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# "Ultrasound Based Localisation & Space Positioning Method and its Hardware Realisation"

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***Abstract***

**This paper presents a discrete method of positioning various object of apt dimensions into the target space by the use of ultrasound .This is done by trans-receiving a signal based on both the property of two chaotic systems generating the similar chaotic signal when they are in synch and the property of pulse position modulation (PPM) to be robust to the distortions of the transmission channel. This method use active trilateration techniques, i.e. they rely on measuring the Time-of-Flight (ToF) an ultrasound signal needs to go from one emitter to one receiver, and AOA(Angle of arrival). AOA is a technique which is used to determine the direction of the incoming signal. The method is elaborated by designing of ultrasonic radar systems, in which the transmitter and receiver, both containing ultrasonic transducers are placed besides each other, and the received signal consists of the transmitted signal reflected by an object or say obstacle. A reference sinusoidal signal is superimposed to a chaotic signal generated by a master chaotic system, and the whole signal is modulated according to the PPM method and transmitted by the sensor. The received signal is demodulated, and the demodulated signal makes chaotic subsystem to produce the chaotic signal embedded in it, which allows recovery of the sinusoidal signal by removing this chaotic signal from the demodulated echo. The difference of the phases of the reference sinusoidal signal and the recovered sinusoidal signal allows computation of the time of flight of the signal and, consequently, the distance of the radar system from the obstacle.**

***Keywords***— **ultrasonic , radar, obstacle, embedded, PPM, chaotic signal, localisation**

## I. Introduction

This is a versatile project with many practical applications in indoor surveillance and security systems for shops, cars and home. RADAR is an acronym for Radio Detection and Ranging. It uses electromagnetic waves or in this case ultrasonic sound waves to remote sense the position, velocity and identifying characteristics of targets. This is accomplished by illuminating a volume of space with electromagnetic energy or sound waves and sensing the energy reflected by objects in that space. Radar is used to extend the capability of one's senses for observing the environment, especially the sense of vision Transmitter radiates high power ultrasonic signals towards target. The target intercept small part of this signal and radiates back towards the transmitter. The receiver collects reflected signal and process it to collect information about the target i.e. range, velocity and angle information of the target It has a set of ultrasonic receiver and transmitter which operate at the same frequency. When something moves in the vicinity of the circuit range the circuit's fine balance is disturbed and the alarm (optional) is triggered. The circuit is very sensitive and can be adjusted to reset itself automatically or to stay triggered till it is reset manually after an detection .

The transducers used will be standard 40 kilo-hertz piezoelectric transducers which will constitute for the transmitting and receiving systems for the RADAR. The other subsystems will include a two stage amplifier circuit, a peak detector circuit, a comparator unit and an very sensitive (generating huge changes in the output for any small notable change in the input) detection unit. For the purpose of space mapping and precise direction sense the PPM modulated wave transmission and the stepper motor control will be kept in synchronisation by the use of microcontroller unit which will be furthermore enhanced by coupling it to a graphical display device (a PC or laptop)by a serial or USB port. For better graphic interface special programs shall be made using visual basic or some open source processing language . The circuit will also be able to sense distance and speed of a moving objet.

## II. Block Diagram

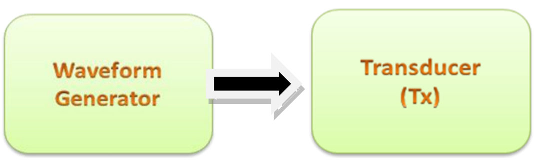


**Fig1. At Transmitter**

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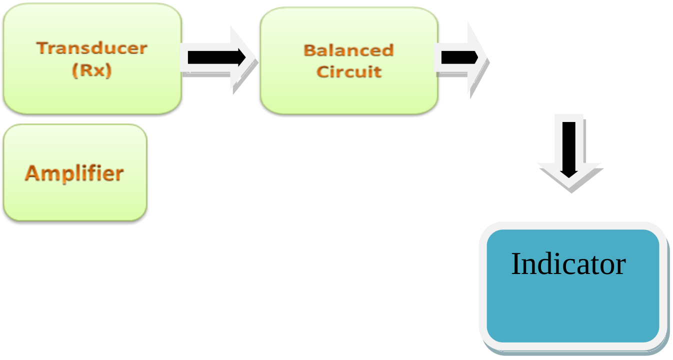


Fig 2. At Receiver

## III. Construction

This section include the schematically directed constructional instructions with a brief working of each system specified .The transmitter is built using two NAND gates of the four found in IC3 which are used here wired as inverters and in the particular circuit they form a multivibrator the output of which drives the transducer. The trimmer P2 adjusts the output frequency of the transmitter and for greater efficiency it should be made the same as the frequency of resonance of the transducers in use. The receiver similarly uses a transducer to receive the signals that are reflected back to it the output of which is amplified by the transistor TR3, and IC1 which is a 741 op-amp. The output of IC1 is taken to the non inverting input of IC2 the amplification factor of which is adjusted by means of P1. The circuit is adjusted in such a way as to stay in balance as long the same as the output frequency of the transmitter. If there is some movement in the area covered by the ultrasonic emission the signal that is reflected back to the receiver becomes distorted and the circuit is thrown out of balance. The output of IC2 changes abruptly and the Schmitt trigger circuit which is built around the remaining two gates in IC3 is triggered. This drives the output transistors TR1,2 which in turn give a signal to the alarm system or if there is a relay connected to the circuit, in series with the collector of TR1, it becomes activated. The circuit works from 9-12 VDC and can be used with batteries or a power supply. This whole transmitting and receiving setup is fixed on to the stepper motor , which is itself governed by another controlling unit. The stepper control unit is well synchronised with the multivibrator clock in the transmitting section. The stepper motor control and the obstacle detection can further be cross-programmed to modify the post detection actions.

A 8051 or another ready to use stepper motor drivers can be used for controlling the steeper motor.

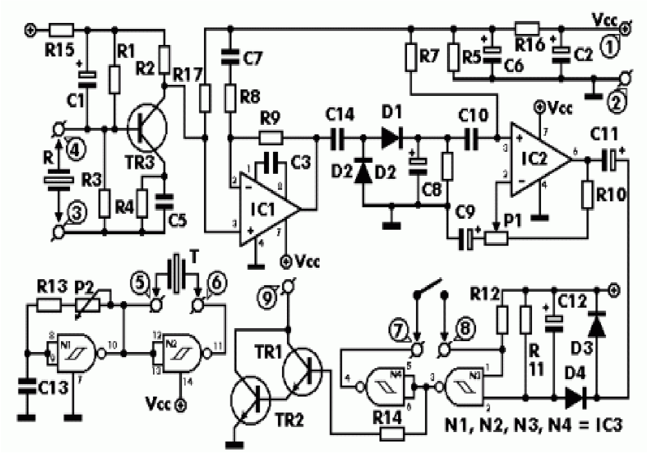


Fig 3. circuit diagram for Ultrasonic Radar

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Parts-
R1 180 KOhm
R2 12 KOhm
R3, 8 47 KOhm
R4 3,9 KOhm
R5, 6, 16 10 KOhm
R7, 10, 12, 14, 17 100
K&#937;
R9, 11 1 MOhm
R13, 15 3,3 KOhm
C1, C6 10uF/16V
C2 47uF/16V
C3 4,7 pF
C4, C7 1 nF
C5 10nF
C8, C11 4,7 uF/16V
C9 22uF/16V
C10100 nF
C12 2,2 uF/16V
C13 3,3nF
C14 47nF
TR1, 2, 3 BC547 , BC548
P1 10 KOhm trimmer
P2 47 KOhm trimmer
IC1, 2 741 OP-AMP
IC3 4093 C-MOS
R TRANSDUCER 40KHz
T TRANSDUCER 40KHz
D1, 2, 3, 4 1N414
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## IV. System Analysis

As it has been already mentioned that this system uses a set of transmitter and receiver and both of them work on the same frequency. These sensors deploy the use of piezoelectric transducers as input and out devices respectively. A rangefinder emits a brief pulse of high frequency sound that produces an echo when it hits an object. This echo returns to the emitter where the time delay is measured and thus the result is displayed. The Polaroid rangefinder is composed of two different parts. The transducer acts as a microphone and a speaker. It emits an ultrasonic pulse then waits for the echo to return. The ranging board is the second part this board Provides the high voltages required for the transducer, sensitive amplifiers, and control logic. A stepper motor rotates the transducer to get a 360 degree field of view. An Experimenter is hooked up to the ranging board to control the ranging board and to measure the round trip time of pulses. It also controls the stepper motor and communicates with the control. It takes about 360 microseconds to transmit the pulses. The transmitter waits 1 millisecond for the pulse transmission and transducer to complete it's task. Then the experimenter waits for the pulse echo to return. If a pulse is detected the board sets ECHO at high. The Experimenter times the difference between BINH going high to ECHO going high. The experimenter sets INIT to low, waits 0.5 seconds for the echo, if no echo is heard the experimenter cancels the measurement. The measured time is sent to the computer which then calculates, at thousands of calculations per second, the distance based on the speed of sound (1100 feet per second). With a program called DISTANCE.BAS the exact speed of sound can be calculated according to the local weather conditions. The stepper motor is used to rotate the radar so it can scan 360 degrees around the room. An ordinary DC motor would not do for such a project. The rotation must coincide with the emissions and the receptions of the echoes. In a DC motor the armature rotates and the brushes connect successive commuter bars to windings to provide the torque. The speed of this motor depends heavily on how much load there is and how much voltage is applied. A stepper motor has different wires to each winding. By energizing a winding the armature rotates slightly, usually few degrees. By sequentially charging one winding after another the armature can rotate completely around. By controlling the windings energized, the operator (in this case the Experimenter board) can control exactly how many degrees the motor turns and at a precisely controlled speed.

In this case a stepper motor is used because it gives precise motor-shaft location for the Experimenter board (processor) to follow. In a DC motor the board wouldn't know shaft position and it would not be possible for the computer to take the distance readings at evenly spaced intervals. With the control of the stepper we can control the number of steps and the step rate required between each transmission. The Experimenter(processor) will control all things.

## V. Accpected Result

On properly assembling the above discussed circuit and controlling system the resulting device will perform the action as accepted.

## VI. Conclusion

This SONAR assembly is quite a interesting project. Through this project we aim to acquire plethora of knowledge in the field of electronics and communication at the same time design a good security system. In this quest, we are working on the project ultrasonic transceiver which is basically one kind of radar. Though, the hardware implementation based on this application is on small scale basis, we would learn a lot. This process of gaining knowledge has many Problems but we look forward to eventually deal with it. .. Moreover this project also includes the latest kind of of microcontrollers ,GUI(Graphic User Interface) and the use of complex controlling programmes thus gives a better understanding of the Embedded Systems Thus the journey of facing and overcoming difficulties would train us for the future higher end projects.

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