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Microcontroller Based Real Time Distance Measurement System

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Abstract

The easy and accurate measurement of distance has been major subject of study in the field of engineering and physics from the time men began to walk on earth. Many different techniques have been devised until date for the measurement of distance from the observer to a target, for the purposes of surveying, navigation, determining focus in photography, or accurately aiming a weapon. The proposed system employs ultrasonic waves for distance measurement, the directional properties of the wave and comparatively lower attenuation encountered makes it highly suited for distance measurement. Objective of the proposed technique was to develop a device based on a highly that can be used to measure the distance of the target with high precision using ATmega16a as a processor. . The pulse echo or time-of-flight method of range measurement is subject to high levels of signal attenuation when used in an air medium, thus limiting its distance range.

Keywords: *Obstacle avoidance, ultrasonic sensor, Doppler Effect, atmega 16 microcontroller, MATLAB, LEGO.*

1. Introduction

ultrasonic technology is one of the medium on how the distance will be measure and this is one of the ways that the world today widely used especially in some kind of general application such as in warfare applications, engineering applications and also in scientific and medical applications. Basically this ultrasonic technology is based on ultrasound and a common use of ultrasound is in range finding that perfectly related to the objectives of this project. This technology can be used for measuring: wind speed and direction (anemometer), fullness of a tank, and speed through air or water. For measuring speed or direction a device uses multiple detectors and calculates the speed from the relative distances to particulates in the air or water. To measure the amount of liquid in a tank, the sensor measures the distance to the surface of fluid.

Generally, the distance can be measured using pulse echo and phase measurement method. Here, the distance can be measured using pulse echo method. The ultrasonic module transmits a signal to the object, then receives echo signal from the object and produces output signal whose time period is proportional to the distance of the object. The mechanism of the ultra sonic sensor is similar to the RADAR (Radio detection and ranging). This circuit calculates the distance of the object based on the speed of the sound wave at normal temperature and displays the distance on LCD. Doppler Effect should be taken into account while computing distance through ultrasonic sensor.

2. Problem Identification

Lately the use of a surveillance system for image detection is becoming more important. An embedded surveillance system is frequently used in the home, office or factory for image processing of the surveillance system and also for traffic monitoring , but this configuration requires a high performance core, which works against some advantages of embedded systems, such as low power consumption and low cost. Some designs propose the use of different sensors to track the sequence of the human body movement. Other researchers construct an external signal to trigger the embedded surveillance system by means of a PIR sensor, which is triggered when an intruder enters the monitoring area. However, a PIR sensor has a high miss rate when the intruder walks at a slow speed. Hence, to solve this problem, we use ultrasonic sensors to implement an embedded home surveillance system. Ultrasonic sensors are already used in automatic cars and robots for measuring distance. There is some use of ultrasonic transmission in medical detection, such as high-frequency ultrasonic transmission based on a specific result of ultrasound attenuation in different materials with different characteristics, combined with signal processing, which shows images. Moreover, ultrasonic transmission is sometimes used in examining pregnant women. In addition, because a single receiver can be influenced by refraction and reflection, we use several sensors to receive the ultrasonic transmissions in order to enhance their liability of the system.

2.1 Bad weather conditions under heavy rain

2.2 Bad weather conditions under fog

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2.3 protections from underwater crest using ultrasonic sensor.

2.4 application of LEGO kit in submarines

3. Design proposed

The design proposed for real time embedded system is based on ultrasonic senor with atmega 16 interface. Normally Doppler Effect is taken into consideration while echoes from ultrasonic sensor are travelling in various medium .in this paper, the prototype proposed is proposed and simulated in MATLAB 7. The work done has come into existence in following steps:

3.1 PCB Layout

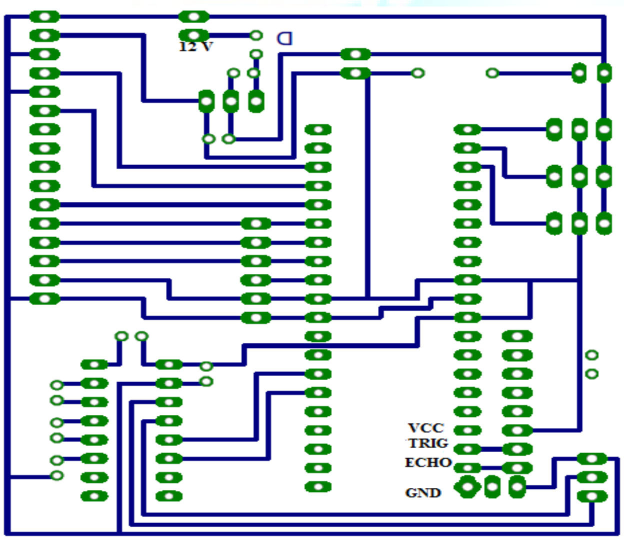


Fig. 1 PCB Layout for proposed circuit

3.2 Prototype design

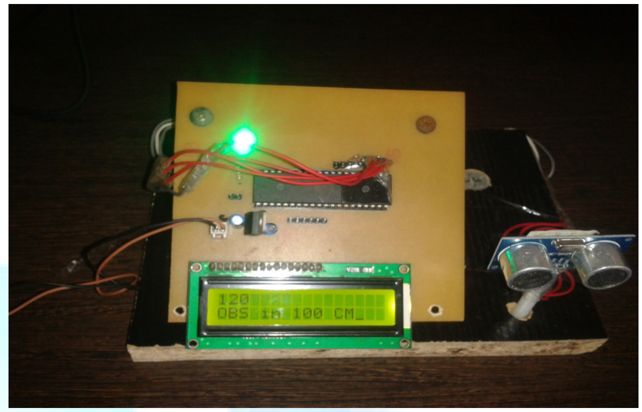


Fig. 2 Prototype of real time embedded system

3.3 Ultrasonic sensor used HC-SRO4

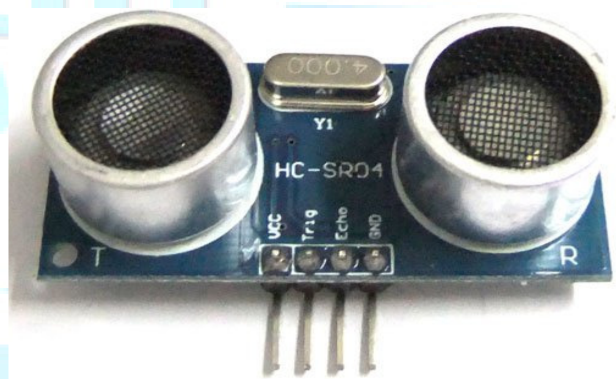


Fig. 3 Tx, Rx and pins of prototype design sensor

3.4 Doppler effect with equations got applaud in real time embedded system

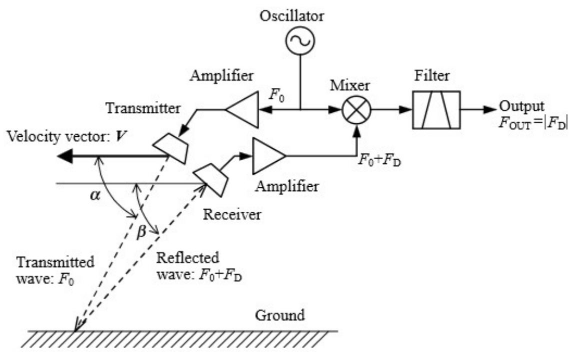


Fig. 4 Block diagram of a conventional ultrasonic Doppler speed sensor

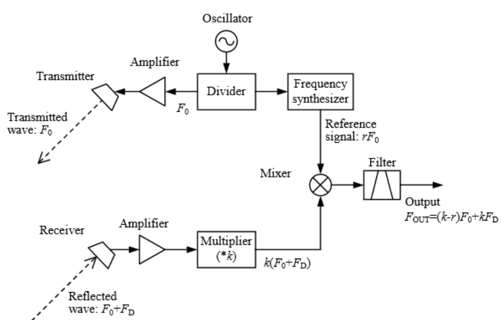


Fig. 5 Block diagram of a conventional ultrasonic Doppler speed sensor developed

The sonic wave is reflected diffusely on the ground where it is separated into many weak sounds, a few of which are received by a receiver. The Doppler Effect causes the frequency to be shifted. If F_D denotes the Doppler shift, the frequency of the received signal is $F_0 + F_D$. The signal is amplified and mixed with the transmission signal in a mixer to create the beat-frequency signal Therefore, the output frequency F_{OUT} is equal to the absolute value of Doppler shift $|F_D|$. On the assumption that air is stationary relative to the ground, the Doppler shift F_D is given by

$$F_D = F_0\left(\frac{Cs + V\cos\beta}{Cs - V\cos\beta} - 1\right)$$

where C_S is the velocity of sound in air, V is the vehicle velocity relative to the ground, α is the angle between the vehicle velocity vector and the transmitted direction of the ultrasonic wave, and β is the supplement of the angle between the vehicle velocity and the direction of the received wave.

If $V << C_S$, the output frequency F_{OUT} is approximately expressed as follows:

$$F_{OUT} = F_D = F_0\left(\frac{Cs + V\cos\beta}{Cs\ \ V\cos\beta} - 1\right)$$

or $\frac{|V|}{Cs}(\cos\alpha + \cos\beta)$

The signal of frequency $k(F_0+F_D)$ is mixed with a reference signal of frequency rF0 that is generated from the same oscillator as used for the transmission signal using a frequency synthesizer. The mixer outputs a signal of the differential frequency that is the sensor output. The output frequency F_{OUT} is expressed as follows:

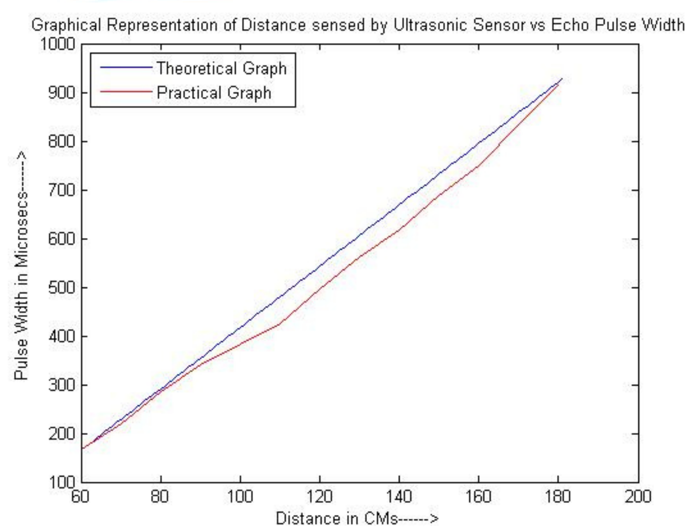
$$F_{OUT} = k|F_D + F_0| - rF_0$$

$$F_{OUT} = k|k - r| + kF_D$$

In the equation, we can choose the value of coefficient suitably by the setting of the electronic Circuit. Therefore, the value of $k|k - r| + kF_D$ can be kept positive, however the value of F_D is negative when the vehicle travels in reverse. Hence, the output frequency is expressed as follows

$$F_{OUT} = k|k - r| + kF_D = kF_0\left(\frac{k-r}{k} + \frac{V\cos\alpha + \cos\beta}{Cs}\right)$$

3.5 Comparison results with low time consumption and maximum efficiency:



S.No.	Distance In meters	Pulse width without ATMEGA16 interface in µ-sec.	Pulse width withATMEGA16	Time saving in %
1	0.6	69	55	20.21
2	0.7	90	73	18.89
3	0.8	120	95	18.84
4	0.9	136	114	16.18
5	1.0	144	128	16.18
6	1.1	163	142	12.89
7	1.2	189	165	12.70
8	1.3	210	187	11.04
9	1.4	238	206	15.45
10	1.5	258	229	11.25
11	1.6	281	250	11.04
12	1.7	314	278	11.47
13	1.8	349	305	12.61
14	1.9	391	342	12.54

3.6 Result and Discussions:

Fig 6 continuous wave form of graphical representation of distance sensed by ultrasonic sensor vs. Echo pulse width

Graphical representation of proposed system with echo pulse response with analog form is shown in figure 6.

Fig 7 digital wave form of graphical representation of distance sensed by ultrasonic sensor Vs. Echo pulse width

Similarly figure 7 shows digital response of ultrasonic sensor with returned echo pulse. the overall simulation is done in MATLAB 7 tool and Atmega programming is done in BASCOM. PCB and circuit diagrams are verified in EAGLE 5.2 version of EDA tool.

4. Conclusion:

Used to measure the obstacle distance. This system used in automotive parking sensors and obstacle warning systems. Used in terrain monitoring robots. It is used in car parking. Ultrasonic sensors are attached to moving object and equipment to provide collision protection. The sensor continuously relays proximity data to a controller many industrial users include Automotive Automation Logistics Metal working. They are widely used as range meters and proximity detectors in industries Parking assistance system In Industries used to measure object counter

The system is able to detect object within the sensing range .The system can calculate the distance of obstruction with sufficient accuracy. This can also communicate with pc through its serial ports. This offers a low cost and efficient solution for non-contact type distance measurement. The microcontroller with LCD makes it user friendly. Less hardware are used so smaller in size. Inexpensive components are used so that reduces the cost per unit.

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