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Automatic Emergency Braking System using Hydraulic Actuator for Preventing Road Accidents

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Abstract: ***The active safety progression and its implementation reduce the number of fatalities universally at present. The system enables to assist the driver during emergency and risky. The conventional braking system never prevents the collision during critical situation during sudden braking and the vehicle tends to impact. The statistics describes that near miss accidents are huge. The autonomous braking system plays wide role today to prevent the accidents and sadly the system is used only in expensive vehicles. The proposed design and the system can use in the low end vehicles to reduce the fatality rate by using mechanical actuator is connected to the brake pedal for compressing whenever the IR sensor senses the object. The aim of the research is to sense the object and to stop down the vehicle during emergency.***

Keywords: IR sensor, hydraulic actuator, braking system.

I. INTRODUCTION

Automatic braking system uses an infra red technology in a large sort of wireless applications and the most of the areas such as sensing and remote control system. The electromagnetic spectrum is the infrared portion is spitted into three regions and they are close IR region, far IR region and middle IR regions. The wavelength of the regions and their applications are given. The close infrared region is 700 nm to 1400nm, fibre optic middle infrared sensor is 1400-3000nm and heat sensing infrared region is 3000nm to millimetre. For optical sensing and optical communication, icon optics technologies are utilized in the close to infrared region because the light-weight is a smaller amount complicated than RF once enforced as a supply of signal. Optical wireless communication is finished with IR information transmission for brief vary applications. The emergency braking system combination and with driver assistant system are used to slow down the automobile vehicle and potential warning before the collision. The research deals with the implementing of emergency braking using autotronics [1]. Today most of the automotive trendy vehicles rely upon automotive safety to cut back the harm and injury to the drivers and pedestrians. Machine driven safety systems besides enhancing active safety devices because of inflated rate of accidents in India. The results advised that several of those accidents were caused by basic cognitive process. Automatic braking system mix sensors technology with brake system to forestall high speed impact and number of the automated braking systems will stop collisions altogether however most of them are designed and placed for the luxurious high price vehicles. Since high-cost vehicles are additional doubtless to be fatal than affordable automatic braking systems will save lives and scale back the number of property harm that happens throughout an accident in traditional vehicles. a number of these systems use lasers others use radio detection and ranging and a few even use video information. The IR detector input is employed to work out if there is any objects gift within the path of the vehicle. The IR detector is placed before bumper; the system will then confirm the speed of the vehicle is larger than the speed of the thing before of it. A big speed of the vehicle could indicate that a collision is probably going to occur during which case the system is capable of mechanically activating the brakes. The signal from the IR detector that is connected to the stepper motor through control unit which create the braking system to manage at this example. The speed detector senses the speed of the vehicle and stepper motor is activated depends on the speed of the vehicle. The braking is activated by programmed within the management unit. The stepper motor that drags the braking cable which is connected to the front and rear wheels at variable force. However, automatic brakes will save your life if you ever suffer from a short lapse in concentration. The idea of this project is price effective and might be used these in rider vehicle [2]. Vehicle population has increased gradually as well collision increases rapidly due to drivers fault and collision due to brake failure, brake handling issues.

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Active safety systems research area had developed predominately day by day and reported that autonomous emergency braking system prevents the accidents and reduces the fatality rate. The research deals that offers a collision functionality in production vehicle, a system which can operate automatically with the help of high profile sensors based relay circuit and some modification in traditional braking system that can alert the driver in front collision and apply the brake automatically in emergency or critical situation [3].

II. PROPOSED SYSTEM

The propose system consists of number of components such as IR sensor kit, arduino controller and hydraulic actuator with brake pedal. The layout of the object detection shown in the fig 1. The IR sensor senses the object in front of the vehicle and the signal is forwarded to controller unit and the warning signal is given to the driver. If the driver not responses automatically the controller activates the braking system by measuring the speed of the vehicle and the braking is applied depends on the speed of the vehicle. The infrared system can detects the objects which is present front of the sensor. The system consists of transmitter and receiver. The IR transmitter also called as IR LED. The transmitter sends a signal with certain frequency with the IR receiver which had a task to sense it. There are varieties of sensor to detect the objects such as proximity sensor is used to detect the nearby objects, contrast sensor to find the way to find the objects.

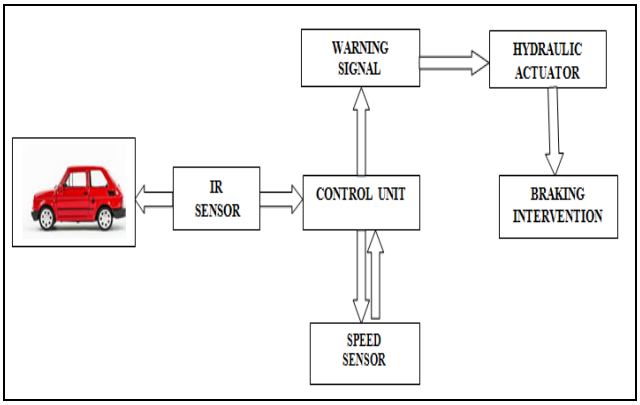

Fig.1. Layout of proposed system

The IR sensor which is the one used for sensing the objects distance which is present in front of the vehicle. The autonomous braking system is used to sense the object and the brake down the vehicle speed during sudden object detection. The infrared LED is a simple working which consumes 3V DC voltage and the 20 mA. The infra red receiver consists of photodiode used for detecting the infrared radiation and it is emitted from the transmitter. The LM358 is used as diode and with resistors. The circuit diagram of object detection system shown in the fig 2. The resistors R1, R2, R3 and voltage regulators for carrying the voltage channels to simply the circuit without any damages.

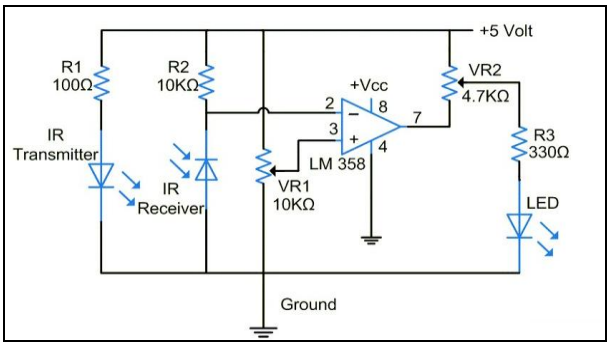

Fig.2. Circuit diagram of IR sensor

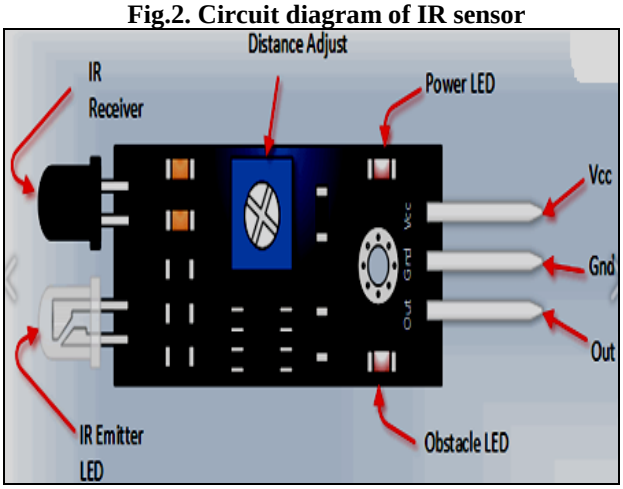

Fig.3. Schematic diagram of object detection system [18]

1. Vcc – 3-5V power supply
2. Gnd – reference
3. Out- digital output

The fig 3 shows the object detection system which consists of receiver, transmitter used for detecting the object and receives the signal from the object. The distance is measured by using the IR sensor and varies depends upon the vehicle speed and distance of obstacles or object which is present in front of the sensor.

III. HYDRAULIC ACTUATOR

The hydraulic actuator which is used for compressing the brake pedal of the vehicle and the system is designed for the passenger vehicles. The hydraulic actuator is designed, modeled and tested in vehicle. The actuator is connected to the brake pedal and it controls by using the controller. The dominions of the actuator are customized by calculating the dimensions and the actuator is designed. The actuator made up of cylinder barrel, inlet ports, exit port for fluid movement and the piston. The dimensions of the hydraulic actuator shown in the fig 4. The piston one end which is connected to the brake pedal of the vehicle. The compression and extraction depends upon the solenoid valve compression by the signal from the controller or by IR sensor.

The size of the barrel determines the force produced in the cylinder. The piston design is calculated as per the displacement length. The cylinder barrel 1.8 inches and the piston rod are 0.6 inches for extraction. The stroke length of the piston is 6.69 inches for compressing the brake pedal. The hydraulic actuator made up of aluminum alloys for thermal resistance and the alloying elements are magnesium, zinc, copper, tin, Silicon. The maximum load applied on the piston is 1900N which can withstand and the minimum load enough for compression is 200N.

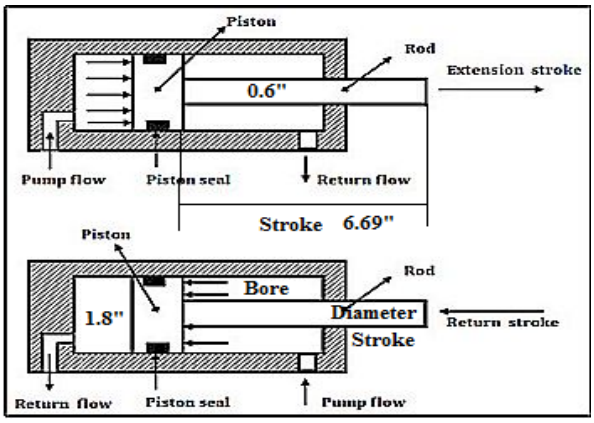

Fig.4. Dimensions of the actuator

The analysis of piston is tested using anysis software and the test is conducted is load test and thermal test is made by using the maximum load and minimum load shown in figure 5 AND 6. The deformation is analyzed during load and thermal loads were given. The minimum load is 200N is given and the maximum load 2000N which the piston can withstand. The maximum load required for the braking is 200N. The assembled design shown in the fig 5 and 6 which is the complete part after analysis and the real time model are shown in the fig 7. The real time model is used for testing the system which is incorporated in the testing vehicle.

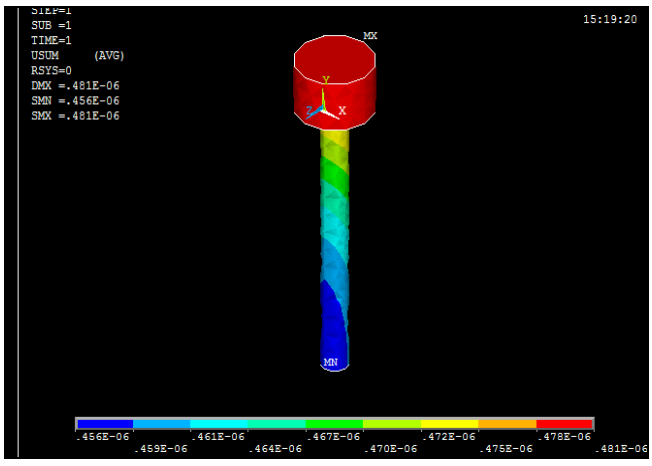

Fig.5. Piston analysis

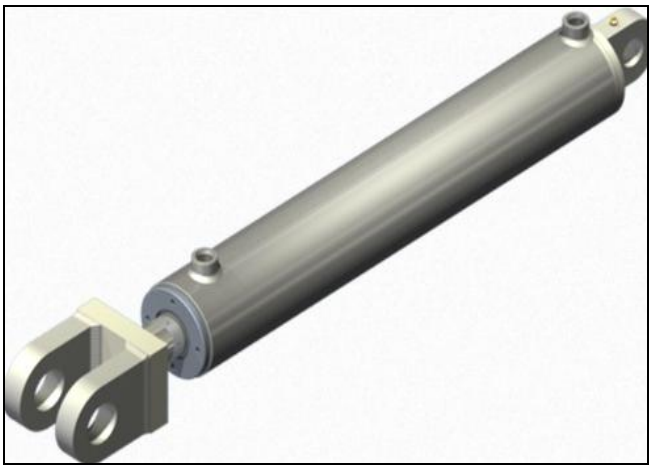

Fig.6. Actuator assembled model

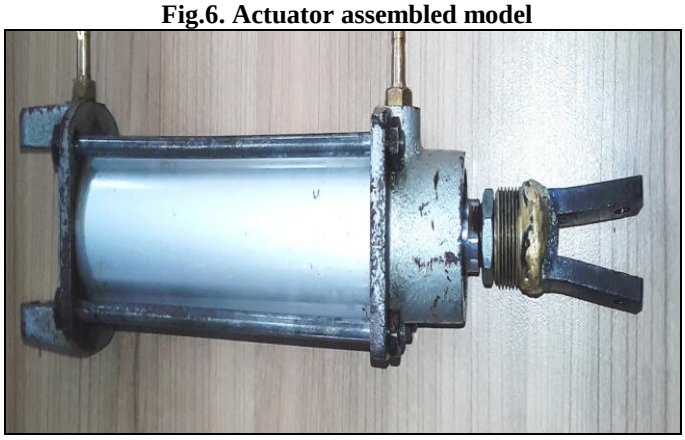

Fig.7. Hydraulic actuator

The piston is designed for the distance between the actuator piston and brake lever. The total piston stroke length of the actuator is 169 mm for compressing the pedal. The piston length is the important criteria for compressing the brake pedal of the vehicle.

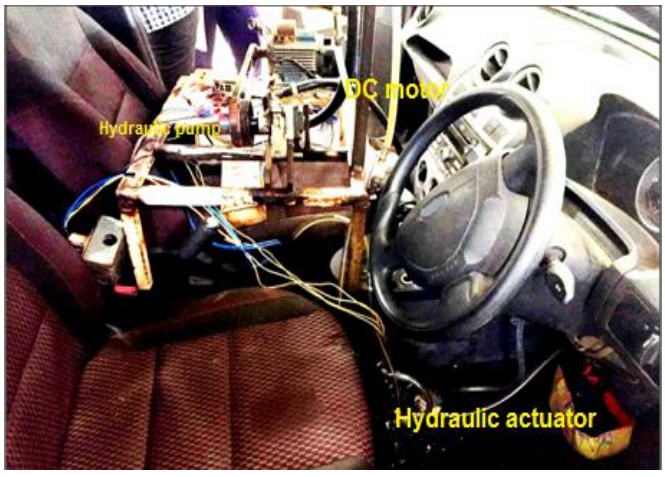

Fig.8. Experimental setup for testing

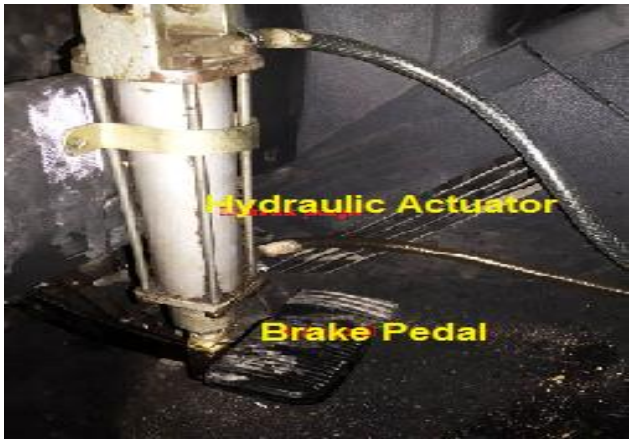

Fig.9. hydraulic actuator setup for testing

IV. RESULTS AND DISCUSSIONS

The proposed system is tested as experimentally by incorporating in the passenger vehicle and the testing is done by using chassis dynamometer. The vehicle is placed on the chassis dynamometer for calculating the stopping distance. The hydraulic actuator is connected to the brake pedal of the vehicle and IR sensor which is placed in the bumper for the testing. The testing is done by placing the object in front of the bumper and makes the actuator to activate therefore to compress the brake pedal of the vehicle. The purpose of IR sensor is used to sense the object and gives the signal to the actuator to activate and this process is tested for the static condition. The speed of the vehicle is calculated by using the dashboard speedometer. The stopping distance is calculated by using the reaction distance and braking distance of the vehicle.

The stopping distance is calculated for the proposed system for automatic braking. The table 1. Shows the stopping distance calculation of proposed system. The stopping distance is calculated by considering the reaction distance and braking distance. The reaction distance defines the response time taken to realise the object is present after by seeing the naked eye. The response time duration covers the distance that distance called as reaction distance. The response time for the average human is 1 to 2 seconds and the braking distance defines when the driver starts to compress the brake pedal duration and the vehicle covers the certain distance called as braking distance. The reaction and braking distance combined and calculated the distance called as stopping distance. The automatic manual braking system or proposed system braking distance is calculated by the formulae in equation 1 & 2.

The stopping distance calculated by using the formulae.

(1) Reaction distance calculation

$$d = (v \times r) / 3.6 \ldots\ldots\ldots\ldots (1)$$

d = reaction distance in meters
v = speed in km/h.
r = max reaction time in seconds (1.5 second).
1/3.6 = fixed for converting km/h to m/s.

Reaction distance = **41 meters** for 100km/hr on dry road.

(2) Braking distance calculation [4]

Conditions: 1.Good and dry road conditions
2. Good tires and good brakes.

$$d = V^2 / 2\mu g \ldots\ldots\ldots\ldots\ldots\ldots (2)$$

d = reaction distance in meters
v = speed in km/h.
μ = coefficient of friction (0.8) [5]
g = acceleration due to gravity m/s^2

Braking distance
= 49.3 meters for 100km/hr on dry road.

Stopping distance
= Reaction distance + Braking distance
= **90.3 meters**

Table.1. Theoretical Braking distance calculation

Speed	Reaction distance	Braking distance	Stopping distance
(Km/hr)	(m)	(m)	(m)
10	4	0.5	4.5
20	8	2.2	10.2
30	12	4.6	16.6
40	16	8.2	24.2
50	20	12.5	33.5
60	24	18.2	42.2
70	29	24.5	53.6
80	33	32.2	65.3
90	37	40.7	77.7
100	41	49.3	90.3

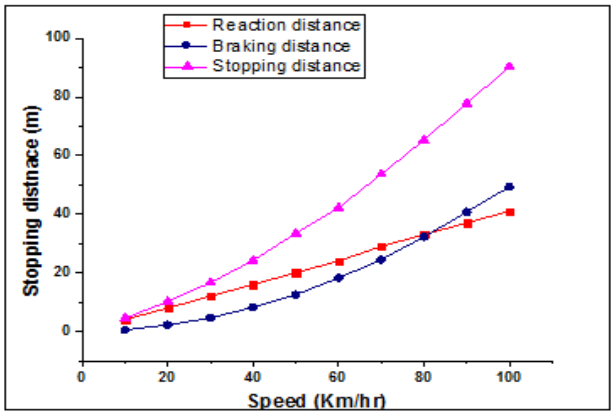

Fig.10. Effect of stopping distance on speed (graphical)

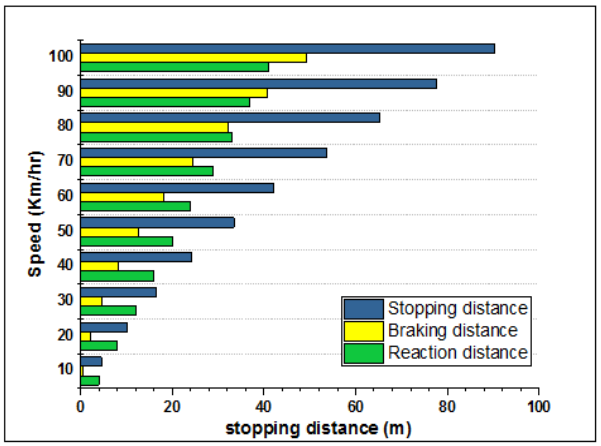

Fig.11. Effect of stopping distance vs speed

V. CONCLUSION

The proposed system senses the object detection which is present in front of the vehicle. Whenever the sudden object detection is detected the speed of the vehicle is reduced by applying the brake gradually after the warning signal. The velocity of the vehicle is reduced by using hydraulic actuator which is connected to brake pedal to compress during emergency. The stopping distance is calculated for the proposed system and the automatic braking is activated before vehicle impacts. The proposed system reduces the collision and damage to the vehicle.

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