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DESIGN AND FABRICATION OF AN AUTOMATIC CAR BRAKING SYSTEM USING ULTASONIC SENSOR

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Abstract*- The aim of this project is to design and fabrication of an automatic breaking system for a car to avoid accidents. This system includes; an ultrasonic wave emitter provided in a front portion of an automatic braking car producing and emitting ultrasonic waves frontward in a predetermined distance in front of the car. Ultrasonic receiver also formed in a front portion of the car operatively receiving a reflective ultrasonic wave signal as reflected by obstacles positioned within the pre-determined distance in front of the automatic braking car. The reflected wave (detection pulse) was measured to get the distance between the vehicle and the obstacle. Then a servo motor is controlled based on detection pulse information to brake the car intermittently for a safe braking purpose. The model is designed so that it breaks when there is any obstacle within 30cm in front of it.*

Keywords: Car breaking system, Automation, Ultrasonic Sensor.

1. INTRODUCTION

Driving is a compulsory activity for most people. People use their car to move from one place to other place. The number of vehicle is increasing day by day. Nowadays, the numbers of accident is very high. These accidents are mostly caused by the delay of the driver to hit the brake[1].

This project is designed to develop a new system that can solve this problem where drivers may not brake manually but the vehicles can stop automatically due to obstacles. This project is about a system that can control braking system for safety. Using ultrasonic as a ranging sensor, its function based on ultrasonic wave. After transmit by transmitter, the wave can reflect when obstacle detected and receive by receiver. The function of the braking circuit is to brake the car automatically after received signal from the sensor.

1.1 Car breaking system:

Braking system is the most important system in a car. If the brakes fail, the result can be disastrous. The brakes are in essence energy conversion devices, which convert the kinetic energy of the vehicle into thermal energy.

1.2 Car breaking issues:

Traffic congestion is a worldwide problem. This problem is mainly due to human driving which involves reaction times, delays, and judgment errors that may affect traffic flow and cause accidents. In many such cases, the cause of the accident is driver distraction and failure to react in time. Advanced system of auxiliary functions has been develop to help avoid such accident and minimize the effects of collision should one occur. This is done by reducing the total stopping distance. By that means, the car brake itself should have a good software system to assist a driver along the road[2].

The purpose of the automated car braking system is to develop an automated control system that would maintain a safe driving distance from obstacles while in traffic. The system will successfully detect an obstacle ahead at a specific range and create a way for the system to avoid collision by braking the car. By that, it will results in a more enjoyable and less stressful drive.

1.3 Need for automation:

Automation can be achieved through computers, hydraulics, pneumatics, robotics, etc., of these sources, pneumatics form an attractive medium for low cost automation.

Automation plays an important role in mass production.

- To reduce man power
- To increase the efficiency of the vehicle
- To reduce the work load
- To reduce the fatigue of workers
- To achieve good product quality
- Less Maintenance

1.4 Ultrasonic sensor:

Ultrasonic sensors (also known as transceivers when they both send and receive) work on a principle similar to radar or sonar which evaluate attributes of a target by interpreting the echoes from radio or sound waves

respectively. In comparison to X-Rays, ultrasonic encompasses a region where the frequency is much lower. Ultrasonic or supersonic implies a range of frequencies above the audible range. We, the human beings can listen to frequencies in the range between 20Hz to 20,000 Hz. Ultrasonic can currently be produced for frequencies as high as 10^9 Hz [3].

Fig. 1: An ultrasonic sensor.

1.5 Fundamentals of ultrasonic sensor:

Ultrasonic ranging and detecting devices use high-frequency sound waves to detect the presence of an object and its range. The systems either measure the echo reflection of the sound from objects or detect the interruption of the sound beam as the objects pass between the transmitter and receiver.

An ultrasonic sensor typically utilizes a transducer that produces an electrical output in response to received ultrasonic energy. The normal frequency range for human hearing is roughly 20 to 20,000 hertz. Ultrasonic sound waves are sound waves that are above the range of human hearing and, thus, have a frequency above about 20,000 hertz. Any frequency above 20,000 hertz may be considered ultrasonic[3].

Most industrial processes, including almost all source of friction, create some ultrasonic noise. The ultrasonic transducer produces ultrasonic signals. These signals are propagated through a sensing medium and the same transducer can be used to detect returning signals. Ultrasonic sensors typically have a piezoelectric ceramic transducer that converts an excitation electrical signal into ultrasonic energy bursts. The energy bursts travel from the ultrasonic sensor, bounce off objects, and are returned toward the sensor as echoes. Transducers are devices that convert electrical energy to mechanical energy, or vice versa. The transducer converts received echoes into analog electrical signals that are output from the transducer[3].

The piezoelectric effect refers to the voltage produced between surfaces of a solid dielectric (non-conducting substance) when a mechanical stress is applied to it.

Conversely when a voltage is applied across certain surfaces of a solid that exhibits the piezoelectric effect, the solid undergoes a mechanical distortion. Such solids typically resonate within narrow frequency ranges. Piezoelectric materials are used in transducers, e.g., phonograph cartridges, microphones, and strain gauges that produce an electrical output from a mechanical input. They are also used in earphones and ultrasonic transmitters that produce a mechanical output from an electrical input[3].

Ultrasonic transducers operate to radiate ultrasonic waves through a medium such as air. Transducers generally create ultrasonic vibrations through the use of piezoelectric materials such as certain forms of crystal or ceramic polymers.

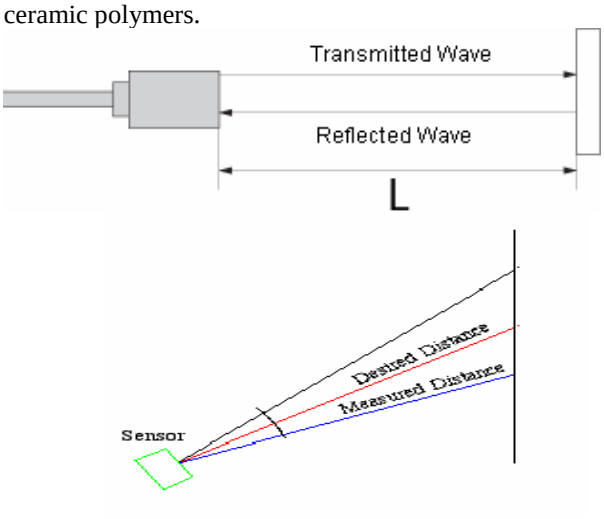

Fig. 2: Basic ultrasonic operation.

Target angle: This term refers to the "tilt response" limitations of a given sensor. Since ultrasonic sound waves reflect off the target object, target angles indicate acceptable amounts of tilt for a given sensor.

Beam spread: This term is defined as the area in which a round wand will be sensed if passed through the target area. This is the maximum spreading of the ultrasonic sound as it leaves the transducer.

There are several environmental factors that affect the operational procedure if an ultrasonic sensor, i.e.

1. Temperature.
2. Air turbulence and convection currents.
3. Atmospheric pressure.
4. Humidity.
5. Acoustic Interference.
6. Radio frequency interference.
7. Splashing liquids.

1.6 Sensors target considerations:

Composition: Nearly all targets reflect ultrasonic sound and therefore produce an echo that can be detected. Some textured materials produce a weaker echo, reducing the maximum effective sensing range. The reflectivity of an object is often a function of frequency. Lower frequencies can have reduced reflections from some porous targets, while higher frequencies reflect well from most target materials. Precise performance specifications can often be determined only through experimentation.

Shape: A target of virtually any shape can be detected ultrasonically if sufficient echo returns to the sensor. Targets that are smooth, flat, and perpendicular to the sensor's beam produce stronger echoes than irregularly shaped targets. A larger target relative to sound wavelength will produce a stronger echo than a smaller target until the target is larger than approximately 10 wavelengths across. Therefore, smaller targets are better detected with higher frequency sound. In some applications a specific target shape such as a sphere, cylinder, or internal cube corner can solve alignment problems between the sensor and the target[3].

1.7 Target orientation to sensor:

To produce the strongest echoes, the sensor's beam should be pointed toward the target. If a smooth, flat target is inclined off perpendicular, some of the echo is deflected away from the sensor and the strength of the echo is reduced. Targets that are smaller than the spot diameter of the transducer beam can usually be inclined more than larger targets. Sensors with larger beam angles will generally produce stronger echoes from flat targets that are not perpendicular to the axis of the sound beam. Sound waves striking a target with a coarse, irregular surface will diffuse and reflect in many directions. Some of the reflected energy may return to the sensor as a weak but measurable echo. As always, target suitability must be evaluated for each application[3].

2. DESIGN & FABRICATION OF THE SYSTEM:

There are three systems in the model. They are –

1. Mechanical system
2. Electrical system
3. Programming of microcontroller

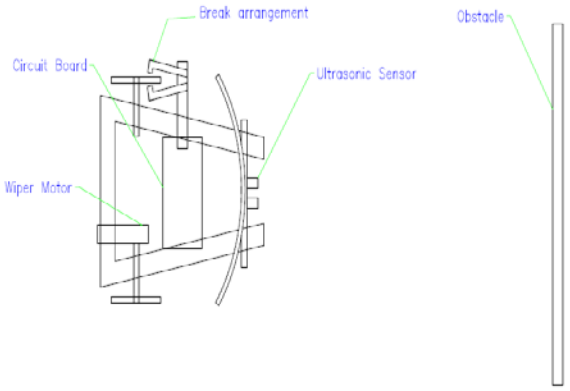

Fig. 3: Design of the model.

2.1 Mechanical System:

The Automatic Breaking System is installed in a toy car. The mechanical part consists of:

Wheels: A wheel is a circular component that is intended to rotate on an axial bearing. The wheel is one of the main components of the wheel and axle which is one of the six simple machines. Wheels, in conjunction with axles, allow heavy objects to be moved easily facilitating movement or transportation while supporting a load, or performing labor in machines. The diameter and width of wheel in the toy car used are respectively 5 inch and 0.8 inch.

Shafts: Shaft is a mechanical component for transmitting torque and rotation. In my project the toy car has shaft to connect wheels with motor and frame.

Frame: I have made a wooden frame because it is lighter than metal. I have made a three wheeler car and give this car a triangular shape. Solar panel can also be attached to the frame and directly connected to the motor when the car will run in a sunny day.

Steering: I have used steel pipe for steering. I have made a collar on front wheel and welded a steel pipe with it. Then I connected this with the main frame of the car by using two flay bars. For preventing rust, I have colored the steering.

Fig. 5: Steering.

2.2 Electrical System: The Required equipment's of this system are:

- 1 Microcontroller
- 1 Relay
- 1 Servo motor
- 1 Ultrasonic sensors
- Electrical wire
- Breadboard
- 1 push - push switch
- One 6V Battery and one 12V Battery etc.

PIC16F877A Microcontroller:

The Core Features of PIC16F877A are:

• High performance RISC CPU

• Only 35 single word instructions to learn

• All single cycle instructions except for program branches which are two cycle

• Operating speed: DC - 20 MHz clock input DC - 200 ns instruction cycle

• Up to 8K x 14 words of FLASH Program Memory, Up to 368 x 8 bytes of Data Memory (RAM) Up to 256 x 8 bytes of EEPROM Data Memory

• Pinout compatible to the PIC16C73B/74B/76/77

• Interrupt capability (up to 14 sources)

• Eight level deep hardware stack.

Battery: An electric battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. Each battery consists of a negative electrode (anode) that holds charged ions, a positive electrode (cathode) that holds discharged ions, an electrolyte that allows ions to move from anode to cathode during discharge (and return during recharge) and terminals that allow current to flow out of the battery to perform work. In my project I have used one 6V rechargeable lead acid battery and one 12V rechargeable lead acid battery that can be discharged and recharged for multiple times.

Wiper Motor: Wiper motors are generally used in windscreen wiper of motor vehicles. Wiper motors are designed for two speed operation. The motor consists of three brushes namely; common, low speed and high speed. Two of the brushes will be supplied for different mode of operation. The torque is high but speed is low. Its speed is about 30 rpm. I have used

this motor because it can carry more load than micro metal geared motor which are generally used in this kind of toy car. I have used a 12V DC wiper motor in my project.

2.3 Breaking system using servomotor:

A servomotor is a rotary actuator that allows for precise control of angular position. It consists of a motor coupled to a sensor for position feedback, through a reduction gearbox.

Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing [4]. Here I used the servo motor to break the car, I used it to rotate two mashed gear which are connected with two bars with the break shoe.

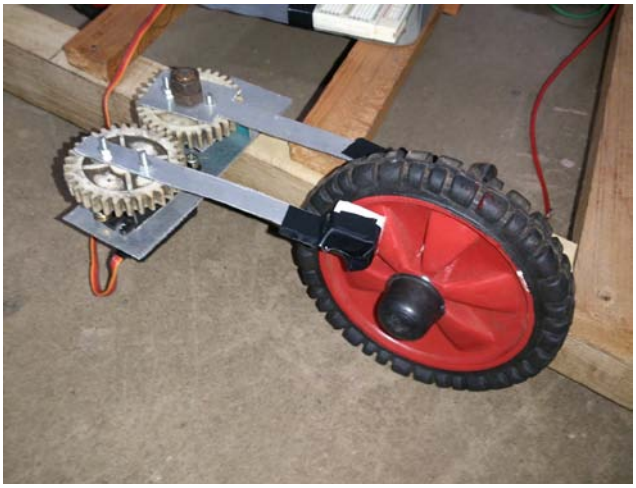

Fig. 6: The Breaking arrangement.

2.4 Control System: Control system is done by electrically, using a microcontroller and a switch. The toy car is operated with a wiper motor. When there is any obstacle within 30cm in front of the car, the microcontroller turns off the motor and also rotates the servo motor to hold the break.

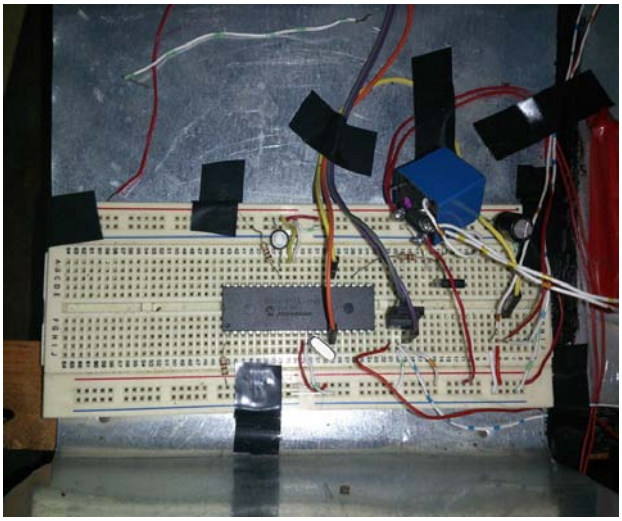

Fig. 7: Control system hardware.

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2.5 Circuit Design:

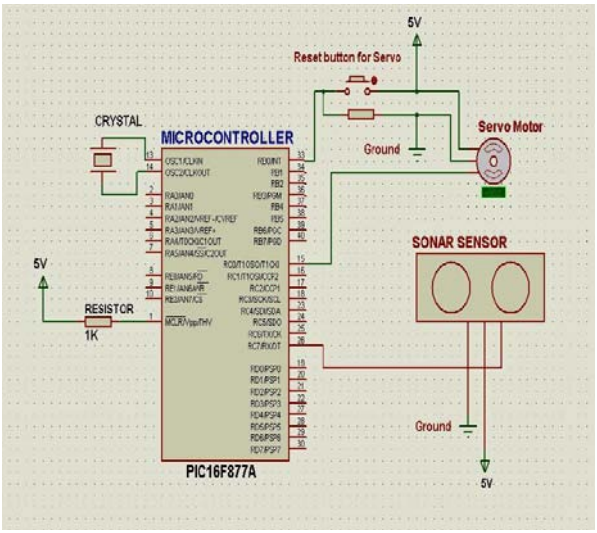

Fig. 8: Circuit Diagram.

3. WORKING PROCEDURE OF THE SYSTEM

3.1 Flow chart of working procedure:

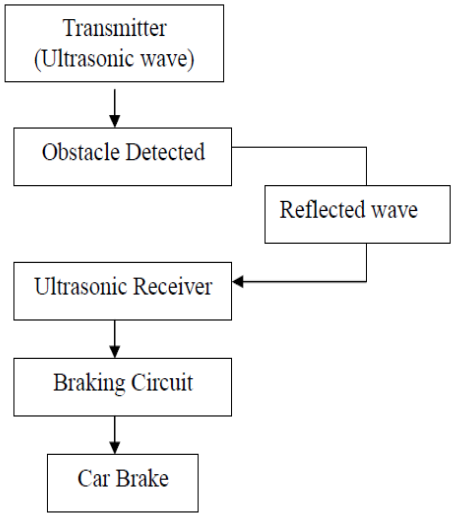

Fig.9: Flow chart

An ultrasonic sensor was placed in front of the model which emits ultrasonic waves frontward in a predetermined distance in front of the car. Then the ultrasonic receiver in the sensor receiving a reflective ultrasonic wave signal as reflected by obstacles positioned within the pre-determined distance in front of the model. A circuit was designed with a microcontroller which was programmed to calculate the distance between the vehicle and the obstacle. If the obstacle is within the range of 30cm, then a servo motor is controlled based on detection pulse information to brake the car intermittently for a safe braking purpose.

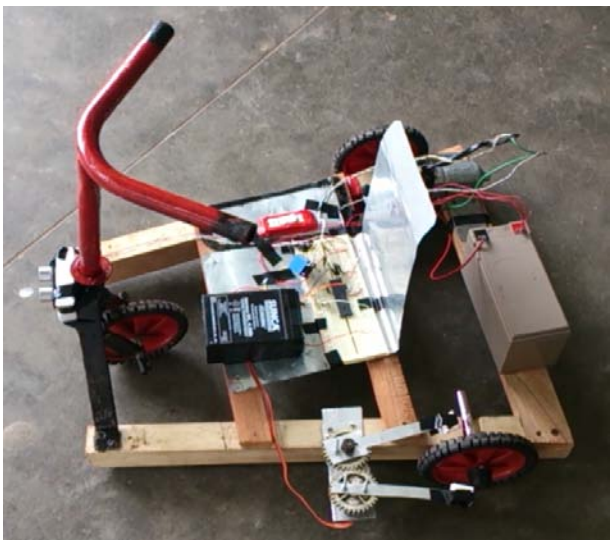

Fig. 10: Complete automatic car breaking system.

4. DISCUSSION

People have higher expectations of cars and need safer, smarter and more comfortable cars. Therefore, the safety system of cars will be better developed and have more market demands. The automatic car braking system can help to reduce the amount of accidents happening every day. The system can achieve measurements with high accuracy and improved short distance measurement also. The system is very suitable in case of tight parking and heavy traffic conditions. The sensors worked well. we have programmed to detect object up to 30 cm distance from the sensor. This project represents the safety in low speed, like for slow moving vehicles in traffic. It does not apply for high speedy vehicle. The gripping action of wheel is good.

5. CONCLUSION

The following conclusions can be drawn from the above presentation

- The sensors worked well.
- The model system detect the object up to 30 cm distance from the sensor.
- This project represents the safety in low speed, like for slow moving vehicles in traffic. It does not apply for high speedy vehicle.
- The gripping action of wheel is good.

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