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Distance Measuring (Hurdle detection System) for Safe Environment in Vehicles through Ultrasonic Rays

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Abstract - Cars and vehicles have been incorporated into culture as one of the most resourceful, easiest and accessible means of transportation available. But besides being a suitable and common means, it is equally an incredibly dangerous mode of transport. Thousands of people die in vehicle accidents each year, whether it is accident with another vehicle or with a motionless object. A method of early accident exposure and evasion can control several accidents that may be associated to factors such as loss of control, careless driving, tired/intoxicated drivers, and not paying concentration to the road. As the current market does not present a normal safety feature in any car, the use of sensory tools to sense potentially hazardous objects a definite distance away and either slows the car down or shove to a safer path has not been released. In this research paper a new technique is introduced for safety against accidents. Eight ultrasonic sensors are used to sense different types of objects. By implementing a possible improvement in safety/sanctuary systems in vehicles, the vehicle and sensor would be able to operate normally until the sensor detects possible risk. In our project, the sensor does not give output or signal until the car comes within ~75 feet of an object, at which timer sends information of hurdle to driver. The sensor only indicates the presence of an object; it is up to the user or driver to tackle the hurdle.

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Distance Measuring (Hurdle detection System) for Safe Environment in Vehicles through Ultrasonic Rays

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Abstract - Cars and vehicles have been incorporated into culture as one of the most resourceful, easiest and accessible means of transportation available. But besides being a suitable and common means, it is equally an incredibly dangerous mode of transport. Thousands of people die in vehicle accidents each year, whether it is accident with another vehicle or with a motionless object. A method of early accident exposure and evasion can control several accidents that may be associated to factors such as loss of control, careless driving, tired/intoxicated drivers, and not paying concentration to the road. As the current market does not present a normal safety feature in any car, the use of sensory tools to sense potentially hazardous objects a definite distance away and either slows the car down or shove to a safer path has not been released. In this research paper a new technique is introduced for safety against accidents. Eight ultrasonic sensors are used to sense different types of objects. By implementing a possible improvement in safety/sanctuary systems in vehicles, the vehicle and sensor would be able to operate normally until the sensor detects possible risk. In our project, the sensor does not give output or signal until the car comes within ~75 feet of an object, at which timer sends information of hurdle to driver. The sensor only indicates the presence of an object; it is up to the user or driver to tackle the hurdle.

I. Introduction

Today Personal Computer usage has been increased very much for different purposes and for performing important tasks and its usage is increasing day by day in many fields.

The technique presented here has three parts, each part containing some tasks to perform through the computer. First part includes controlling the car through computer by using data pins of parallel port. Second part includes hurdle detection through sensor and displays this information from left, right, front and back side of the vehicle on the computer screen. The third and last part is implementation in which the vehicle moves automatically and selects its right path with the help of sensors.

The procedure adopted for doing the above mentioned tasks includes the use of parallel port of the computer. The main hardware of the presented technique will be attached to the parallel port of PC so that all tasks are being handling by this port. The software programmed in Visual Basic is interfaced with the hardware for implementing all the above mentioned tasks. Visual Basic is used because of the reason that it is user friendly language and provides easy and efficient support in interfacing with the hardware. Visual Basic programs can easily access the parallel port [1].

II. Previous Work

Today many companies work to create the safe environment (Hurdle detection and distance measuring) for drivers, out of which the most important companies working on these issues are **Mercedes Benz** and **Honda. Mercedes Benz** [2] is prepared with the option of innovative '*distronic'* distance control system which makes sure the security of cruise control for highway by reducing the vehicle speed if the system detects a slower running vehicle up to 150 meters in front of it. The Mercedes is installed with a radar sensor which senses the hurdle at a distance of 150 meters from the driver's car and slows down the car according to the distance which means that as the distance decreases, the speed of car is also decreased. These sensors observe the traffic with a high performance computer so that the safety distance remains maintained. When the vehicle moves too close to another vehicle, the electronic system automatically reduces the speed of the car and activates the brakes as well whenever it is required to do so. Once a safe distance gets covered, the system comes back to the pervious selected driving speed. The second most prominent company **Honda** has designed the Honda intelligent [2] Driver Support System (HIDS) that helps the driver in two driving tasks- keeping in lane and maintaining vehicle speed. The millimeter wave radar is used with C-MOS camera to detect and analyze the lane marker and to determine the other vehicle. Allison Smyth used an automotive accident monitoring system that mounts on the front of archetype vehicle. [3] The system tested for this device would be conducted at speeds less than 20 mph. This device uses sonar technology (mostly used in submarine) to send out signal from the front of vehicle. This signal will warn the driver if the vehicle he is driving is too close with another vehicle. The warning will be sent through a chain of light emitting diodes (LEDs). A green LED tells the driver that he is doing fine, amber LED is a warning and red means that the driver needs to slow down immediately. Another

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system having similar concept has been developed with the exception that the speed has already been set depending on the distance between the two cars. This system is based on the laboratory scale and PIC was used as the core of the project in order to slow down the motor. This is to make sure that the distance is always maintained in a certain range. Otherwise, the speed will reduce robotically. There were 3 distances that had been classified: Far>30 cm; Medium 15 cm_x_30 cm; Critical_15 cm. The speed will retort based on the distance. Infra red sensors were used in the project and it was found out that a lot of limitations need to be considered if it was to be applied in real environment [2] [3].

III. Proposed Work

The proposed method for safe environment includes three main parts, each one providing different functionality according to the tasks assigned to it. These parts are mentioned below:-

1. Distance of object (Hurdle) from vehicle.
2. Speed of coming object (Hurdle).
3. Location (Side) of hurdle.
4. Collision time (Future Planning)

In the proposed technique the user can easily drive the vehicle through computer. The proposed method will automatically inform about the hurdle in the path of the vehicle on the computer with the help of different sensors. In this technique the vehicle is controlled through parallel ports of computer. Ultrasonic sensors are connected in the vehicle to sense the object (Hurdle) and send signals to the computer. The computer takes different actions based on these signals in order to create a safe environment for the driver (user).

a) Car Movement Controlling System

The system involves the controlling of vehicle through the PC. Different commands are sent to the ports to control its movement. The controlling function receives commands denoting the direction of the vehicle and output an encoded 8 bit value of these directions. The input signals will come from metal contacts of the switches on the original controller to 4 input port pins (indicating forward, reverse, left and right).

If you notice a vehicle has total six movements.

1) Forward
2) Reverse
3) Forward + Right
4) Forward + Left
5) Reverse + Left
6) Reverse + Right

Parallel ports have 8 data pins but 4 will be used out of them to control the car.

Forward	Reverse	Right	Left	
0	0	0	0	
1	0	0	0	Forward
0	1	0	0	Reverse
1	0	1	0	Forward + Right
1	0	0	1	Forward + Left
0	1	1	0	Reverse + Right
0	1	0	1	Reverse + Left

Figure.1 : Binary codes to control vehicle mechanism.

According to figure 1, 9 combinations are spare. The combinations shown in figure will be applied on first four data pins of parallel ports [4] [5]. "0" means OFF and "1" means ON for ports. In Visual Basic-6, these combinations will be used for port handling command. These combinations will then be sent to the circuitry connected between computer and remote control of vehicle for controlling its different moves.

b) Hurdle Detection on Different sides

The purpose of this part of the proposed method is the secure movement of car or security of driver and vehicle against different hurdles. To achieve this target ultrasonic sensors are used on left, right, back and front sides. Each sensor has one transmitter and one receiver. The transmitter of each sensor will continuously transmit the signals. When these signals will collide with any object and will be reflected back, the receiver of sensor will catch these reflected signals and forward them to the computer on port 889 of parallel port. To find out the object side the signal is send to processing unit through parallel ports. Each side or receiver has its own address which is unique. Through this uniqueness or address the proposed method finds out the side of object (Hurdle). In ultrasonic sensor the power is directly proportional to range of ultrasonic sensor.

$$P \propto \text{Range}$$

c) Ultrasonic Hurdle detection Circuit

The speed of the sound in the dry air is about 340 m/s. We can not hear the echo if we send a short ultrasonic pulse at 200 KHz in the air but it is possible to detect the back pulse with an ultrasonic sensor. If you know the time of the forth & back travel of the ultrasonic wave, you know the distance. Divide the distance by two and you know the range from the ultrasonic sensor to the first hurdle in front of it. Here the proposed method also uses an ultrasonic piezzo transmitter with its receiver because they are very efficient, easy to find and quite cheap.

In the proposed technique, first send the pulse: it is easy to get a 20 KHz pulse from a PIC PWM output. You can drive an ultrasonic transmitter directly from the PIC output, but the sense range will not exceed 50 cm.

Using a transistor and a resonator circuit, the ultrasonic transmitter will get around 20 volts to generate 200 KHz pulse and the sense range will be extended up to 75 feet.

d) Creation of Ultrasonic Cycle

To achieve this target 8 ultrasonic sensors are used. The range of these sensors is equal to ~75 feet which means that they sense ultrasonic rays at a distance of 75 feet. As this distance is covered the ultrasonic rays are going to be stretched as shown in diagram.

The ultrasonic rays get disappeared after traveling a distance of ~75 feet. All eight sensors are attached with the vehicle in a way that they create an ultrasonic wall around the vehicle but no overlapping between the ultrasonic waves of sensors as shown in figure 4.

All eight ultrasonic sensors are connected to the computer parallel port (LPT port) which sends information (distance, location) about hurdle at real time [7]. This wall is only used to gather information about hurdle which means that it neither restricts the driver nor does it slow down the speed of vehicle like Mercedes Benz because of the reason that the driver may have some better option to handle the hurdle detection problem.

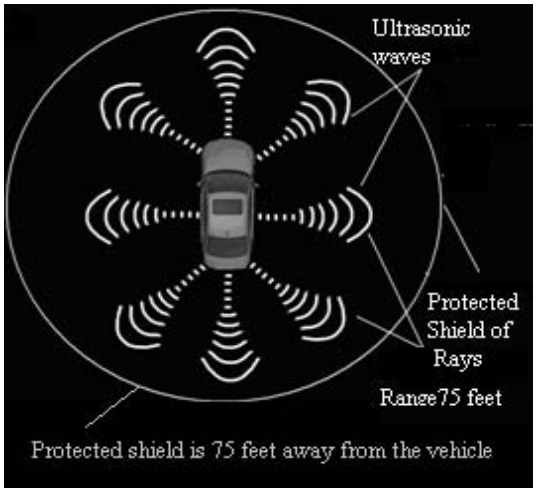


Figure.4 : Wall response on hurdle

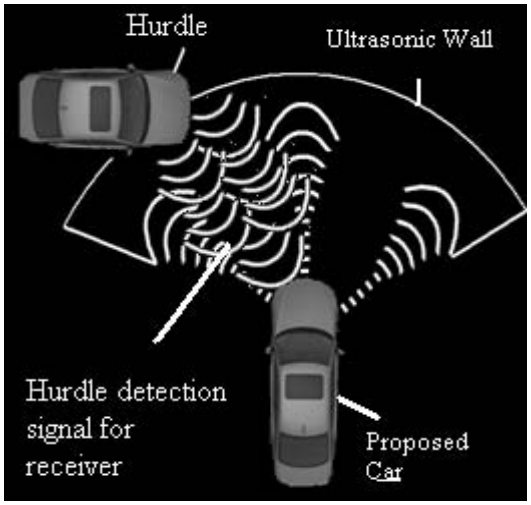
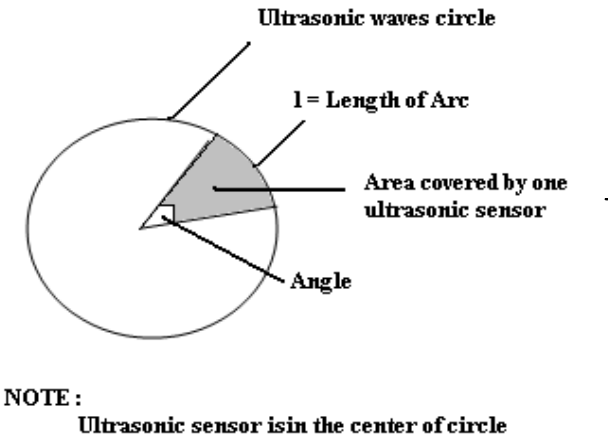


Figure.5 : Ultrasonic Wall creation



$$\textbf{Diameter of circle} = T_{uls} * L_1$$

L = *Length of arc of one ultrasonic sensor*

T_{uls} = *Total Number of Ultrasonic Sensor*

$$\textbf{Length of arc} = r\theta$$

Radius (R) = Range of ultrasonic Sensor

Figure 6 : Role of one ultrasonic sensor in circle

e) Identification of Object

To fulfill this target we attached a computer with the vehicle and eight ultrasonic sensors are connected with the computer parallel ports (printer port) to receive the signals coming from ultrasonic sensors [12]. These sensors are attached with the vehicle in such a way that

they create an ultrasonic wall or layer around the vehicle to sense any object (hurdle) coming towards it from either side. In this layer all rays travel independently without any overlapping between them. The sensors attached to all sides of vehicle work according to their specified directions. For example, if an object comes from left side of vehicle, only left sensor will send the signal to the computer. In order to find out that the computer has received signal from which specific sensor, we have attached the transmitters and receivers of all sensors with data pins (D0 to D7) of the computer because of the reason that each pin has its own unique address which find out that which sensor has sent signal, Through this unique address we can easily identify that which sensor sense the object means on which side of the car object is come. To find out these unique addresses we put object against the each sensor and when sensor send signal on pin of parallel port then parallel port send address of this pin to computer and this address is unique means each pin of parallel port has its own address. These unique addresses are use to find the side means to find out that on which side of the car object is coming. Another more important thing is that when two or more that two sensor sense a objects at a same time then another unique address is created through this we ca easily find out that when two sensors give response at a same time then which type of address is coming and when six sensors response at same time then which type of sensor is coming out. Mostly such situation is created when a wall is coming in front of the vehicle or in the back of the vehicle. So in the proposed method no object can enter in range without giving an information.

f) Distance measurement of hurdle from Vehicle

For distance measuring the voltages or signals of receiver first convert into digital because ultrasonic sensor work in analog signals and computer works on digital signals so for this we first convert the analog signal into digital signals**[11].** If we take a diagram of voltages of ultrasonic receiver then you note that when distance is less then the height of the wave of voltage on oscilloscope is tall but when distance is greater. The height of wave is small on oscilloscope. Actually this module of proposed method is work on correspondence between the height of wave and distance. For distance measurement the proposed method set a background table (Correspondence table between height of wave and distance). The first six iteration of correspondence table are set by manually calculation of distance. The further iteration is set by automatically by proposed algorithm to find out the distance.

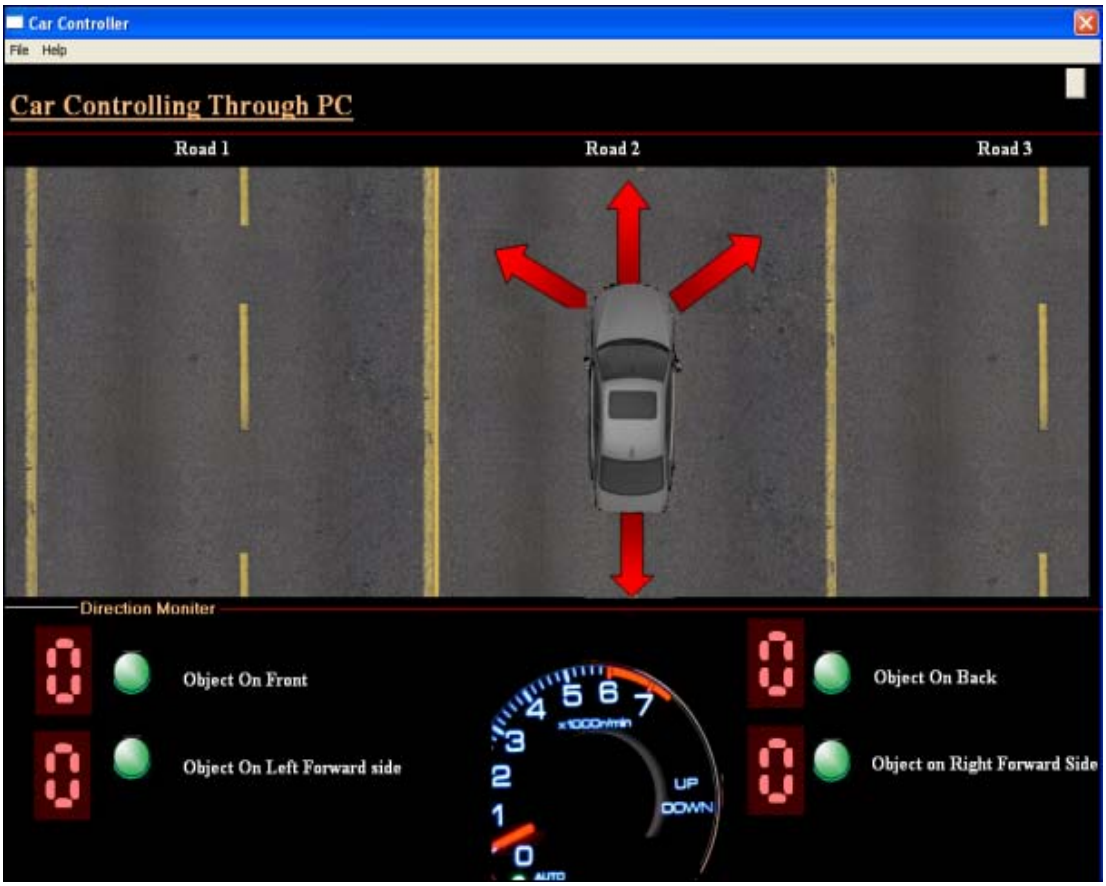


Figure.7 : Distance Measuring interface on PC (Software)

Another way to find out the distance between hurdle and vehicle is that first find out the elapsed time **(T_e)** and multiply with **speed of sound (Ultrasonic wave)** and divide this product by two.

$$\textbf{\textit{Distance}} = \frac{\textit{Elapsed Time * Speed of Sound}}{2}$$

IV. Response of Different Ultrasonic Frequencies on Flat Surface

Relative Echo Levels for different Ultrasonic frequencies

In case of ultrasonic waves the entire wave is reflected when ultrasonic waves are reflected from flat surface. This total reflection is equivalent to a virtual source at twice the distance.

$$\textit{Spreading loss for reflected wave} = 20 \log (2R)$$

$$\textit{Absorption loss} = 2\alpha R.$$

To reduce this loss it is necessary that the flat surface is larger than the entire ultrasonic wave and perpendicular to the wave. [14]

The below Equation (2) is used to find out the relative effect from different distances from ultrasonic sensors of varying the sound frequency on echoes created from a large flat reflector (surface).

$$SPL\ (R_0) = 20 \log (p) \quad (1)$$

$$SPL(R) = SPL\ (R_0) - 20 \log (R/R_0) - \alpha\ (f)\ R \quad (2)$$

SPL(R)	sound pressure level at distance R in dB//1µPa
$SPL(R_0)$	sound pressure level at distance R_0 in dB//1µPa
α(f)	attenuation coefficient in dB/unit distance at frequency f
R	Reference Distance
P	Pressure of sound in micropascals

In reference 14 a graph is drawn on assumption that all ultrasonic sensors create same SPL at a range of on feet. This graph represents that changes in EL are just a function of varying reduction and the reason of that are only the different frequencies of sound. For each frequency the maximum reduction for all humidities was use for the value of **α.**

V. Internal Design of Vehicle

All ultrasonic sensors in the car are connected with the parallel port (LPT port) of computer and computer is attached inside the vehicle to detect the hurdles on real time bases.

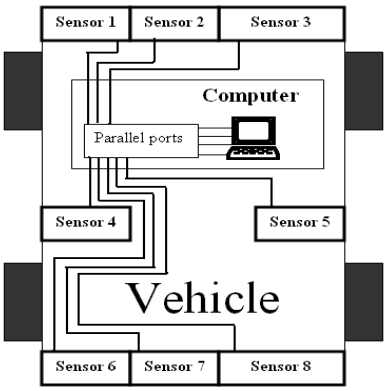


Figure.8 : Block diagram of interfacing Ultrasonic sensor with Vehicle

VI. Experimental Result

In this section, experimental results are illustrated to demonstrate the feasibility and validity of our proposed hurdle detection and distance measuring mechanism through ultrasonic rays. In this section different situations (environments) and conditions are applied upon proposed method. Actually the only way that researcher can establish cause-and-effect relationship through research is by carrying out an experiment. In a formal experiment, the relationship between two or more variables is investigated by deliberately producing a change in one variable in a salutation and observing the effects of that change on other aspects of the situation.

Several steps are involved in carrying out an experiment, but the process typically begins with the development of one or more hypotheses for the experiment to test.

Case.1

In case 1 the proposed vehicle is tested upon different speed limits and observes the quick response of ultrasonic sensors on different speed limits. In case.1 the proposed car was run on 130km / hr and ultrasonic sensor build in car has range of 75 Ft and car that run on 130km/hr cover this distance in 5.35979 seconds and time limit of ultrasonic hurdle detection response is

$$\textit{Speed} = \textit{Distance} / \textit{Time}$$

$$V = D / T \ \Rightarrow (V*T) = D$$

$$T = D / V$$

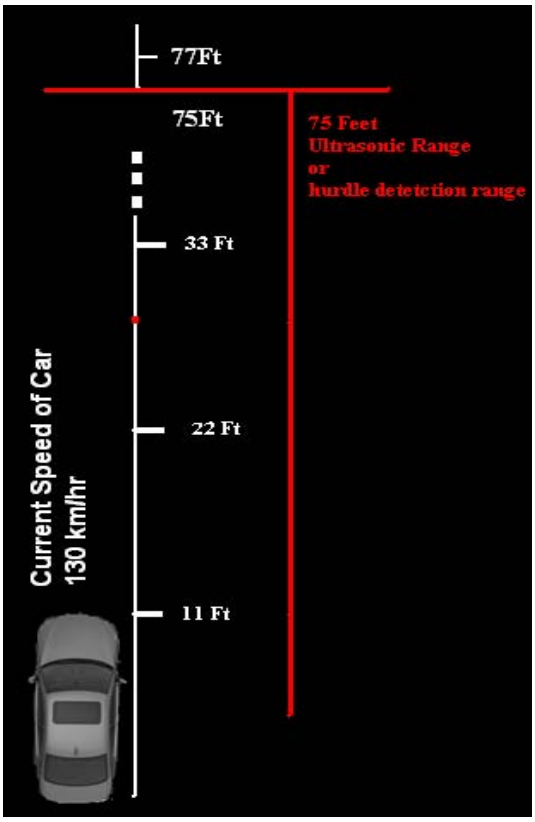


Figure.10 : Case.1 Distance and speed simulation of proposed Vehicle

Case.2

In case.2 the proposed vehicle was check in different weather (fogy, rainy, sunny). The ultrasonic ways work perfectly in rainy weather because in submarine the sonar was used in which ultrasonic waves are used to sense the different hurdle in water so in this way ultrasonic waves has no problem to work in rainy and fogy weather.

Case.3

In case.3 the proposed vehicle checked in night or on those places where there is no light mostly in parking areas or where the vehicle head lights not work. In these places the infrared rays and video technology cannot work. On these places the proposed vehicle work very accurately tells information (Distance, location) of other vehicle.

VII. Comparisons of Different Sensors Technologies

	Lidar	Ultrasonic	Video camera
Direct velocity measurement	--	**0**	--
Operation in rain	-	**0**	**0**
Operation in fog & snow	-	+	-
Operation in dirt	**0**	+	--
Operation in night	++	++	--

++ (perfectly matched)

\+ (fine Performance)

0 (achievable)

\- (realistic)

-- (impractical)

Figure.11 : Comparison of different Domains for distance measuring in different conditions

Figure.11 shows that ultrasonic technology gives a cost effective method to achieve the result with exclusive properties not obsessed by other sensing technologies. For e.g.

1) Ultrasonic works for long ranges up to 50 feet whereas inductive sensors and limit switches do not.
2) Another very major property of ultrasonic senor is broad area detection .Ultrasonic senor work in both wide and narrow area while a number of photo electric sensors can sense over long distances they lack the skill to detect over a wide area without using a large number of sensors.
3) Ultrasonic sensor can easily work in different environments (liquid, solid, porous, wood, dust, night and etc).
4) Work on all colors (black, red, yellow and etc).

VIII. Conclusion

Overall, our design met our basic expectations; however, we were not able to achieve everything that we wanted due to time constraints. In this research work we more emphasizes on the on hurdle detection through ultrasonic waves which is the back bone of this technique. By applying different environments on proposed work it is not easy enter in the ultrasonic wall without giving any information (distance and location) to user. In the ultrasonic wall creation we observe that there is no side or there is no gap from which anything enters in the area of ultrasonic waves it means that wall is fully filled with ultrasonic waves without overlapping of

ultrasonic waves. However, there are some problems need to be worked on, such as low frequency environmental noise, reverberation, and hurdle strength, etc.

References Références Referencias

1. "Parallel port Interfacing". http://www.ingenierias.ugto.mx. [Retrieved on 22, March, 2006]
2. "Perangkaan Kematian Jalan Raya". http://www.panducermat.org.my. [Retrieved on 20 August 2007].
3. Nathan Stong, (2000), "The use of Field Programmable Gate Arrays for Reusable Interfaces", Ogden Air Logistics Center,IEEE Journals (2000).
4. Gabriel Torres. "How to build parallel port prototypes", October 2005
5. Eggebrecht, L. C., "Interfacing to the IBM Personal Computer, Second Edition," Howard W. Sams and Co., 1990.
6. "Didya.com.IC16F84"http://www.didya.com/16f84.asp. [Retrieved on 30 August 2007].
7. "Traffic statistic road Accidents". http://www.gov.my. [Retrieved on 20, August, 2007]
8. Allison, Smyth (2005). "Crash Monitoring Device for Vehicle with Four or More Wheels". Massachusetts Academy of Mathematics and Science.
9. Noor Fariza bt. Ariffin, Norfazilah bt. Ja'afar (2004). "Development of Intelligent Distance Detection System for Car Safety". Tesis Ijazah Sarjana Muda (PSM). Kolej Universiti Teknologi Tun Hussein Onn.
10. Xuebai.Zang, Yaru.Mao, Hongwei.Zhao, Xin.Guan (2004). "The Research of Ultrasonic Detection Method for Car Back Obstruction". Jilin University, ChangChun, China. http://www.ndt.net/article/wcndt2004/pdf/automotive/695_yaru.pdf. [Retrieved on 22 August 2007].
11. Elmer, H. Schweinzer, H (2004). "Ultrasonic Distance Measurement system with a well defined and adjustable detection area.". IEEE. Sensor Journal, Vol 1. pp.437-440.
12. "IEEE Standard Digital Interface for Programmable Instrumentation," Institute of Electrical and Electronic Engineers, Inc., New York, 1978.
13. William, J. Fleming (2001). "Overview of Automotive Sensors." IEEE Sensors Journal, Vol. 1, No. 4, pp. 1.
14. "Choosing an Ultrasonic Sensor for proximity". Questex Media Group LLC, 2011
15. Frank Massa. May 1992. "Ultrasonics in Industry," Fiftieth Anniversary Issue, *Proc IRE*.
16. B.-F. Wu, C.-J. Chen, H.-H. Chiang, H.-Y. Peng, J.-W. Perng, L.-S. Ma and T.-T. Lee, "The Design of an Intelligent Real-Time Autonomous Vehicle, TAIWAN *i*TS-1," *Journal of the Chinese Institute of Engineers*, Vol. 30, No. 5, 2007, pp. 829-842.
17. J. Chinrungrueng, U. Sunantachaikul, S. Triamlumlerd, "Smart Parking: an Application of optical Wireless Sensor Network," *Applications and the Internet Workshops, 2007. SAINT Workshops 2007. International Symposium on Jan. 2007 Page(s):66 – 66.*
18. P. Kanathantip, w. Kumwilaisak, J. Chinrungrueng, "Robust Vehicle Detection Algorithm with Magnetic Sensor," Proc. IEEE Symp. Electrical Engineering/Electronics Computer Telecommunications and Information Technology (ECTI-CON), IEEE Press, May. 2010, pp. 1060-1064. doi: 1O.l109IECTI.201O.2657940.