Development of Digital Vehicle Distance Monitoring System

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Abstract ? Nowadays, transportation users have increased drastically since 2006 compared to 2001. The increase in some ways has contributed many traffic problems such as traffic jam and accidents. Therefore, some kind of system such as an enhanced tool is needed to reduce such problems by designing a digital distance monitoring system. The main orientation of this paper is specifically focused on the accident. The development of the tool could help driver get a sense of how far the car is from an object either it is in front or behind the car. The ultrasonic sensor is located in front of the car in order to detect the object. Then, the signal is sent to the microcontroller which has been programmed using MPLAB software. The microcontroller analyses the signal, sends the command and measure the distant of the object from the vehicle within the specific range of detection in between 1 meter to 5 meters. The data is displayed on the seven segment display. The implementation can provide a new alternative in the safety system and could reduce car accident.

Keywords : *distance meter, signal, MPLAB, vehicle*

INTRODUCTION

Generally, in designing a 'smart cars' there must be one characteristic of system that can monitor and immediately perform calculation the gap between two object to measure exactly the distance in the range of few centimeters to a few meter. Distance can be defined as the property created by the space between two objects or point [1]. Thus the main purpose of this paper is to discuss about the digital distance monitoring system that could warn the driver to take immediate action on approaching objects before collision encounter. By having this kind of mechanism, perhaps it could reduce the number of car accident on the road. The device is accompanied with a sensor as a detector to capture and calcu late the distance between any object and obstacle to the car. Sensors are defined as device (or transducer) that transform physical quantities such as pressure or acceleration into output signal (usually electrical) that serve as input for control systems [2]. As a prototype, a seven segment display is connected to the detector to show the distance. Even though the general concept of the device was completed, wide scale testing is required to prove that it would help the driver as well as reduce accidents.

PROBLEM

Year by year, the statistic has indicated that the number of people that involved in accidents especially in Malaysia was increased dramatically especially during festival holiday. There were 6223 cases of accidents reported in 2004 [3] in which 3075 person died and many injured in the accidents [4]. One of the main factors is that the driver cannot estimate exactly the distance during speeding and brake system malfunction before it crash or hit any object. Due to these factors they could not be able to take immediate action. Most of the sensors installed nowadays only provided at the behind of the car to warn user during reversing the car. It buzzed the alarm when the distance is approaching but no digital display provided. Therefore, this research project is implemented to provide new alternative so that the driver not only has been warned by the buzzer but know exactly the distance.

A. Objectives

The objectives of this project are:

i. To determine the distance of any object from frontor behind the vehicle.
ii. To design circuit that can convert signal to digital display.
iii. To develop software and hardware for the distance detector system.

RELATED WORK

A. Previous Work

Mercedes Benz new S-class [5] equipped with the option of the innovative *'distronic'* distance control system which is an "adaptive cruise control system" to make sure that the safety of cruise control for highway by reducing the vehicle speed if the system detects a slower moving vehicle up to 150 meters in front of it. The Mercedes is installed with a radar sensor mounted in the radiator grille, and a high performance micro-computer to make sure the car is within a safety distance to other vehicles in front of it. The radar sensors located

behind the radiator grille comprises of three transmitting and receiving units. These sensors will monitor the traffic with a micro-computer so that the safety distance always maintained. When the vehicle moves too close to another vehicle, the electronic system automatically reduces the speed of the car. If needed, brakes will be activated. Once a safe distance has been re-established, the system will accelerate back to the origin selected driving speed.

Another car company, Honda was designed the Honda Intelligent Driver Support System (HIDS) that available to assist the driver with two driving task- keeping in lane and maintaining vehicle headway. The millimeter wave radar used with C-MOS camera to detect and analyse lane marker and to determine of following vehicle [5]. Allison Smyth used an automotive collision monitoring system that mounts on the front of prototype vehicle [6][13]. The system tested for this device would be conducted at speeds less than 20 mph. This device uses sonar technology to send out signal from the front of the vehicle. The vehicle will warn the driver if following too closely with another vehicle. It will warn the driver of these dangers through a series of light emitting diodes (LEDs). A green LED tells the drivers are doing fine, amber is a warning, and red means the driver need to slow down immediately.

Other system which has similar concept has been developed [7], but the speed has already been set based on the distance of the two cars. The system was based on the laboratory scale and PIC was used as the core of the project was to slow down the motor. This is to make sure the distance is always maintained in certain range. Otherwise, the speed will reduce automatically. There were 3 distances that had been classified: Far>30 cm; Medium 15 cm=x=30 cm; Critical =15 cm. The speed will react based on the distance. Infra red sensors were used in the study and were found that a lot of limitations need to be considered if it were to be applied in real environment.

B. Sensors

A sensor is a technological device or biological organ that detects or sense a signal or physical condition and chemical compounds. From this, it will produce a measurable output. Sensors and sensor system may be mechanical, electrical, or a combination of both. They are used in many fields example in industrial, civil, military, and domestic. Most sensors are electrical or electronic. A sensor is actually a type of transducer. Sensors are either direct indicating (e.g. a mercury thermometer or electrical meter) or with an indicator (perhaps indirectly through an analog to digital converter) so that the value that sensed becomes human readable. Since a signal is a form of energy, sensors can be classified according to the type of energy they detect [8]. For example;

Light sensors: photocells, photodiodes, phototransistors, photo-electric tubes.
Sound sensors: microphones, hydrophones, seismometers.
Motion sensors: radar gun, speedometer, tachometer, odometer, turn coordinator.
Distance sensors (non-contacting) that several technologies can be applied to sense distance.

Different classifications of sensors were studied and comparisons were made to find a suitable type of sensors for this project.

Table 1. The Sensor Comparison

	Radar Sensor	Sonar Sensor	Ultrasonic Sensor	Laser Sensor	Infrared Sensor
Application	Military, Car	Robot	Short Range Distance Detector	Speed Laser Gun	Remote Control, Robot
Temperature	-20 c to 60 c	0 c to 40 c	-20 c to 60 c	50 c	0 c to 5
Range	>150 meters	11 meters	<10 meters	1 meter to 150 meters	<5 meters
Cost	Very expensive with other equipment and system	Around RM 200	RM 25 – RM 80	>RM 1000	Cheap with different type
Advantage	-Can sense the object in long range distance -More accuracy	-Operate from single supply - Accuracy is (+/-) 1% -Mostly used in robot -Cheap	-Suitable in certain distance -Using the signal that harmless(long wavelength) -Cheap and easy to build	-Can reach quite long distance -Hard to interrupt with interference -Very sensitive	-Good sense for shot distance -Common used and easy to get -Easy to build
Disadvantage	-Expensive cost -Not so popular -Operate with other equipment	-Short distance instead -Hard to apply in open condition	-Short distance -Not so Sensitive	- Expensive -Dangerous for human sight -Only direct emit	-Distance not suitable -Easy interrupt

C. Ultrasonic

Ultrasonic is used in security technology such as car collision avoidance and distance measurement and it also can be used in detecting obstruction behind the car when backing up. As stated in [8], the author had analysed the interference of ultrasonic signal when it transmitting and receiving, and then resolve it by software. There is a blind area and distance limitation in ultrasonic distance measurement. The cause of distance limitation is that the amplitude value of received signal is at least larger than the specified threshold value. However the requirement is low, the minimum amplitude value of received signal must be lager than that of the noise; otherwise it is difficult to distinguish the signal that need from the noise [8]. There were one major problem of ultrasonic distance measureme nt which is the strongly object dependent detection range: objects providing strong echoes (e.g. well aligned planes) can be detected in a much wider distance than "small objects" reflecting only a fractional amount of the incoming sound energy e.g. edges. In conventional sensor constructions not only the maximum measurable distance along the sensor axis varies, but also the field of detection where measurement values are delivered. As a consequence, the decision if an object is located inside or outside a defined area is hardly possible without a pure knowledge of the object's reflection properties. This work presents a measurement principle that provides a well defined and objects independent detection area that moreover can be dynamically adjusted to achieve high resolution for algorithms based on contact-less ultrasonic "touching" of objects [9].

D. Analog to Digital Converter

The Analog to Digital (A/D) converter module has five inputs for the 28-pin devices [11]. The conversion of an analog input signal results in a corresponding 10-bit digital number. The A/D module has high and low voltage reference input that is software selectable to some combination of VDD, VSS, RA2 or RA3. The A/D converter has a unique feature of being able to operate while the device is in sleep mode. To operate in sleep, the A/D clock must be derived from the A/D's internal RC oscillator. The A/D module has four registers. These register are:

A/D Result High Register (ADRESH)
A/D Result Low Register (ADRESL)
A/D Control Register 0 (ADCON0)
A/D Control Register 1 (ADCON1)

The ADCON0 register controls the operation of the A/D module. The ADCON1 register configures the functions ofthe port pins. The port pins can be configured as analog inputs (RA3 can also be the voltage reference) or as digital I/O. Additional information on using the A/D module can be found in the PICmicro® Mid-Range MCU Family Reference Manual (DS33023).

METHODOLOGY

This section discusses the method that has been used to collect data and information in order to achieve the objective of the project. Figure 1 illustrates the methodology used in designing the device. In phase 1 and 2 usually performed in parallel. Generally we find a general concept and perform the literature study to ensure its implementation contains contribution to the user and country. In designing phase, process of designing a circuit and assemble the equipment is performed and the testing has been done in implementation phase to ensure its functionality and work accordingly. While the last phase is maintaining process when the device is ready to be used and troubleshoot any technical problem encountered during populated to the commercial applications.

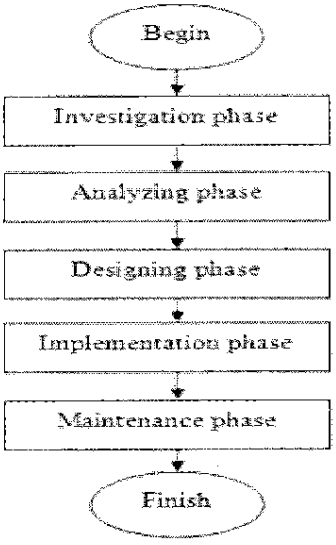

Figure 1. Block Diagram of Methodology

RESULT AND ANALYSIS

This section discusses the development of the project and analysis was performed on the entire important component in the circuit. The tests have been conducted to identify the ability of the circuit and also identify the weakness in the whole system. The result of the tests can determine whether the system developed is working accordingly. Figure 2 below illustrates the circuit designed.

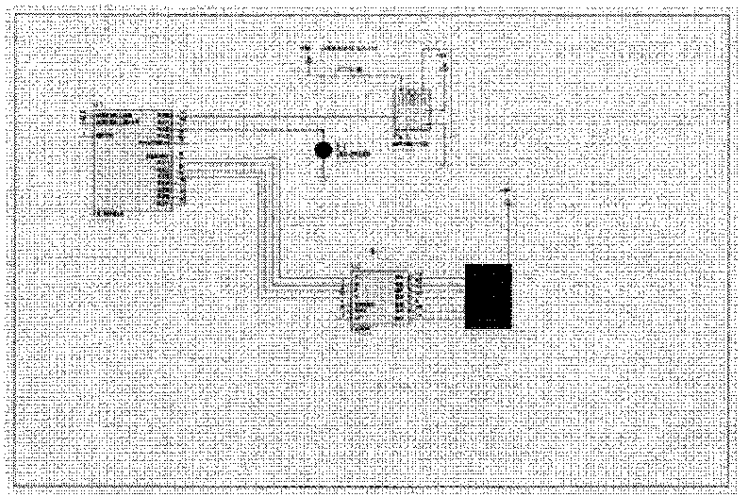

Figure 2. Circuit of the System

Figure 2 shows the circuit simulation using Proteus software. The simulation is done to make sure the connection between each component in the circuit and the program in the PIC16F84A is correct. The hardware is built after the simulation shows the desired outputs and the display shown the distances that supposed to be.

A. Ultrasonic Sensor

This sensor consists of transmitter and receiver. Based on the table 2, the voltage of the transmitterbefore the sensor detect obstacle is higher than once itdetects an obstacle.

Table 2. Output Voltage of the Ultrasonic Sensor Circuit

Ultrasonic sensor	Value	
	Not detect	Detect
Transmitter	Vrms = 4.73V Vmin = 4.58V Vmax = 5.00V	Vrms = 2.66V Vmin = 2.50V Vmax = 2.70V
Receiver	Vrms = 0.31V	Vrms = 0.31V

B. Microcontroller circuit

The main function of the source code is to control the component in the circuit. Therefore, the microcontroller circuit must operate in good condition. There are some steps to test the microcontroller circuit such as:

i. Make sure the clock frequency at pin 15 and 16 is 4MHz because the crystal oscillator that has been use is 4MHz.

ii. Make sure the input voltage to the microcontroller is 5V.

C. Seven Segment Display

The resultant output voltage from the seven segments is shown in the Table 3. Based on the table 3, the voltage is higher when the prototype detects an obstacle.

Table 3. Output Voltage from the Seven Segments

Not detect	Detect
Vrms =213.42 mV	Vrms = 3.85 V

CONCLUSION

The vehicle distance monitoring system contains ultrasonic sensors based on the ADC concept which converts the analog signal from transducer to digital signal, and LCD as output. Ultrasonic sensors were an option because it has a unique advantage over conventional sensors like infrared sensor. It can measure and detects distances to moving objects and inflexible to target materials, surface and color. Otherwise, ultrasonic sensors can detects small objects over long operating distances. It is resistant to external disturbances such as vibration, infrared radiation, ambient noise and EMI radiation. Other than that, ultrasonic sensors are not affected by dust, dirt or high-moisture environments. PIC16F84A microcontroller was used because it is more familiar and easy to understand. To make it function, the PIC need to be programmed. It is important to write the program that can be executed by the microcontroller to produce the output for this project. The compiler software employed is MPLAB and the programs are downloaded into the chip by ALL-11 Universal Programmer and Tester. The complementation of hardware and software need synchronization to make it operable and troubleshooting needs when there is error. As the conclusion, this vehicle distance monitoring system will provide a smart way to prevent accidents among driver. It is capable to measure the distance exactly when the car is too close from any object or obstacle by showing on display. Further improvement of this device can be expanded to connect to the car driving system so that it could immediately send a command to brake and gear system to reduce the speed and activate the brake without human intervention.

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