Ultrasonic RADAR

Electronic Design Lab (EE-318)

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1. INTRODUCTION

Radar is an object detection system that uses electromagnetic waves to identify the range, altitude, direction, or speed of both moving and fixed objects such as aircraft, ships, motor vehicles, weather formations, and terrain and when instead of electromagnetic waves, we use **ultrasonic waves, it is called an ultrasonic radar**.

The main components in any Ultrasonic radar are the Ultrasonic Sensors. **Ultrasonic sensors** work on a principle similar to radar or sonar which evaluates attributes of a target by interpreting the echoes from radio or sound waves respectively. Ultrasonic sensors generate high frequency sound waves and evaluate the echo which is received back by the sensor. Sensors calculate the time interval between sending the signal and receiving the echo to determine the distance to an object. This technology can be used for measuring: wind speed and direction (anemometer), fullness of a tank and speed through air or water. Further applications include: humidifiers, sonar, medical ultra pornography, burglar alarms and non-destructive testing. Systems typically use a transducer which generates sound waves in the ultrasonic range, above 20,000 hertz, by turning electrical energy into sound, then upon receiving the echo turn the sound waves into electrical energy which can be measured and displayed.

Transducer

Transducers are defined as elements which can convert one form of energy to another. The Ultrasonic transducers convert electrical energy into the sound waves and vice versa. There are basically two kind of transducers used here, one to convert the electrical waves into the sound waves which is called Ultrasonic Transmitter and the other to convert the sound waves into the electrical waves or energy, called Ultrasonic Reciever.

Below we have explained the various blocks that the project could be broken into.

BLOCKS:

1. TRANSMITTER CIRCUIT

The Ultrasonic sensors used in this project work at the frequency of 40 Khz. The 40 KHz signal is generated in the Micro Controller (uc). We use Atmega32 as the microcontroller. Atmega32 has a feature of timers which has been exploited to generate 40khz. This was a major challenge as we required exact 40khz for our circuit. This is then amplified before it is fed into the transmitter. The output of Micro Controller is amplified using an Open Collector Buffer (OCB) circuit.



The open collector buffer is an inverter with the open collector at the output. We attach, say a 10K resistor from the output pin to 15V. To keep the signal polarity the same as the input (not inverted) we place an inverter before the open collector one (inverting twice). We have used the inverter IC 7406 to perform the operation of open collector buffer and the IC 7404 to invert the output of Micro Controller. The reason for not using traditional ways for amplifying like the Operation Amplifier (say LM741) because Op Amps like LM741 will not have the bandwidth to output a decent square wave at 40 kHz and the output becomes triangular.

2. Receiver Circuit

The Ultrasonic Receiver receives the sound waves if any and converts them into electrical pulses which are mostly sinusoids. The amplitude of the received signal is about 40 mVolts to 50 mVolts which is quite less to carry out any kind of processing with. The signal hence is amplified using to about 100 times so that it comes in the range of few volts. Here we can use an Op Amp because we are not concerned with the shape of the pulses, we just measure the amplitude to generate an interrupt.



3. Interrupt Generator

In order to make the Micro Controller aware about the detection of any object an interrupt must be given to it. Interrupt generator circuit comprises of a Schmitt trigger which gives a high output whenever its input is above a threshold value or else it remains at low value (0v). The output of the Schmitt trigger is inverted with respect to the input signal, hence in order to restore the phase we invert the output of Schmitt trigger and then give it to the Micro Controller. The Micro Controller then finds the distance of the object from the sensor by calculating the delay between the time of sending pulses and the interrupt generated.

4. Stepper Motor

The stepper motor used in the project has a step angle of about 1.8 degrees. The sequences of the motor are controlled by the Micro Controller. To supply amount of current to the motor a motor driver IC is used. Our Stepper takes a 14.4 degree step and then evaluation is done at that point.



5. NOKIA 3310 LCD

Nokia 3310 LCD has been used to display the output. The output is like the one we see in radar systems. The scan is shown by a line and it moves from 0 to 180 as stepper moves. Whenever a object is detected lcd glows at that point.

Nokia LCD:



Display was similar to that shown in the figure below:



Overall schematic of the project circuit:



The Eagle Board file image of the overall circuit.

Demo: In the demo we successfully showed that we were able to scan 0-180 degree in steps of 15degree. Whenever an object appeared in front of sensors the LCD would glow. Thus, we were able to achieve our challenge successfully