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PREDICTIVE VEHICLE COLLISION AVOIDANCE SYSTEM USING RASPBERRY - PI

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ABSTRACT

Highway obstacle detection is the most versatile and challenging task in real time scenario. With the enhancement of emerging embedded technologies in automotive field, the life of people becomes more comfortable and provides safety against accidents. Now a day, almost in all vehicles an intelligent safety and alert system is implement which warns the driver to avoid accidents. In proposed work, advanced collision avoidance system is introduced which detects the presence of obstacle in front as well as in blind spot of vehicle and alert the driver accordingly. This system implants ultra sonic sensor for detection purpose of real time moving and stationary object under all weather environment.

Keywords: raspberry - pi, collision avoidance, obstacle detection, blind spot, ultrasonic radar sensor.

1. INTRODUCTION

With the emerging of new technologies in different field of science the human life has become more comfortable and effortless. Advancement of embedded technologies in automotive industries makes the human life safer and convenient for living. According to a survey there about 1.3 lac deaths in India which are caused by road accidents. The obstacle detection in real time is the most versatile and challenging task for road vehicle and passenger safety. The very first obstacle detection system was developed by Delco System Operations, Goleta of California in 1988. This system was basically a safety system which detects the obstacle on rad and alerts the driver. This system was also capable of detecting the moving objects on nearby lane [2]. After this system, another object detection technique is implied in automotive that make use of infrared sensor, radar and ultrasound sensors [7].

The increasing demand of embedded technologies in automotive industry provides a better and reliable safety feature for the passenger and driver safety. A number of obstacle detection system are introduced which provides safety measures and increase the transport efficiency. Autonomous vehicle technology are implemented in most of the vehicles nowadays which includes a number of sensors to detect the obstacles in front [6], side and rear of the vehicle [4] [10]. The main work of this paper contributes to the detection of obstacles in lateral blind spot of the vehicle and in front of the vehicle. The system will alert the driver so that the driver may apply brakes or steer the wheels and avoid collision. In this proposed ultrasonic sensor are planned to be implant for the detection purpose as they can detect the object very close to the vehicle and have an immediate response and generates an accurate distance between the obstacle and the vehicle.

2. RELATED WORK

Previous works of obstacle detection involves the use of infrared sensors [5] which were widely used as proximity sensor for obstacle avoidance. As IR sensor resembles non linear behaviour and the basic concept depends on the reflection from surrounding object, it produces error in the measured distance. So these sensors were not reliable for precise measurements. Thus these sensors are suitable only for short distance measurement upto 25 cms.

The image/vision technology are also introduced for pedestrain safety and detection [8]. It is the most challenging task as fast processing is needed to alert the driver as soon as possible. Pedestrian has to be detected in every frame in which it appears [9]. But the system using image/vision technologies have some drawbacks. The system fails in some unfriendly whether situations like fog, harsh and extreme rainy enviornment. The system sometimes produces error to differentiate between shadows and pedestrian. The system requires high resolution cameras and implementation of such system is a difficult task as it produces error due to damping and vibrations of the vehicles.

Recently ultrasonic sensors and radar sensors are used for obstacle detection techniques in vehicles [7] [12]. The advanced driver assistance system uses RADAR [2] because of its long detctable range and higher reliablility. The LiDAR sensors [3] [6] are to used to scan road boundaries and detects obstacle and generate a safe vehicle path. The downward looking LiDAR sensors are used to detect the obstacle and detect the road side boundaries. But implementation of such system is not easy as it consumes more power and has higher cost, so ultrasonic sensors are better approach for obstacle detction [7].

Figure-1 reprsents the blind spot area of vehicle where the rear-vew mirror will not able to detect the object, and it may create a chance of big accident [1].

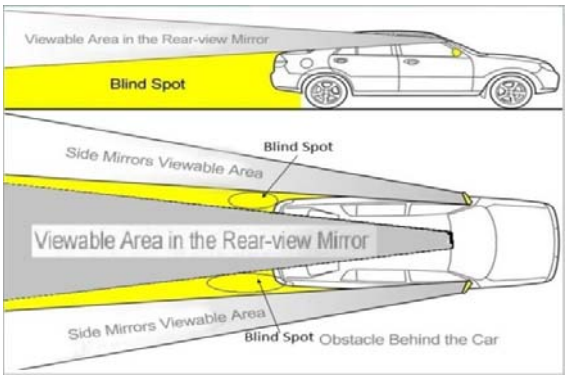

Figure-1. Blind Spot area for vehicle.

In the proposed work the ultrasonic sensors are planned to be used as these sensors are able to measure the distance at close distance. The ultrasonic sensors are used to detect and measure the distance with respect to moving or stationary objects. The ultrasonic sensors are implanted in such a way that they can be used to detect the obstacle present in front of the vehicle as well as obstacle present in the blind spot of the vehicle [11]. This system can be implemented in the vehicle which able to measure the distance. This system is needed to be designed especially for Indian transport scenario at mostly highway side and traffic zone area where the number of accidents has take place due to blind spot and suddenly coming of any object on road.

3. HARDWARE DESCRIPTION

The hardware components of the system comprises of a control unit including Raspberry Pi board, ultrasonic sensors, display board and buzzer which alerts the driver before collision.

A. Control unit

The control unit consists of a raspberry pi. It is a small sized single board computer like credit card size of 85mm X 56mm developed by Raspberry Pi Foundation. The raspberry pi consists of Broadcom BCM2835 SoC (system on chip) with core architecture of 32-bit ARM11 processor of operating frequency 700MHz. The B+ model has a memory of 512 Mb SDRAM, 40 GPIO pins, 4 USB-2.0 ports, one Ethernet socket, video output, audio output, 15 pin MIPI camera serial interface with a micro SD card slot [13].

It has a power consumption of 5V, 2A. The operating system boots from micro SD card with a current version of Linux operating system such as Raspbian, Debian, NOOBS, and Fedora etc.
Figure-2 represents the Raspberry pi model B+.

B. Sensor module

The sensors implanted here consist of two types of ultrasonic sensor module which differs in their distance measuring ranges. For forward distance measurement the sensor used is GH - 311 and for blind spot detection the sensor module implied is HC - SR04. The measuring range of HC-SR04 is 2cm - 4m.

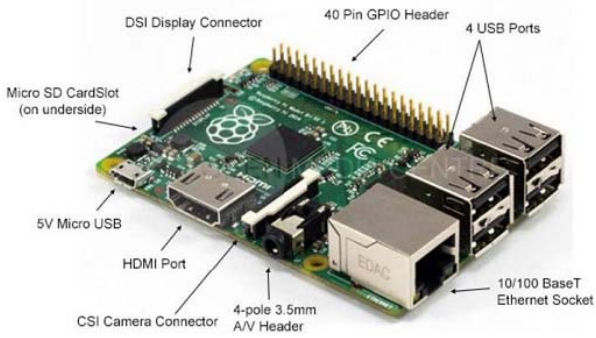

Figure-2. Raspberry Pi B+.

Figure-3. Ultrasonic radar sensor module HCSR-04.

It has a high precise range of 3mm. The working of the sensor module remains unaffected in all-weather environmental conditions. The module includes ultrasonic transmitter, receiver and control circuit. The input voltage of the module is 5V and can measure at an angle of 15 degree. Its operating frequency is 40 kHz. The main advantage of ultrasonic sensor is that it provides highest reliability in getting proximity and has lesser absorption than RF and IR frequencies.

Figure-3 represents the ultrasonic radar sensor module - HCSR-04 [14].

The trigger pin is given a supply of 5V i.e. high for about 10us to initiate the sensor module. A burst of 8 cycles of 40 kHz is transmitted and wait for the echo signal. When the sensor detects echo signal, the Echo pin is supplied by 5V i.e. high and a delay for a period which is proportional to distance. The distance is computed by the formula:

Distance = Time/58 (in cms.)
Distance = Time/148 (in inches)

where,

Time = width of echo pulse in micro second (us).

Another sensor module which is to be used is GH - 311 [15]. The operating voltage of this module is 6-12V DC and can measure a distance up to 8 meters. This 3 - pin sensor module has a working frequency of 40 kHz. The

operational principle is that when the module is triggered at high signal level for 10 us (micro seconds) the module automatically starts sending eight 40 kHz square wave and then detects the echo pulse automatically.

Figure-4 represents the ultrasonic radar sensor module - GH-311. The distance is computed through the formula

Distance = (high level time * sound velocity (340m/s)) / 2

Figure-4. Ultrasonic radar sensor module GH-311.

Figure-5. Timing diagram of Ultrsonic sensor modlue.

Figure-5 represents the working principle of ultrasonic sensor.

C. Display and alert system

The LCD display is used to display the measured distance between the obstacle and the vehicle and a buzzer and LED indication is used to alert the driver so that the driver will apply brake or steer wheels to control speed to avoid collision.

4. PROPOSED SYSTEM MODEL

In the proposed work the system is going to be implemented using Raspberry - pi board along with ultrasonic sensor module. The control unit is the main processing unit through which all the other modules are connected. The ultrasonic sensor GH - 311 is a high range sensor which can detect the obstacle up to 8 meters. This sensor module is implemented in the front of the vehicle which serves as forward vehicle collision avoidance. The other two sensor modules HC - SR04 are used in such a way that they can detect the obstacle in blind spot of the vehicle. The sensor can detect the distance between the vehicle and the obstacle. The calculated distance can be displayed on the LCD and a buzzer is blown to alert the driver if the distance between the obstacle and vehicle crosses the minimum safe distance.

Figure-6 represents the block diagram of the collision avoidance system. The system comprises of Raspberry - pi as central unit surrounded by three ultrasonic sensors, one in front of the vehicle and others are placed on the blind spot of the vehicle. The LCD display, buzzer and LED are connected with the raspberry board which shows the distance between the object and alert the driver prior collision.

Figure-7 represents the flow chart of the system. When the system starts, the sensor is activated and it starts sensing the object in its range. If there is an object in front of the vehicle,

Figure-6. Block diagram of proposed system model.

Figure-7. Flow chart representation.

the forward sensor senses the presence of the obstacle and the distance is calculated which in turn indicates the driver

and a buzzer will be blown which alerts the driver. Likewise the right and left sensor are used to cover the blind spot and to detect if any object or obstacle is present in the blind area of the vehicle. The driver is indicated by the buzzer, LED and the distance to the object are shown on the LCD display.

5. EXPERIMENTAL SETUP

The whole system is implemented using Raspberry - pi board on a small demonstration model. Three ultrasonic sensors are used in this system. One in front to detect the obstacle in forward and two on left and right side to cover the blind spot. All the three sensors are connected through the control unit. LCD display is used to show the distance between the vehicle and obstacle and a buzzer and LED indication is

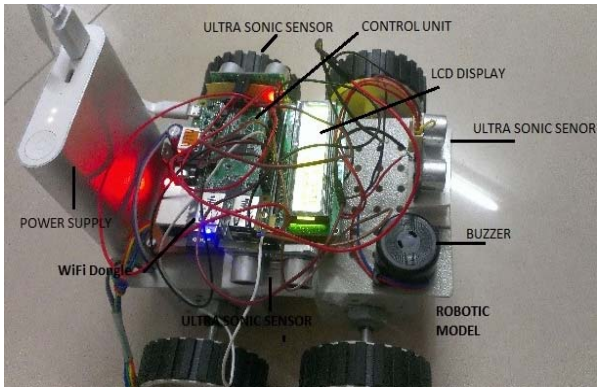

Figure-8. Experimental model.

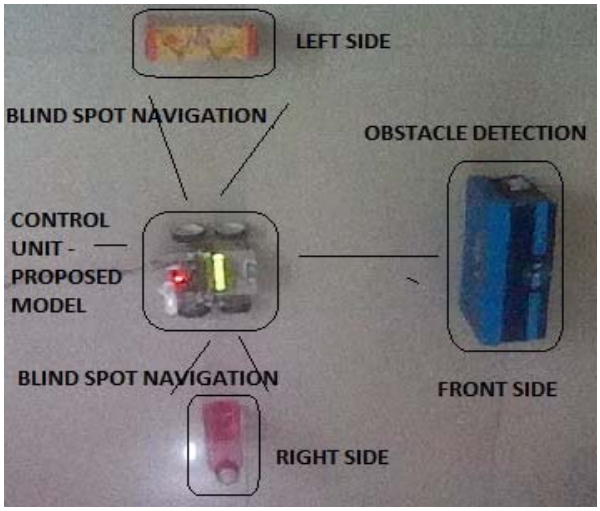

Figure-9. Real time demonstration setup.

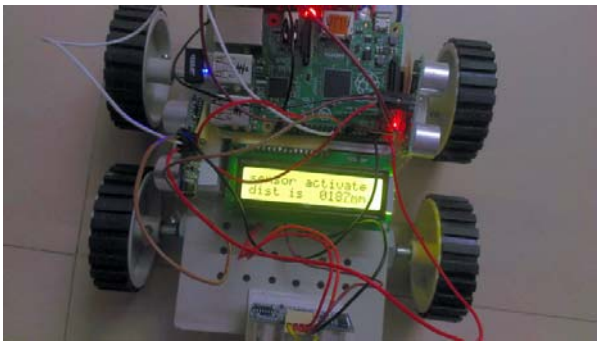

Figure-10. Real time demonstration setup.

```
Starting Measurement...
3.72076034546
pi@raspberrypi ~/Gaven $ sudo python rangefinder.py
Starting Measurement...
6.84976577759
pi@raspberrypi ~/Gaven $ sudo python rangefinder.py
Starting Measurement...
77.6901245117
pi@raspberrypi ~/Gaven $
```

Figure-11. Result on Raspberry Pi.

used to alert the driver so that he may apply brakes or steer the wheel and avoid collision.

Figure-8 representing the experimental model of the proposed system model.

Figure-9 represents the real time demonstration setup of proposed system model which represents the collision avoidance system. An obstacle is placed in front of the vehicle and on left and right side. The system starts detecting the obstacle as it comes in the range of the vehicle and the measured distance is displayed on LCD display board, buzzer is blown and indication by LED. The programming language used here is python which is the basic language of the Raspberry - pi.

Figure-10 represents that the above output is acquired while testing the demonstration model in a real time scenario. This result is shown on the terminal screen of the Raspberry pi in Figure-11.

6. CONCLUSIONS

In this paper, an effective method is proposed for the collision avoidance system of a vehicle to detect the obstacle present in front and blind spot of the vehicle. The driver is made alert via a buzzer and LED indication as the distance between vehicle and obstacle reduces and is displayed on display board. The ultrasonic sensor detects the state of the object whether it is in motion or static with respect to the vehicle. This system is useful for detecting vehicle, motorcycle, bicycle and pedestrians that pass by the lateral side of vehicle.

The future scope of this work is to develop a system that can detect the obstacles by implying image processing methodology and can be able to measure the distance of the obstacles which are beyond the range of the ultrasonic sensor module. The system will be made

independent by applying the brake automatically through ABS and accidents can be avoided.

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