatic Bumper for Automobiles" by Gaurav Kumar and Pratik D. Gurnani (2019):

This paper presents the development of a Smart Pneumatic Bumper for automobiles. The system uses a microcontroller to control the pneumatic cylinder that is connected to the bumper. The system also uses ultrasonic sensors to detect the distance between the car and the obstacle. The paper presents the design of the system, the experimental results, and the limitations of the system.

Working

- The system of the pneumatic bumper and breaking works on the pneumatic system. Ultrasonic sensor detector is used to descry the obstacle. The signal sends to the microcontroller which operate the solenoid valve. Compressed air supplied to the pneumatic selector through compressor. For condition of the solenoid valve compressed air is passed through the solenoid valve which actuates the pneumatic selector. The piston of the pneumatic selector will move on forward direction. On removing the obstacle, the selector will set to its original position. And at the same time break will also apply.

VII. COMPONENTS REQUIRED

1. LINEAR BASIC AIR CYLINDER :-

- A linear basic air cylinder is a device that converts compressed air energy into linear motion. It consists of a piston, piston rod, cylinder barrel, and end caps. When compressed air is supplied to one end of the cylinder, it pushes the piston in the opposite direction, which in turn moves the piston rod and any attached load. The piston and piston rod are sealed to the cylinder barrel using seals or O-rings to prevent leakage of the compressed air.
- The function of a linear basic air cylinder is to provide linear force or motion in a wide range of industrial applications. It can be used for lifting, pushing, pulling, clamping, and holding objects. The force or motion generated by the cylinder depends on the size of the piston and the pressure of the compressed air supplied to it.
- Linear basic air cylinders are available in various types such as single-acting, double-acting, and telescoping cylinders. Single-acting cylinders use air pressure to extend the piston rod and a spring to retract it. Double-acting cylinders use air pressure to extend and retract the piston rod. Telescoping cylinders consist of multiple cylinders of different sizes nested inside one another, allowing for extended reach without increasing the overall length of the cylinder.

Fig.2 Linear: Basic Air Cylinder

2. SOLENOID VALVE :-

- A solenoid valve is an electromechanical device that controls the flow of fluids, such as air, water, or gas, by opening or closing a valve. The valve is composed of a coil, plunger, and spring. When an electric current is applied to the coil, it generates a magnetic field that attracts the plunger, compressing the spring and opening the valve.
- The function of the solenoid valve is to control the flow of fluid in a system. It can be used to start, stop, or modulate the flow of fluid by opening or closing the valve. The valve can be operated manually or automatically, depending on the application. In an automatic system, the solenoid valve can be controlled by a sensor or a microcontroller that sends an electrical signal to the valve to open or close it based on the system's needs.
- In pneumatic systems, solenoid valves are commonly used to control the flow of compressed air. They are used in various applications, such as controlling pneumatic cylinders, actuating valves, and controlling air pressure. Solenoid valves are also used in hydraulic systems to control the flow of hydraulic fluid.

3. ARDUINOUNO:-

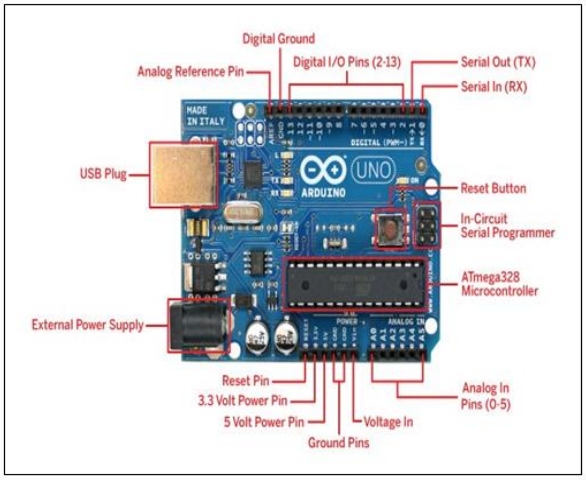

Fig.3 Arduino

Arduino Uno is a popular microcontroller board that is used for various electronic projects, including the design and development of smart pneumatic-based auto bumper and braking systems. The Arduino Uno board can be used to control and monitor various components of the system, such as sensors, actuators, and other electronic components.

Here are some specific functions of the Arduino Uno in the design and development of a smart pneumatic-based auto bumper and braking system:

- Sensor interface: The Arduino Uno can interface with various sensors such as ultrasonic sensors, infrared sensors, and pressure sensors, which are used to detect obstacles and other relevant parameters for the bumper and braking system.
- Control of pneumatic valves: The Arduino Uno can be used to control the opening and closing of pneumatic valves, which are used to control the air flow in the system and actuate the pneumatic actuators.
- Data acquisition and processing: The Arduino Uno can collect data from various sensors and process it to determine the appropriate action to take, such as activating the brakes or deploying the bumper.
- Communication interface: The Arduino Uno can be used to communicate with other electronic devices in the system, such as a display unit, a motor controller, or a wireless communication module.
- Programming and customization: The Arduino Uno is highly programmable and can be customized to suit the specific requirements of the pneumatic-based auto bumper and braking system. This allows for flexibility in the design and development of the system.

4. BEARING:-

The main objective of designing and developing a Smart Pneumatic Based Auto Bumper & Braking System is to enhance the safety and functionality of automobiles. The system is designed to detect obstacles in the path of a moving vehicle and activate the brakes or deploy the bumper to prevent collisions.

The specific objectives of this system can include:

- Accident prevention: The primary objective of the system is to prevent accidents and reduce the risk of injury to passengers and pedestrians.
- Improved vehicle control: The system can improve the control of the vehicle in different driving conditions, such as during sudden stops or emergency maneuvers.
- Increased driver awareness: The system can alert the driver of potential hazards, giving them time to react and prevent collisions.
- Reduced vehicle damage: The system can help to reduce the damage to the vehicle in the event of an accident.
- Increased overall vehicle safety: The Smart Pneumatic Based Auto Bumper & Braking System can improve the overall safety of the vehicle by providing an additional layer of protection against accidents.

Fig. 4 Bearing

5. SHAFT:-

In the design and development of a Smart Pneumatic Based Auto Bumper & Braking System, shafts are used in several different components to provide specific functions.

Here are some of the functions of shafts in this system:

- Power transmission: Shafts are used to transmit power from the motor or engine to other components in the system, such as the pneumatic pump or actuator.
- Torque transfer: Shafts are used to transfer torque from one component to another, such as from the motor to the pump or from the pump to the actuator.
- Rotation: Shafts are used to rotate components in the system, such as the wheels or the pneumatic cylinders.
- Support: Shafts are used to support and stabilize rotating components, such as the wheels or the flywheel.
- Alignment: Shafts are used to ensure proper alignment of the components in the system, which is important for efficient and safe operation.

6. SPROCKET:-

In the design and development of a Smart Pneumatic Based Auto Bumper & Braking System, sprockets are used in conjunction with chains to transmit power from one component to another. Here are some specific functions of sprockets in this system:

- Power transmission: Sprockets are used to transmit power from one component to another using a chain, such as from the motor to the wheels or from the motor to the pneumatic pump.
- Torque transfer: Sprockets are used to transfer torque from one component to another, such as from the motor to the wheels or from the pump to the actuator.
- Speed reduction or increase: Sprockets can be used to reduce or increase the speed of the system, depending on the ratio of the sprockets used in conjunction with the chain.
- Precision: Sprockets are designed to have precise teeth and pitch, ensuring accurate power transmission and reducing the chance of slippage or misalignment.
- Strength and durability: Sprockets are designed to be strong and durable, withstanding the forces and stresses involved in power transmission over time.

7. WIPER MOTOR:-

In the design and development of a Smart Pneumatic Based Auto Bumper & Braking System, a wiper motor is typically used to power the windshield wipers of the vehicle. Here are some specific functions of a wiper motor in this system:

- Powering the wiper blades: The wiper motor provides the necessary power to move the wiper blades back and forth across the windshield, clearing away rain, snow, and debris.
- Control of wiper speed: The wiper motor can be used to control the speed of the wiper blades, allowing for different speeds based on the weather and driving conditions.
- Integration with other systems: The wiper motor can be integrated with other systems in the vehicle, such as the rain sensor or the automatic headlight system, to provide coordinated functionality.
- Compact design: The wiper motor is designed to be compact and lightweight, allowing for easy installation and integration with other systems in the vehicle.
- Durability and reliability: The wiper motor is designed to be durable and reliable, providing long-lasting performance in a range of weather and driving conditions.

- Speed = 30rpm
- Voltage = 12V
- Bond = 1 Times
- Torque needed for motor is = 10Nm
- Power = 190watt
- cargo Current = 8/ 10A
- Weight = 4.8 kg ● Color-black

Fig.5 Wiper Motor

III. ANALYTICAL CALCULATIONS

FRAME DESIGN

Material used –mild steel, square pipe
Area=1*1inch=25.4*25.4=645.16mm2
Length of link=20 inch=508 mm
Weight of project=15 kg= 15*9.81 =147.15 N
Solution
1. Effective length
Effective length, when both ends fixed,
Le=L/2=508/2=254 mm
2. Internal Area
3 mm thickness,
d=b=38.1-2*3 =32.1 mm
3. Moment of inertia
I=(BD^3-bd^3)/12=(25.4*⟦25.4⟧^3-
19.4⟦*19.4⟧^3)/12=22882.048 mm4

4. Crippling load by Euler's formula
Pc=(π^2 EI)/⟦Le⟧^2 =(π^2*210*10^3*22882.048)/⟦254⟧^2 =
=735.1 kN

Motor Specification:-

Motor selection for wheels
Given

Diameter for wheel=170mm
Weight of wheel with assembly is =6kg
Torque required for one motor
Torque=force*radius of wheel
=6*9.81*85
=5003.1Nmm
=5 Nm
Therefore, we are selecting motor with min 5 torque.
By battery,
Voltage = 12V, Current = 1.3Amp, T= 5 Nm
Power output of DC motor is =voltage *current
=12*1.3
=15.6 watt
Power=2*pi*N*5/60
15.6=2*pi*N*5/60
N=29.79 rpm
This is the min rpm value.
so We are selecting motor with 30rpm

Bearing Dimension:-

We select the deep groove ball bearing
d = 20mm, D = 52mm
Bearing Designation = 6304

Pneumatic Cylinder:-

For Bumper,
Assumption: -
Maximum force acting on bumper =150 N
Factor of Safety =1.25
Pressure= 0.6 MPa
Total force acting on bumper= 150*1.25 = 187.5 N
For outstroke
F = P*A
187.5 = 0.6 *A
A = 312.5 mm2
We know that
A =π/4*D2
312.5= π/4*D2
D=19.94 mm

Consider standard diameter is equal to 20 mm
Instroke force = Outstroke force
Effective area = π/4*(202 –d2)
Where d= Piston rod area
F = P* A
187.5 =0.6* π/4*(202 –d2)
d =1.45 mm
Select standard diameter= 10mm
So Stroke length is equal to 50 mm.
Outstroke force (Fo) = Pressure *Area of cylinder
= 0.6*235.61
=141.371N
Outstroke force =instroke force =141.37N

Stopping distance calculation:-

Breaking distance= v2/2*μ*g
μ = coefficient of dry friction
= 0.7
Consider model velocity =2 m/s
breaking distance= v2/2*μ*g
= 22/ (2*0.7*9.81)
= 0.29m
Vehicle stopping distance after applying the brake
= 290mm
Total stopping distance
= Breaking distance +Bumper stroke
= 290+50
= 340 mm

Total stopping distance = 340 mm

Impact force calculation:-

Consider Velocity of our model = 2m/s
By equation of motion
2as = v2-u2

Where
s = Breaking distance,
v = Final velocity,
u =Initial velocity,
2*a*0.34 =02-22
A= ± 5.88 m/s2
We know that
Force = mass* accln
= 10* 5.88
Impact force =58.8 N

IX. DESIGN

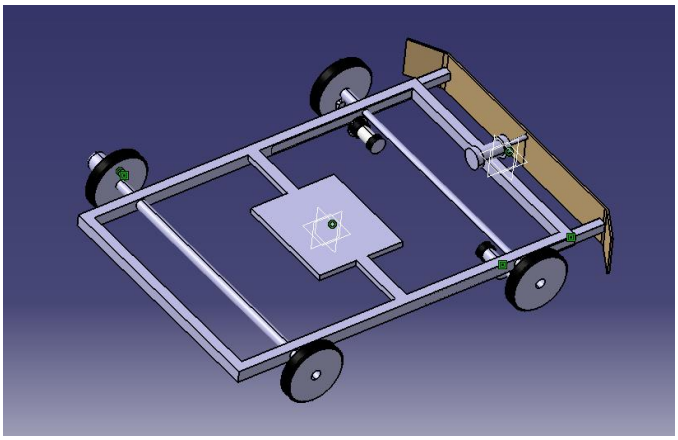

Fig .7 ISO View of Proposed Mechanical Frame

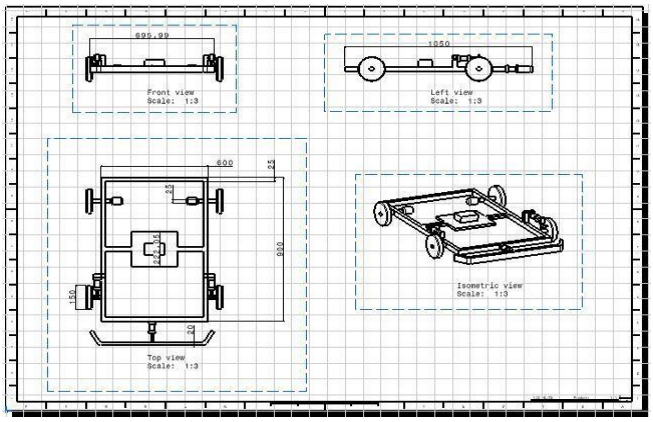

Fig .8 Drafting View of Proposed Mechanical Frame

Cost Estimation :-

Sr. No.	Content	Quantity	Cost
	Frame	1	1500
	Pneumatic cylinder	3	4500
	Solenoid valve	1	1400
	Arduino	1	500
	Ultrasonic sensor	1	250
	relay	1	300
	PU pipe	2	200
	battery	1	700
	Connecting wire		100
	Wheel	4	600
	shaft	1	500
	bearing	4	1000
	Hose pipe	-	400
	Fabrication and assembly	-	2000
	Total		13950/-

Table. 1 Cost Estimation

X. ACKNOWLEDGMENT

It's our proud honor and duty to admit the kind of help and guidance took from several people in making of this report. It would not have been possible to prepare this report in this form without their precious help, co- operation and guidance. We express our sincere gratefulness to our companion,

Prof.(Dr.) Manish Gaikwad, Department of Mechanical Engineering, JSCOE, Hadapsar, Pune for guiding us in examinations for this design and in carrying out experimental work. We hold him in regard for guidance, motivation and encouragement entered from him. Our sincere thanks to

Prof. (Dr.) Pradeep A. Patil, Head of the Department of Mechanical Engineering, JSCOE, for his precious suggestions and guidance throughout the period of this report. First and foremost, we wish to record our sincere gratefulness to operation of this council and to our *cherished lead*,

Prof.(Dr.) R.D. Kanphade*, lead, JSPM's*JayawantraoSawant College of Engineering, Hadapsar, Pune for his constant support and stimulant in making of this report and for making available library and laboratory installations demanded to prepare this report. The design on "Design & Development of Smart Pneumatic Based Auto Bumper & Braking System" was veritably helpful to us in giving the necessary background information and alleviation in choosing this content for the Project. Our sincere thanks to **Prof. (Dr.) EknathAitavade**, design main for having supported the work related to this design. His benefactions and specialized support in preparing this report are greatly conceded.

REFERENCES

[1] Intelligent Braking System with Automatic Pneumatic Bumper ,Mr. Nivesh Thepade1 Mr. LakhanThombare, Mr. PritishVarude, Prof. Ashish Umbarkar, IJSRD - International Journal for Scientific Research & Development| Vol. 4, Issue 04, 2016 [https://www.ijsrd.com/Article.php?manuscript=IJSRDV4I40131]

[2] Automatic pneumatic bumper, Shubham wasnik1 ketangedam,aamirsayed,Shubham mashankar4 shubhamlashkare, vipinraut [https://www.irjet.net/archives/V7/i9/IRJET-V7I9684]

[3] Automatic pneumatic bumper for two wheelerG.kedarnath,u.udaykiran,n.anilkumar,n.mahesh. Ijariie-issn, vol-3 issue-2 2017 [http://ijariie.com/AdminUploadPdf/AUTOMATIC_PNEUMATIC_BUMPER_FOR_TWO_WHEELER_ijariie3917]

[4] J.V.Sai Ram, K.M.S.V.Manikanta, G.Pavanth, B.Jagadeep ,Dr. B.Raghu Kumar Automatic Braking System Using Ultrasonic Sensor International Journal of Innovative Science and Research Technology Volume 2, Issue 4, April– 2017 [https://ijisrt.com/wpcontent/uploads/2017/05/Automatic-Braking-System-Using-Ultrasonic-Sensor]

[5] By Bilal Abdullah BaigHakimuddin. A. Hussain Dr. A. M. Langde Study of Impact onCar Bumper IJIRST – International Journal for Innovative Research in Science &Technology| Volume 2 | Issue 05 | October 2015 ISSN (online): 2349-6010 [http://www.ijirst.org/articles/IJIRSTV2I5044]