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Automatic Vehicle Safety to Prevent Forward Collision

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It is an automated vehicle safety system that can assist during journey to prevent expected forward collision. This collision avoidance system includes a sensor arrangement to detect front vehicle(s). The arrangement is powered by an ultrasonic motion sensor to receive information from the detected object (e.g. Vehicle), this processed information force the brake paddle through a motor if equipped vehicle is in the proximal distance at which collision is imminent. Brake shall continue unless the distance increases to a safe level.

Field of Research: Vehicle safety, Forward collision, Distance, Motion sensor, Brake.

1. Introduction

The probability of road accidents by forward collision of vehicles is increasing with the increase of vehicle day to day. The bad condition of roads & highways are not as real cause as the reckless driving. The accident occurred not only in the bad fitness of the vehicle but also for the reckless driving though having proper brake and control system of the vehicle. Proper consciousness at driving is the essential fact that may prevent the accident. Consciousness or precaution means the alertness of driving with the surroundings which deals the term as “smart vehicle”. (Dunn et al, 2007) and (Thammakaroon and Tangamchit 2010) presented a technique on FCW (forward collision warning) in commercial vehicle and intelligent sidewise collision warning at transit busses. To keep pace with these technologies we tried to construct a simple and cost effective way to ensure the safety.

The system is executed by the synchronization of a DC motor with the sensor. It will warn the driver when the distance to the front car is lesser than the distance (default set value) required for safe brake according to the existing velocity and continue to break automatically if ignored.

2. Literature Review

There are a lot of research projects still running on vehicle safety to avoid forward collision. Some researchers concentrate machine vision system utilizing the measurement of distance to the front car, relative velocity with the front car, and the car’s velocity. Some researchers think about the pedestrian in-front of vehicles with concern forward, rear, side collision warning system of

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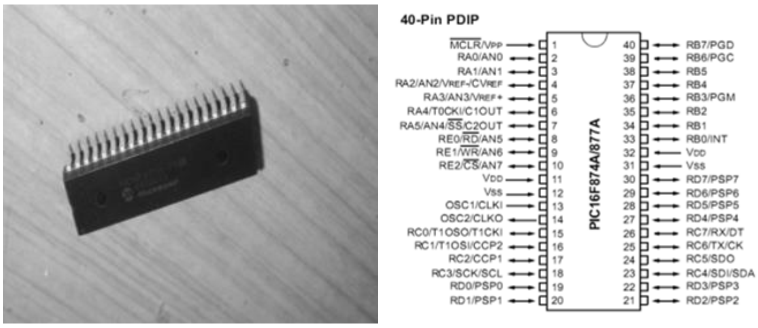
heavy vehicles (Dunn et al, 2007). Others are studying a system, automatic driving control to pass an intersection without stopping (Omae et al 2010). In our study, we are using an ultrasonic sensor as a detecting device and mainly a DC motor drive to control the brake paddle.

3. Devices and Instruments

3.1 Microcontroller (PIC 16F877A)

A microcontroller is an integrated chip that is often part of an embedded system. The microcontroller includes a CPU, RAM, ROM, I/O ports, and timers like a standard computer. In the system PIC 16F877A is used.

Figure 1: The microcontroller PIC 16F877A



3.2 Ultrasonic Motion Sensor

The GH-311 ultrasonic Motion sensor provides precise, non-contact distance measurements from about 0.02 to 3 meters (range). The GH-311 sensor works by transmitting an ultrasonic (well above human hearing range) burst and providing an output pulse that corresponds to the time required for the burst echo to return to the sensor. By measuring the echo pulse width, the distance to the target can easily be calculated. The GH-311 sensor detects objects by emitting a short ultrasonic burst and then sensing the continuous echo. Under control of a host microcontroller (trigger pulse), the sensor emits a short 40 kHz (ultrasonic) burst. This burst travels through the air, hits an object and then bounces back to the sensor. This sensor provides an output pulse to the host that will terminate when the echo is detected; hence the width of this pulse corresponds to the distance to the target.

Figure 2: Ultrasonic Motion Sensor (GH-311)

3.3 Sensor Features and Positioning

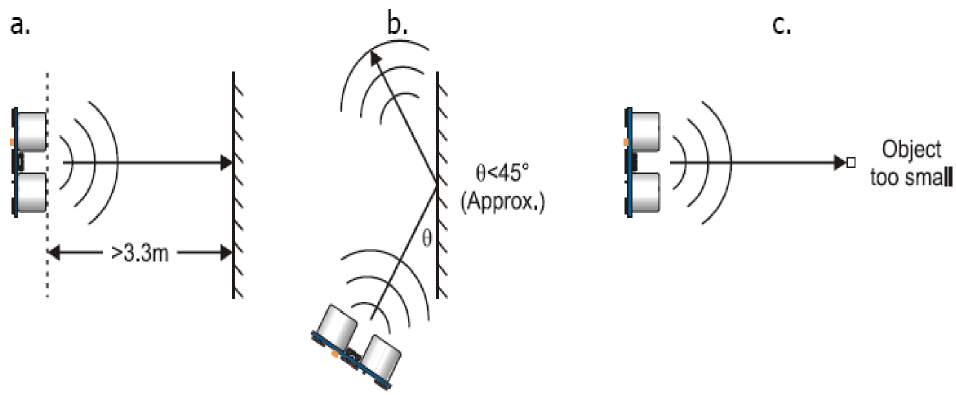
Main Technical Specifications:

a. Power Voltage: DC 6-12V
b. Quiescent current: Less than 2 m A
c. output voltage Level : High 5V
d. output voltage Level : Low 0V
e. Sensing Angle: no greater than 15°
f. Sensing distance: 2mm-3m
g. High Sensitivity, Reliability and Stability
h. Extreme-Temp resistant, moisture proof, shock & vibration-proof

The GH-311 sensor cannot accurately measure the distance to an object that:

a) is more than 3 meters away,
b) has its reflective surface at a shallow angle so that sound will not be reflected back towards the sensor, or
c) is too small to reflect enough sound back to the sensor.

Figure 3: Positioning of Sensor



3.4 Buzzer Alarm

An AC/DC buzzer alarm is used for warning through continuous beep. AD16-

22SM incorporates an LED flashlight, hence it will easily attract the driver visually too. Its main features are mentioned below,

Input voltage : 12V (DC)
Current : 20 mA
Sound : 80db, continuous beep
Lighting : red LED flash

Figure 4: AD16-22SM Buzzer Alarm

3.5 DC motor

A 12V DC wiper motor is used in this experiment to actuate the brake paddle properly. This motor will be installed just under the brake paddle of vehicle and joined with a steel wire to its shaft.

Figure 5: DC motor

3.6 DC Power Supply (16V)

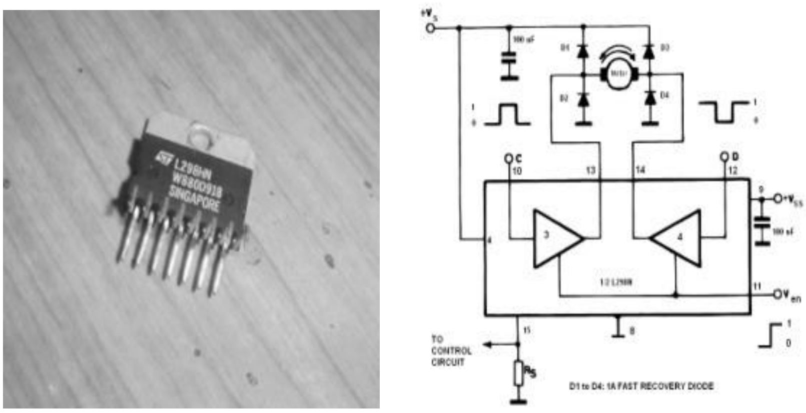
For DC power supply a step down transformer is used to convert the 220V AC to 16V DC (which can be provided from 12V battery). This is completely enclosed in a wooden box which is shown below.

Figure 6: 16V DC Power Supply

3.7 Motor Control, Driver IC

Actually the DC motor is powered by an H-bridge circuit for bi-directional movement and drawing high current capability. The 16V DC motor needs to operate a variable speed which is the main purpose of performing brake because this motor is mechanically connected to the brake paddle. We used L298 IC to operate the PWM circuit. The main feature of this IC is that, It is a high voltage, high current dual full-bridge driver designed to accept standard TTL logic (transistor – transistor logic) levels and drive-inductive loads such as relays, solenoids, DC and stepping motors.

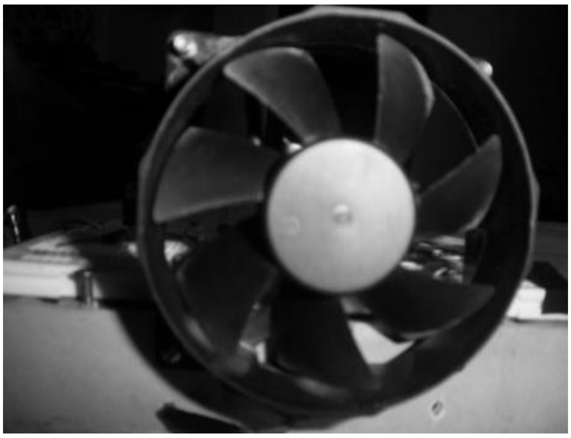
Figure 7: L298 IC and Motor Connection



3.8 DC Cooling Fan

A brushless 12V DC fan is used to cool the L298 IC. Its metallic portion has been extended as a heat sink which will be cooled by the fan. This fan is used for cooling the L298HN IC since it handles high current up to 3A (ampere) that heat up the IC.

Figure 8: 12V DC Brushless Fan

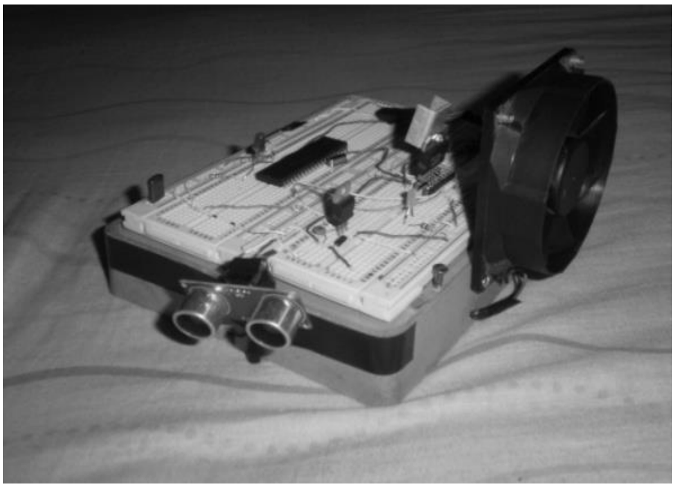


4. Experimental Setup

4.1 Circuit Interfacing With Motor

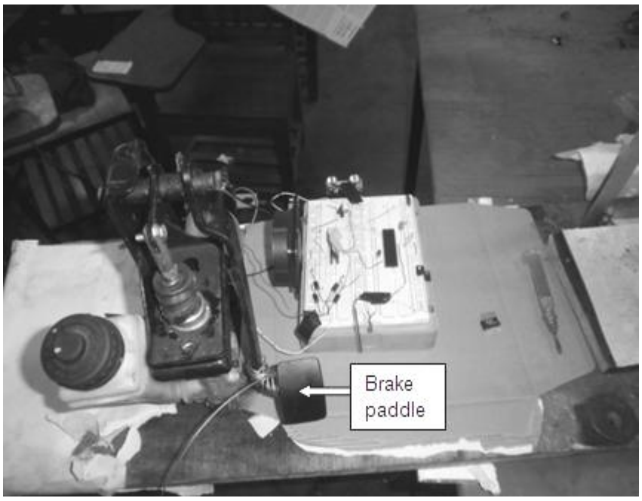
The circuit includes ultrasonic sensor, microcontroller, motor driving IC (L298HN), cooling fan etc. The sensor will be placed in front of the vehicle (installed in the circuit here - Figure 9).

Figure 9: The Experimental Circuit



Thus DC motor placed along with the brake paddle (Figure 10). Brake arm is attached with steel wire to the motor. Additional wiring to the circuit is connected through bread-board.

Figure 10: Circuit With Brake



A program (written on mikro C). Several times we calibrate the program through the program loader to microcontroller. Finally, the program compiled through the microcontroller to control the system as follows,

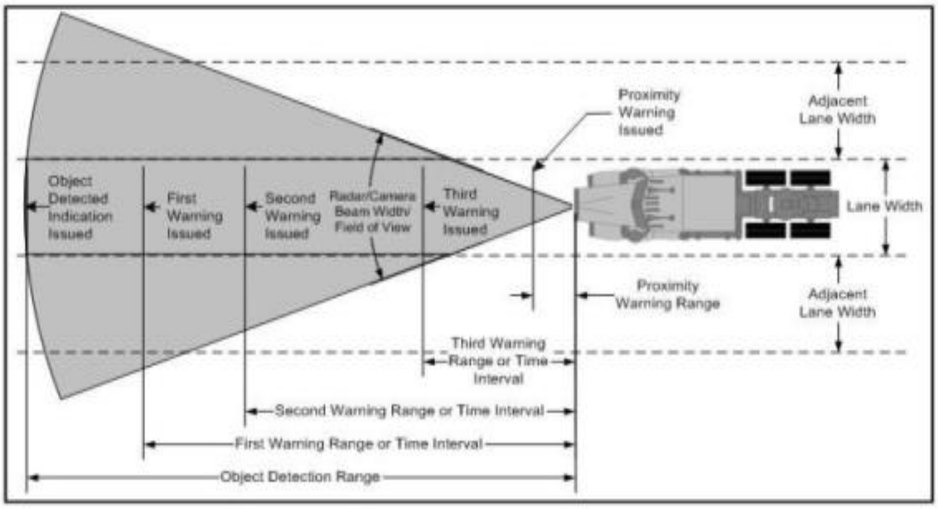
4.2 Programming

```
void main (void)
{
trisc=0;
portc=0;
trisd=0;
portd=0;
trisa=0;
porta=0;
adcon1=0b00000110;
pwm1_init(40000);
pwm_change_duty(200);
pwm1_start();
porta=0;
while(1)
{
If(portb.f0==0)
{
porta=0;
}
If(portb.f0==1)
{
porta=2;
delay_ms(650);
porta=0;
while(portb.f0==1)
{
porta=0;
}
porta=1;
delay_ms(650);
porta=0;
}
}
}
```

5. Methodology

An ultrasonic motion sensor (installed in front of the vehicle) will create the ultrasonic resonance. This is connected to the microcontroller (PIC 16F877A) pin (17) as an input device. A 12V DC motor is installed under the brake paddle. The motor shaft is connected to the paddle by a steel wire. The brake will perform with motor’s clockwise motion and release with its counterclockwise direction (bi-directional movement through the H - bridge circuit). When the driver turns the switch ON, the system will start to scan. The sensor continuously senses the front surrounding of equipping vehicle by transmitting ultrasonic wave. The sensor emits a short 40 kHz (ultrasonic) burst. This burst travels through the air, hits an object and then bounces back to the sensor. If any detectable object (e.g. vehicle) in front of equipping car is sensed within sensing range the buzzer alarm will continue to beep to warn the driver. If ignored, the motor will rotate clockwise direction to energize brake paddle. Brake will continue to stop the vehicle by maintaining a safe distance and will be remained until frontal object goes away from the region (increasing distance). In this experiment the range of this sensor is 3 meters.

Figure 11: Range Zone In Front of Equipped Vehicle.



If any detectable object (e.g.Vehicle)in front of equipping car is sensed within sensing range the buzzer alarm will continue to beep to warn the driver. If ignored, the motor will rotate clockwise direction to energize brake paddle. Brake will continue to stop the vehicle by maintaining a safe distance and will be remained until frontal object goes away from the region (increasing distance). In this experiment the range of this sensor is 3 meters.

6. Results

Here we used a hydraulic drum brake system empirically (Figure 10). We only used a brake system instead of the real life vehicle so, accuracy and implementation could not be obtained hypothetically. According to the strategy, this system can be implemented into an auto transmission - vehicle (having leg operated acceleration and brake paddle) because the clutch operation is automated in these vehicles. That means there is no conventional clutch paddle there. Only one DC motor is issued for accessing the brake paddle.

7. Limitation

Actually, this type of detection system depends on various criteria. Such as equipped vehicle's speed, object type and projected area, front objects speed. In this experiment straight frontal object criteria are concerned and no atmospheric behavior (temperature, humidity, air density etc.) to the sensor is incorporated. Besides, we only used a braking system synchronous with motor and sensor.We could not use a real vehicle here instead.We want to highlight the braking method here. We used steel wire for braking, but a torsion bar hinged with brake paddle could be used for better accuracy. We did not get the result adequately due to 1 ultrasonic sensor. For better response we have to consider RF sensor with suggested aspects.

8. Suggestion

a. Hardware Improvement:

An optical encoder is essential to assess the vehicle speed. The signal can be found from the encoder and this will measurable to tune the braking force (through motor speed).

Besides this, one sensor is not enough for total safety. In this model one sensor is installed to show the range and the brake process only. Radar sensor (instead of ultrasonic sensor) will give better result because it will generate microwave (not sound waves like ultrasonic) and bounce off of the object and travel much faster than ultrasonic wave. Moreover, radar sensors will react differently with different objects regardless of environment condition (temperature, humidity, atmospheric pressure etc.)

b. Mathematical Modeling:

Mathematical manipulation like DSP (digital signal processing) can be used to detect real-time distance and velocity of the forward target vehicle or structure of any object accurately. Besides, it will reduce the total hardware complexity at the same time.

9. Conclusion

In this paper, the design and implementation of the brake control system using a DC wiper motor which can be installed in the vehicle at the brake paddle. The motor is only the actuating device to control the brake paddle. According to this system motor turns to press the paddle instead of human legs. Most of the cases, massive injury or death is a result of front collision and this system may avoid this to a great extent.

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