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Intelligent Braking System in Automobile Applications

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Abstract: This paper provides an efficient way to design an automatic car braking system using Fuzzy Logic. The system could avoid accidents caused by the delays in driver reaction times at critical situations. The proposed Fuzzy Logic Controller is able to brake a car when the car approaches for an obstacle in the very near range. Collision avoidance is achieved by steering the car if the obstacle is in the tolerable range and hence there is no necessity to apply the brakes. Another FLC (which is cascaded with the first FLC for collision avoidance) implements the Anti-lock Braking capability during heavy braking condition. Thus the system is made intelligent since it could take decisions automatically depending upon the inputs from ultrasonic sensors. A simulative study is done using MATLAB and Lab view software. The results obtained by the simulation model are compared with the existing system and the proposed model conveys a satisfactory result which has high consumer acceptance.

Keywords: Ultrasonic Sensors, ABS, Solenoid valve, Brake force distribution, Control unit, Pneumatic brake.

I. INTRODUCTION

The number of automobile users is increasing day by day. At the same time, traffic congestion has become a worldwide problem. This problem is mainly due to human driving which involves reaction time delays and judgment errors that may affect traffic flow and cause accidents. Engineers in the automotive industry put a lot of effort in devising systems which ensure safety in road vehicles. Even with all the advancements in vehicle safety technology, the number of people killed in auto accidents continues to rise. Close to 1.2 million people die each year on the world's roads and that number is expected to rise by 65 percent by the year 2020, says a report by World Health Organization (WHO) and the World Bank. Braking system is the most important system in a car. Generally, a car brake system is operated manually as the driver pushes the brake pedal. If the brake fails, the result can be disastrous. Countless rear-ending automobile accidents could have been prevented or at least reduced in damage cost if the rear-ending driver had applied a sufficient amount of brake pressure at the right time. Unfortunately, the time required by the driver to understand potential accident situations, compounded with driver’s delayed reaction times in applying the brakes, usually causes a lag between the identification of a potential accident situation and the execution of the corrective actions that will prevent the accident. Hence, in such emergency situations an efficient control mechanism has to be employed to avoid accidents. Therefore, by automating the task of assessing the situation and deciding the correct amount of brake pressure, we could prevent numerous accidents. By that means, the car brake itself should have a good software system to assist a driver along the road. This would significantly decrease the amount of property and monetary loss due to accident damage, and it could save lives. There are two issues related to the design of intelligent braking system. Collision Avoidance (CA) is a hard and demanding process for driving autonomous vehicles. The challenge in designing a Collision Avoidance system is in balancing the effectiveness of avoiding collisions versus the risk of false alarms. False alarms are extremely critical, because they may lead to serious consequences. This is used in a critical situation by braking and/or steering the car as long as the accident is still avoidable. Antilock braking is another issue in designing an efficient braking system in automobiles. Conventionally, in automobiles equipped with ABS, it is a part of the engine control unit and prevents the locking up of wheels. Hence, applying fuzzy logic to intelligent control seems to be an appropriate way to achieve this human behaviour, because driver’s experience can be transformed easily into rules and any kind of nonlinearities can be easily tackled.

A. Safety System

The aim is to design and develop a control system based on pneumatic breaking system of an intelligent electronically controlled braking system for comparison of iterative

1) The final phase of the new modern vehicle shall include
a) Development of improved ABS control systems.
b) Development and assessment of an electro-hydraulic BBW (EH-BBW) system.
c) Individual wheel braking combined with traction control.
d) Assessing sensor failure and fault tolerant control system design.
Preliminary studies into an electrically actuated system.
e) Re-engineering using simplified models.

B. Pneumatics

The word ‘pneuma’ comes from Greek and means breather wind, for automation. Pneumatic systems operate on a supply of compressed air which must be made available in sufficient quantity and at a pressure to suit the capacity of the system. When the pneumatic system is being adopted for the first time, however it wills indeed the necessary to deal with the question of compressed air supply.

C. Antilock Braking System

An anti-lock braking system or anti-skid braking system (ABS) is an automobile safety system that allows the wheels on a motor vehicle to uphold tractive contact with the road surface according to driver inputs while braking, preventing the wheels from locking up (ceasing rotation) and avoiding uncontrolled skidding. It is an automated system that uses the principles of threshold braking and cadence braking which were practiced by experienced drivers with previous generation braking systems. It operates at a much faster rate and with better control than a driver could manage.

ABS generally offers better vehicle control and decreases stopping distances on dry and slippery surfaces however, on loose gravel or snow-covered surfaces, ABS can increase braking distance, although still getting better vehicle control.

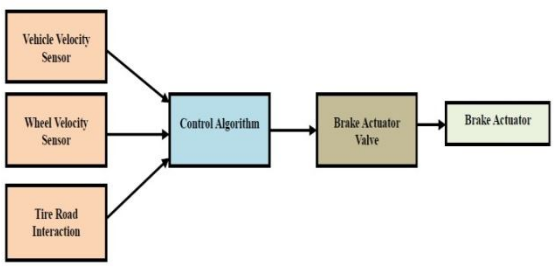

Fig: 1 Block representation of an ABS

D. Actuators

An actuator is a type of motor that is accountable for moving or controlling a mechanism or system. It is operated by a source of energy, in general electric current, hydraulic fluid pressure or pneumatic pressure, and converts that energy into motion. An actuator is the mechanism by which a control system acts upon an environment. There are various types of actuators used, and are as follows

1) Hydraulic actuator
2) Pneumatic actuator
3) Electric actuator
4) Thermal or magnetic actuators
5) Mechanical actuator

II. PRINCIPAL COMPONENTS OF ULTRASONIC SENSOR

Ultrasonic ranging and detecting devices make use of high-frequency sound waves to detect the presence of an object and its range. These systems either measure the echo reflection of the sound waves from objects or detect the break of the sound beam as the objects pass between the transmitter and receiver. An ultrasonic sensor characteristically utilizes a transducer that produces an electrical output pulse in response to the received ultrasonic energy.

The normal frequency range for hearing of humans is approximately around 20 to 20,000 hertz. Ultrasonic sound waves are the sound waves that are above the range of human hearing ability and, so have a frequency above 20,000 hertz. Any frequency which is above 20,000 hertz may be considered as ultrasonic. Most of the industrial processes, including almost all the sources of friction, create some ultrasonic sound. The ultrasonic transducer creates signals. These wave signals transmit through a sensing medium and the same transducer can be used to sense the returning signals. Ultrasonic sensors usually have a piezoelectric ceramic transducer that converts an excitation electrical signal into ultrasonic energy bursts. This energy bursts travel from the ultrasonic sensor, bounce off objects, and are returned as echoes. Transducers are the devices that convert electrical energy to mechanical energy, or vice versa. The transducer converts these echoes into analog electrical signals that are outputs from the transducer.

The piezoelectric effect refers to the voltage produced between surfaces of a solid dielectric (no conducting substance) when some mechanical stress is applied to it. On the other hand, when a voltage is applied across certain surfaces of a solid that exhibits the piezoelectric effect, the solid undergoes a mechanical deformation. Such type of solids characteristically resonates within narrow frequency ranges. These materials are generally used in transducers. For example, they are used in phonograph cartridges, strain gauges, and microphones that produce an electrical output from a mechanical input. Also, they are used in earphones and ultrasonic transmitters that produce a mechanical output from an electrical input.

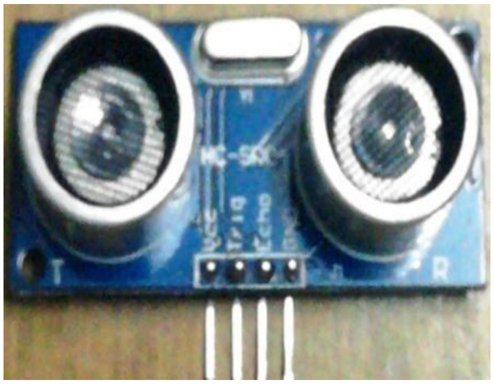

Fig: 2 Ultrasonic Sensor

III. MEASUREMENT PRINCIPLE AND EFFECTIVE USE OF ULTRASONIC SENSOR

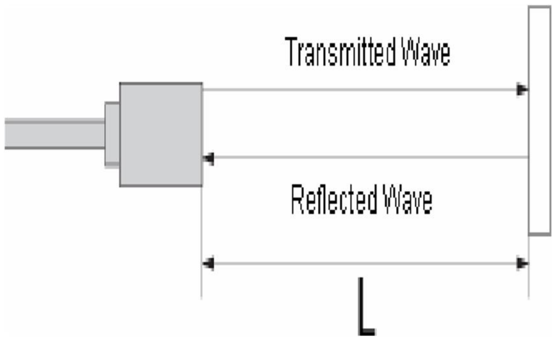

Fig: 3 Operation of sensor

Ultrasonic sensor transmits ultrasonic waves from its sensor head and again receives the ultrasonic waves reflected from an obstacle. By measuring the length of time from the transmission to reception of the ultrasonic wave, it detects the distance and hence the position of the object. These signals are like audible sound waves, except that the frequencies are much higher than them. Our ultrasonic transducers have piezoelectric crystals which resonate to a required frequency and convert electric energy into acoustic energy and vice versa. The below illustration shows how sound waves, transmitted in a conical shape, are reflected from a target back to the transducer. Accordingly, an output signal is produced to perform some kind of indicating or control function. A certain minimum distance from the sensor is required to provide a time delay so that the "echoes" can be interpreted. Some variables which can affect the operation of ultrasonic sensing comprise, target surface angle, reflective surface roughness or changes in temperature or humidity. Targets can have any kind of reflective form. Even round objects can be targets.

IV. METHODOLOGY

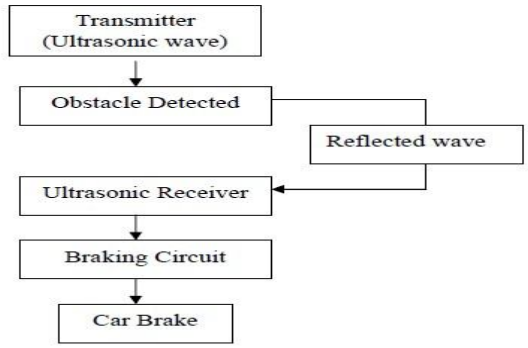

Fig.4 Model block diagram

V. COMPONENTS AND DESCRIPTION

A. Selection Of Pneumatics

Mechanization is broadly defined as the replacement of manual effort by mechanical power. Pneumatics is an attractive medium for low cost automation chiefly for sequential or repetitive operations. May be economic and can be favourably applied to other forms of power).The main advantages of an all-pneumatic system are usually economy and simplicity, the latter reducing maintenance to a low level. It can also have outstanding advantages in terms of safety.

B. Pneumatic components and its description

The pneumatic bearing press consists of the following components to fulfil the requirements of complete operation of the machine.

1) Pneumatic single acting cylinder
2) Solenoid valve
3) Flow control valve
4) IR sensor
5) Unit Wheel and brake arrangement
6) PU connector,
7) Reducer
8) Hose
9) Collar
10) Stand
11) Single phase induction motor.

C. Pneumatic Single Acting Cylinder

Pneumatic cylinder consist of

1) Piston
2) Cylinder

The cylinder is a Single acting cylinder one, which means that the spring returns backward and air pressure operates forward. The air from the compressor is passed through the regulator which controls the pressure to required amount by adjusting its knob. A pressure gauge is attached to the regulator for showing the line pressure. Then the compressed air is passed through the single acting 3/2 solenoid valve for supplying the air to one side of the cylinder.

Fig 5.1 Single Acting Cylinder

One tube takes the output of the directional Control valve and they are connected to one end of the cylinder by means of connectors. One of the outputs from the directional control valve is taken to the flow control valve from taken to the cylinder. The hose is fond of to each component of pneumatic system only by the help of connectors.

VI. METHODOLOGICAL DATA

Single acting pneumatic cylinder

Stroke length : 140 mm = 0.14 m , No. of. Seals: 1 , Seals : Nitride (Buna-N) Elastomeric , End cones: CI, Piston: EN – 8 Media : Air ,Temperature : 0-82 ºC ,Pressure Range: 8 bar.

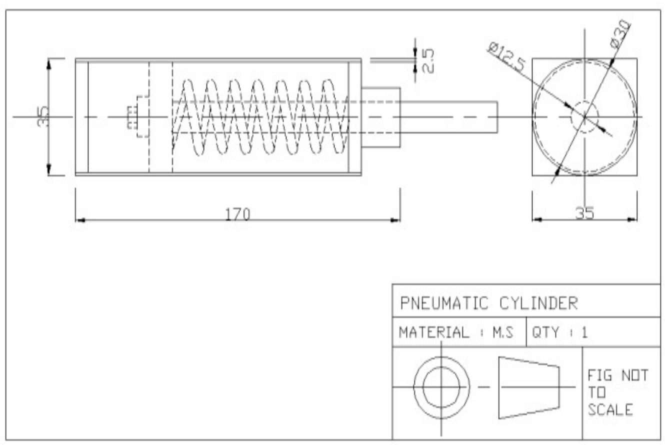

Fig 5.2 Pneumatic Cylinder

A. *Solenoid Valve With Control Unit*

Fig 5.3 Solenoid valve

It is used to operate a mechanical operation which in turn operates the valve mechanism.

B. Brakes

Brake is a mechanical device which inhibits motion or stopping a motion object or preventing its motion. It is generally applied to rotating axles or wheels, but may also take other form such as the surface of a moving fluid.

C. Ir Sensor Unit

The IR transmitter and IR receiver circuit is used to sense the obstacle.

1) Normal Condition The IR transmitter sensor is transmitting the infrared rays with the help of 555 IC timer circuit.

2) Obstacle Condition At Obstacle conditions the IR transmitter and IR receiver, the resistance across the Transmitter and receiver is high due to the non conductivity of the IR waves.

3) Wheel And Braking Arrangement It is fixed to the frame stand.

Fig 5.4 Wheel

4) Pu Connectiors, Reducer And Hosecollar In our pneumatic system there are two types of connectors used; one is the hose connector and the other is the reducer.

VII. CONCLUSION

The existing system used Bang-bang or PID controller in the electronic control unit of the car to prevent the locking up of wheels. The proposed system uses Fuzzy Logic to design the controller and hence the system is more reliable than the existing system and has wide consumer acceptance. It can be summarized that the proposed system has high values of braking deceleration compared to that of the existing Bang-bang controller. Hence, the vehicle could be stopped in a short distance compared to the existing system. The simulation results shows that the curve settles down smoothly and the car will not experience any jerks at high braking conditions in contrast to the existing system.

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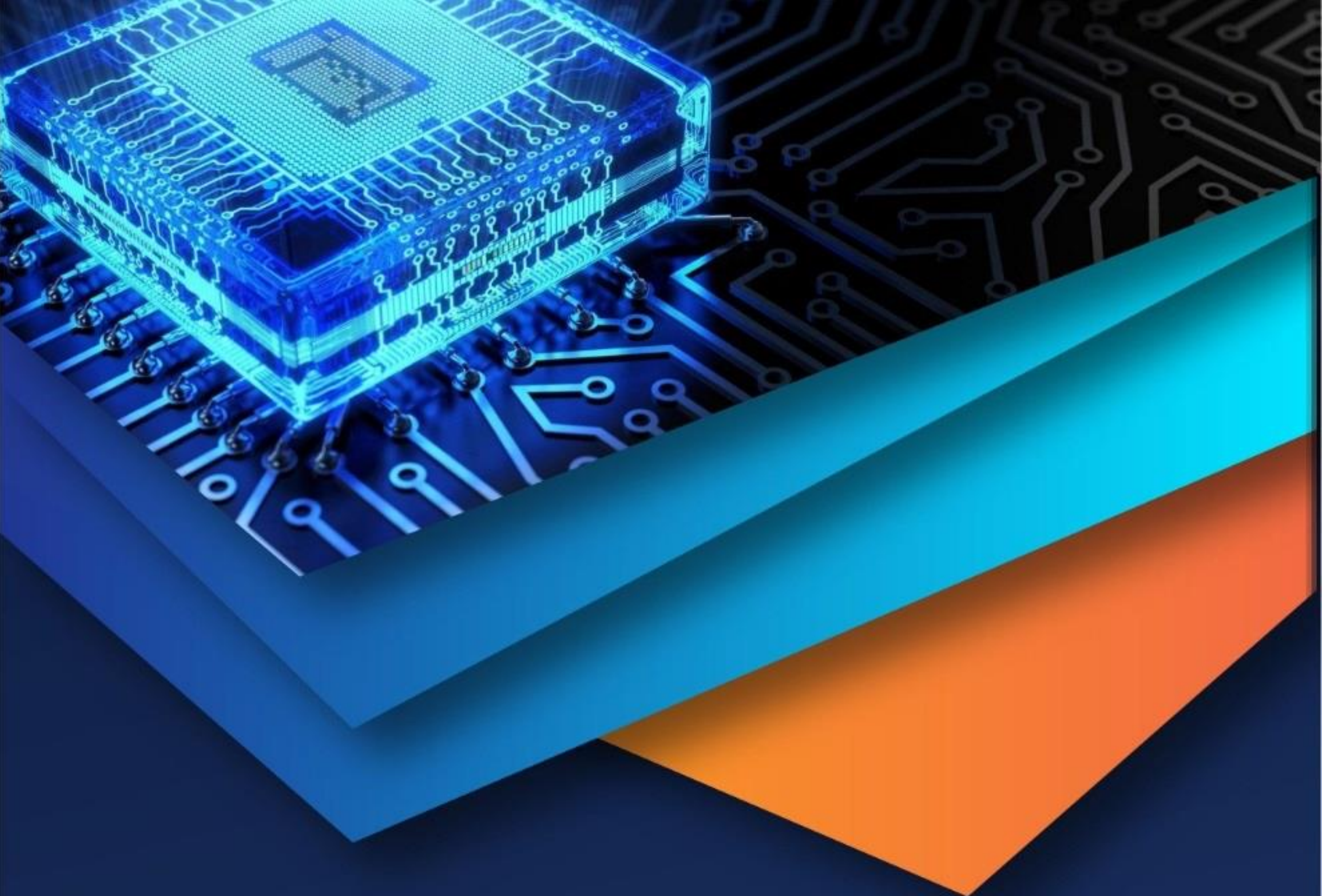

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