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Radar Like Device Using Sonar Technology for Object Detection and Analysis

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Abstract—The system users arduino coupled with an supersonic sensor for detection of target near its surroundings. Sonic wave sensors are not being fully utilized in the current situation and this device can test the possibilities and limitation of using sound waves for detection of objects and analysis. Waves are sent in the environment which on collision with external objects are reflected back, the detection of these reflected waves and their properties are analyzed to detect objects.

Keywords—*ultrasonic waves; arduino; sensor;*

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I. INTRODUCTION

Sonar based devices have received very less publicity in comparison with their counterparts, the radar devices for detection or finding location or tracking the movement of any object in the surrounding. Though the range of a sonar device is very limited due to huge dispersion of the waves in the environment, it can give considerable results in mediums where radar waves are not usable.

The idea behind the system is the simple phenomenon named echo or reflection of sound wave back to its source. A sonar system generally uses ultrasonic sound waves to detect objects under the surface of water. It has been used for various detection purposes and its application extends into mining, fishing and various other field. The Sonar device sends a sound wave, here ultrasonic wave and then senses the reflected echoes, the data is displayed through a UI device.

Process starts with the emission of the acoustic waves through the medium. The received is to be amplified by an amplifier. The Data and analysis Process is then done on the amplified acoustic wave through the PC (in our case: Arduino Board) and the result is then sent to the monitor or any display device attached to display the information.

II. REPORT SURVEY

Ultrasonic sound wave has a frequency well above 20KHz which is the threshold frequency a human can hear. Since a human cannot hear Ultrasonic sound it causes no disturbance to us.
The simple Newtonian Kinematics will be used for calculating the distance of the object.

A. Detection of Object and Analysis

In this particular paper[1] published in 2012 the author's theory on Collision prediction system using intermittent ultrasonic wave year tells an effective method for measuring the propagation time, distance and the forward trajectory of the object under process. It obtains the distance to position of moving object twice. The distance to the object is measured by a method according to the propagation time of ultrasonic based on pulse-echo method. Think of the case that ultrasonic wave is transmitted from SR, and reflected wave will be received at SL and SR.
If tL1, tR1 are defined as the time until coming back SL, SR from transmitting ultrasonic wave when the position of the object is P1.

$$l_{R1} = \frac{t_{R1}c}{2}, \quad l_{L1} = \frac{(2t_{L1} - t_{R1})c}{2} \tag{1}$$

Similarly as shown in equation 1, if tL2, tR2 are defined as the time until coming back SL, SR from transmitting ultrasonic wave when the position of the object is P2(refer equation 2).

$$l_{R2} = \frac{t_{R2}c}{2}, \quad l_{L2} = \frac{(2t_{L2} - t_{R2})c}{2} \tag{2}$$

where c is a sonic speed.
If collision detection conditions is satisfied, and the object has been the uniform linear motion, collision time(refer equation 3) is able to be calculated.

$$t_{tc} : t_{12} = S_2 : S_1 - S_2 \tag{3}$$

Then

$$t_{tc} = \frac{S_2}{S_1 - S_2} t_{12} \tag{4}$$

where t_{tc} is time to move from P2 to collision(refer equation 4), t_{12} is time to move from P1 to P2. S1 is area of $S_L T_1 S_R$, S_2 is area of $S_L T_2 S_R$.

C. Image Processing

After the Information is processed it will have to shown on the display by some kind of Image Generation technique. One Such Technique is described [2]. In their project, four target objects within five case studies were considered for exploring. The distance to the targets is about 30 cm. The objects differ in size and type of surface, in order to check the scattering properties of the targets and the effect of the ultrasonic frequencies on the reflected waveforms. The set of objects is presented in Fig. 1, through their projections on vertical plane. This set of images will be considered as ideal images, which should be delivered by the sonar head. The objects are quite similar and this will generate difficulties in any recognition task.

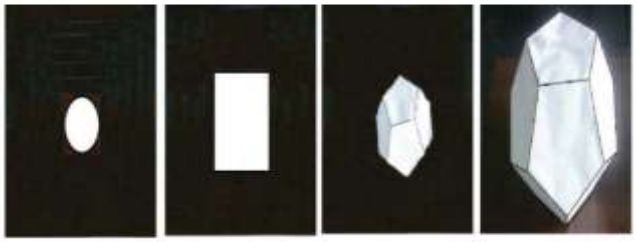

Fig. 1. The objects' projections on vertical plane: ball, box, small size and big size polyhedron

The number of available images is 2 (from left and right sides) x 5 cases x 5 frequencies, which means 50. As example, a set of two images, for two frequencies, is presented in Fig. 2.2[2]. These are raw images, i.e. without special processing like artifact removing or other filtering stages. As in many other cases where ultrasonic images are used, an expert with knowledge of ultrasonic is necessary to interpret the obtained airborne images, and to conclude which area of image corresponds to reality (physical objects) and which corresponds to virtual targets. As general features of the airborne images, the size of the target is decreasing as the frequency is going higher. It is the same with the artifacts, which are decreasing in size and number. The reason is that secondary echoes, i.e. echoes arrived on other paths than the direct one or arrived after multiple reflections, have small amplitude and are absorbed quickly by the air.

D. Blindness Support

The author[3] discusses that object detection is possible by using proximity sensor. It will also include a 3D sound system which will make a sound when there is an object near-by. This mechanism consist of coupling the proximity based ultrasonic sensor. So, when a blind person is walking he will not only hear the presence of object but will also know the distance between them and the object. Which co-relates with our project for object detection and analysis.

He suggested to use a device which will have at least 3 ultrasonic sensors, so that each sensor can detect objects in all directions approx. distance is 2 meters. By using Micro controller unit control, we can control all the ultrasonic sensors in parallel. A beam of ultrasound will be transmitted, now these sensors are arranged in such a way that can directed in different directions. Now if the wave bounce back from an object sensor, each sensor will send a signal to micro controller unit to indicate the existence of that object. Now the algorithm will convert this signal into sound that will be sent to user's ears through air phones or microphones.

The proposed device's microphones were designed based upon the principles of:

Not isolating the user from the outside world, by meaning of not to consider the sounds of the surroundings as a noise, however, will generate an unnatural sound that can be designated by the user and the sound system uses a 3D sound surround technique to enable the user to recognize the direction of the sound. The intensity of the sound refers to the distance of the object.

E. Navigation assistance for visually impaired

ChaitaliKishorLakde and Dr.Prakash S. Prasad(2015) [4] suggested that the system can be made for Navigation assistance for visually impaired (NA VI) . This system helps people with blindness to percept surrounding environment through sound instructions. Many researchers are working to assist visually impaired people in different ways like voice based assistance, ultrasonic based assistance, camera based assistance and in some advance way researchers are trying to give transplantation of real eyes with robotic eyes which can capable enough to plot the real image over patient retina using some biomedical technologies. This device will be very helpful for handicap people with blindness and can change the way of their living style. This system also uses the concept of finding acoustic location of objects through echo detection.

F. Roshni

A system "Roshni"[5] determines the user's position in the building, navigation via audio messages by pressing keys on the mobile unit. It uses sonar technology to identify the position of user by mounting ultrasonic modules on ceiling at regular intervals. This system is portable, easy to operate and is not affected by environmental changes. But this system is limited only for indoor navigation because it requires detailed interior map of the building.

III. Analysis Of The Proposed System

The device will emit ultrasonic sound by supersonic sensors like the Fig. 3.1[6]. Our device will work on similar principal like RADAR system which uses tranducers to transmit and receive sound or radio waves to locate object location, speed and size. Supersonic Sensors are similar to tranceiver. Sensors like ultrasonic active sensor emits high-frequency sound waves and calculate the echo received from reflection sensor, measures the time interval between sending the wave and echo will be received to calculate the distance of an target body.

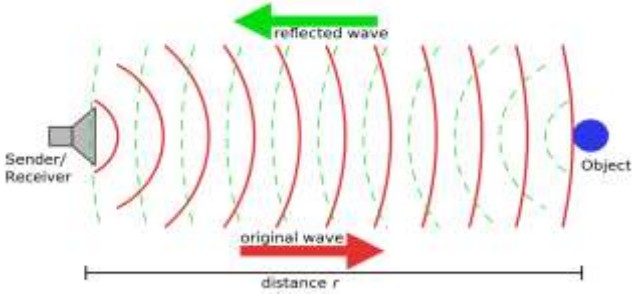

Fig 2. Sound reflection and echo

To calculate the target body location, the time of transmission of signal to reception of signal which will help to determine speed of target by knowing speed of sound. This measured time data is used to calculate the distance.

This system have large number of uses in various application which is based on how it is uesd. In this system the supersonicsonic waves generated in a specific direction overlaps with an object in its path, the pulse partially or fully reflected back to the transmitter as an echo and one can

 ISSN: 2321-8169
281 – 284

analyse this event to detect the range of that particular object by measuring the time difference between the sending signal and arriving signal back to the receiver.

IV. Architecture Of The System

The system's main part will be Active Ultrasonic sensor, Arduino UNO circuit and stepper motor, the sensor wil be mounted on motor, the motor rotation will be controlled by our software program the basics process of system architecture will be like as shown in the fig. 3[7].

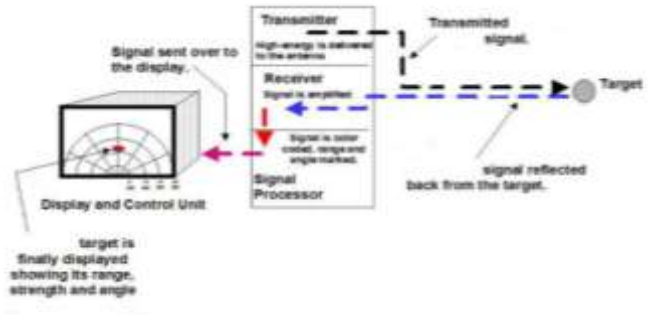

Fig. 3. System Process Architecture

The ultrasonic transmitter will first generate an ultrasonic wave that will be sent in the direction according to the position of the stepper motor. If any object is present in the path of the sent wave then wave will strike on it and scatter. Some of the scarred waves will be lost in the environment and fraction of them would be reflected return to the receiver. Since the much of the wave was scattered the signal receiver will first amplify the fraction of the wave and then send it to signal analyzer where it will analyze if the received waves contains the signals sent by the transmitter.

If the signal contains the transmitter waves the processor will then calculate the distance in which the object is present by the use of the time difference between of that transmission and receiving.

After the processing has been done the data will be then sent to the display device which will display the calculated values in a graphical manner so that the user would be able to understand.

For better understanding of the mechanics the following procedure will be explained :

- Find the distance to a target
- Find the direction to a target
- Determine the target's movement

(1) Distance: Signal Flow

A signal travels at the speed sound. It tracks the time from transmission of singal for reflection, and reception to decide the distance of the target.

(2) Direction: Sweep Angle

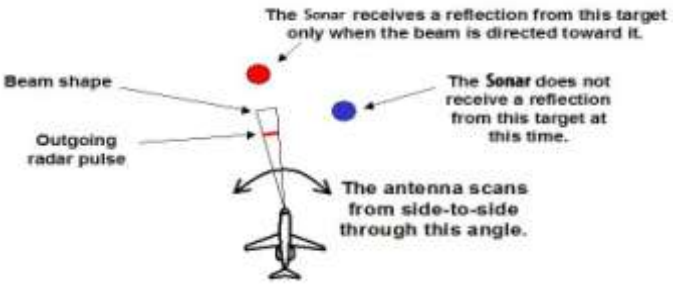

Fig. 4. Finding targets direction

The system will transmit waves continuously by rotating and only receives reflections from target body, which helps to know the direction of target as shown in Fig. 4[7].

(3) Target movements and size:

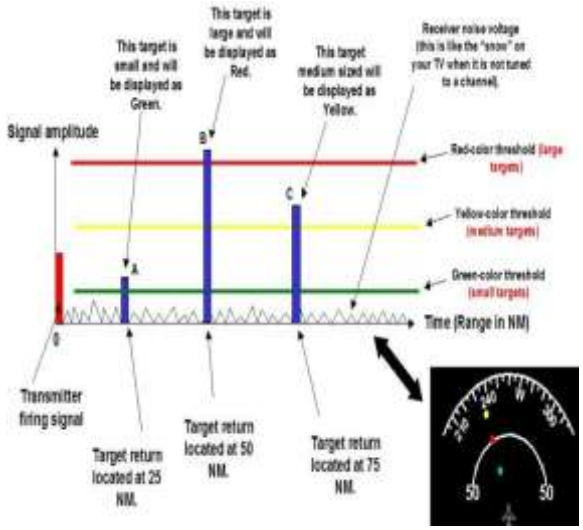

Fig. 5. Determining movements

The system will calculate the amplitude of signal i.e. the reflected wave to calculate the location of target body and it subsequent position with respect to its older one. This position will be used to work out target movement.

V. Conclusion

In this paper, a study of a RADAR like device will be built using an Arduino microcontroller board, a servo motor and ultrasonic range sensor. This particular device is used to detect all nearby objects and the UI will be used to display all the near-by objects just like Radar device. The results that are obtained from this project helps to determine whether ultrasonic ranging is efficient in short range or not. Apart from just ranging the expected results will also be used for motion prediction and to predicting the location of an object after given intervals of time. These kind of results are useful in research works including fast moving object. This device can also be used as an alternative for surveying andCharting inside

water,Inspection of Pipeline , Offshore of wind turbine, Detecting for combustible substances underwater, Searching and rescueing missions etc.SONAR designs are reasearched continually developed and improved and there applications are varying widely but the principals widely remains the same. While there is continous development in the field of laser cameras, underwater charting is reliant only on sound navigation and ranging i.e. SONAR .In upcoming future this device can be interfaced with wireless communication technology and can be remotely operated through any of our devices, be its hand-held smart phones or computers. This device can not only be used in research purposes but it will also be used to find marine creatures, mostly school of fishes which can help in supporting livelihood of people.

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