

A Brief Introduction on Laptop Based Radar

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Abstract - Security concerns have prompted a sharp increase in demand for low-cost, low-power detection and imaging systems. Our goal is to create a laptop based low-cost, low-power range-Doppler imaging system based on an Ultrasonic sensor. The existing design sends analog radar data to a PC via the audio line-in port. The data is saved on the PC as a .wav file. The user can then process the data using a MATLAB script to display range and velocity measurements. A problem with this set-up is that the data cannot be processed in real time. The user must record data, save the data, then process the data at a later time. Our project is to solve this issue by implementing real time data acquisition and signal processing for the radar. The final system shall be capable of plotting, in real time, the range vs. Time, and Doppler (or Velocity) vs. Time spectrum of moving targets at ranges that vary between 0-100m. A graphical user interface (GUI) will be developed on a laptop specifically to display this information.

Keywords: *Ultrasonic sensor, matlab, radar, transmitter, receiver, microcontroller spectrum, GUI.*

1. INTRODUCTION

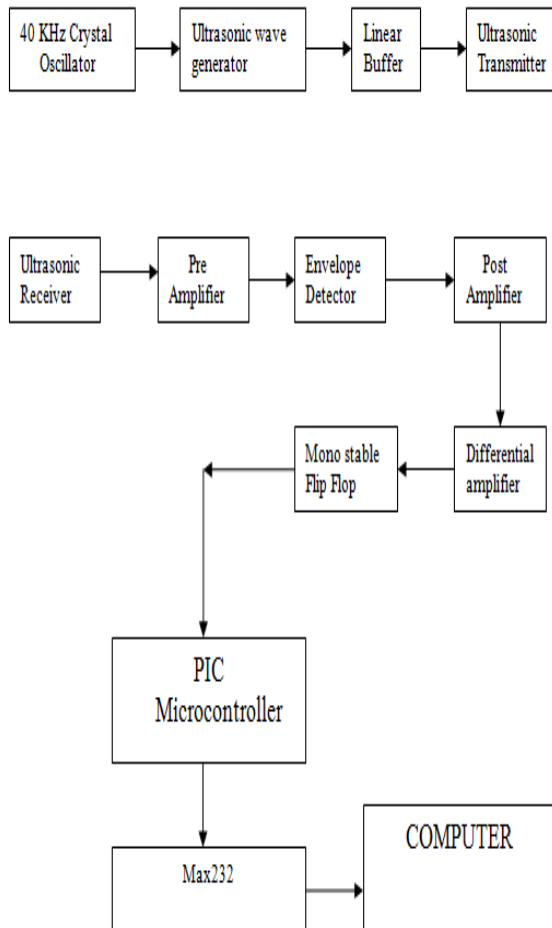
Radars are systems that are used for detecting objects. They accomplish this goal by using electromagnetic waves to determine a variety of detection parameters. Such parameters include altitude, speed, range and direction. In this Innovative project we are going to present radar based on Ultrasonic sensor and display it on computer screen using matlab. Many times it happens that any

object comes under the range of radar then it detects the object and map it on Matlab through a graph, it has three section, Ultrasonic transmitter section, Ultrasonic receiver section, and microcontroller interface section.

The transmitter section transmits ultrasonic wave generated. The transmitter and receiver is placed in such a way that in normal condition when there is no any moving object the wave transmitted by transmitter does not receive on receiver. In case of any moving object in path of transmitted beam, the transmitted beam reflects towards ultrasonic receiver. Thus, causing receiver circuit to create a pulse to acknowledge microcontroller about identified moving object. The microcontroller check incoming input pulse and display a pulse on computer. Ultrasonic sensor also known as transceiver when they both send and receive but more generally called transducers work on principle similar to radar or sonar which evaluate the attribute of a target by interpreting echoes from radio or sound wave respectively. Ultrasonic sensor generate high frequency sound waves.

System shall be capable of plotting, in real time, the range vs. Doppler spectrum of moving targets at ranges that vary between 0---100m. **A graphical user interface will be developed on a laptop specifically To display this information.** The resolution of the system needs to be sufficiently high as to allow the user, and/or GUI to identify the targeted object as a pedestrian, bicycle, automobile or other moving target. The GUI Will classify these objects based upon their speed.

2. SYSTEM IMPLIMENTATION



3. SYSTEM WORKING:

The transmitter section of the Detector is basically a crystal-controlled relaxation oscillator built around a 4049 hex inverter.

One of the 4049 sections, along with resistors, and capacitors, "pings" the 40-kHz crystal into sustained oscillation. The remaining 4049 sections act as linear buffers to drive a 40-kHz ultrasonic transmitting transducer.

The receiver section of the circuit is made up of four AC-coupled stages, each built around one of four sections of an LM324 op-amp. In the first stage, the input voltage developed across resistances is modulated by a 40-kHz, ultrasonic receiving transducer, and is then fed to IC, where it is amplified. The receiving transducer detects any reflected sound produced by the transmitting transducer. If there is no movement, the resulting envelope signal is just a straight line: diode and resistor operate as a negative peak detector to recover the envelope signal. In the second stage, which is built

around IC, the recovered signal is again amplified. The time constant of IC is quite slow so that the envelope can be followed; the output of the second stage is a DC level that represents the strength of the envelope. If there is movement, the envelope will reflect it in the form of a positive or negative signal.

At the input to the third stage—a differential amplifier built around IC—there are two diodes. They detect both positive and negative pulses. When there is no movement, the voltage at pin 7 of IC is half the supply voltage and neither diode can conduct. The voltage at pin 8 of IC is then low. If the signal rises above +0.7 volt (a silicon diode's breakdown voltage), Diode conducts causing the output on pin 8 to go high. If the signal falls below -0.7 volt, Diode conducts, which also causes the output to go high. Thus we have a window detector.

It detects voltages that move both below and above a given range. The fourth stage, built around IC, is set up as a mono-stable flip-flop. That stage converts any signal that gets through the filter into a pulse substantial enough to turn on transistor. When transistor conducts, LED turns on and an output signal is provided to drive a separate relay or any other device connected to the circuit (more on that later). The turned ON transistor also provide input pulse to the microcontroller. The microcontroller is programmed to check status of port. IF PORTA goes low microcontroller provide high pulse at PORTC, this conducts transistor and buzzer start playing according to programmed toted in microcontroller.

4. SYSTEM COMPONENTS

A-ULTRASONIC SENSOR:

Ultrasonic sensor work on a principle similar to the 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.

B-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 Receiver.

C-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.

D. 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 40m Volts to 50mVolts 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.

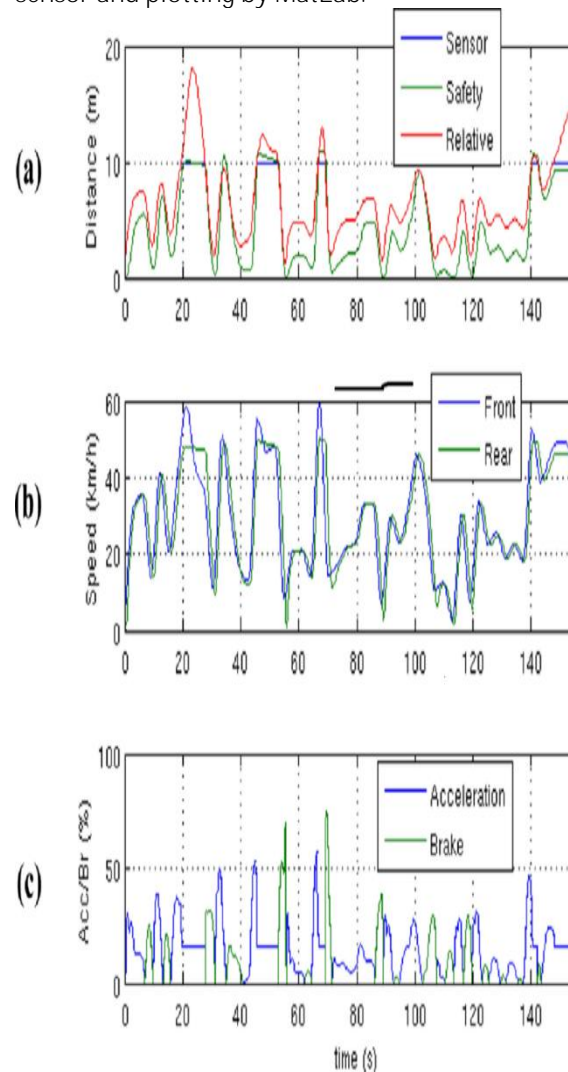
E-MICROCONTROLLER:

In order to make the Microcontroller 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 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.

5. RESULTS:

Distance, speed, acceleration tracking through ultrasonic sensor and plotting by MatLab.



6. CONCLUSION:

The main function of the portable laptop based radar system is to track objects. It has wide applications in the range of microwave applications This will be done by displaying graphics that the user can see and interpret. In order to produce graphics, velocity, position must be measured. This is accomplished by acquiring and processing signals from the RADAR system.

REFERENCES:

- [1]http://en.wikipedia.org/wiki/Serial_Peripheral_Interface_Bus
- [2]<http://www.ti.com/lit/ds/symlink/msp430g2452.pdf>
- [3]<http://cds.linear.com/docs/Datasheet/238216f.pdf>

[4]<http://www.ti.com/lit/ug/slau144h/slau144h.pdf>

[5]<http://www.codeproject.com/KB/directx/directxcapture.aspx>

[6]<http://datasheets.maxim-ic.com/en/ds/MAX3420E.pdf>

[7]<http://datasheets.maxim-ic.com/en/ds/MAX3420EEVKIT-2.pdf>

[8] Davies, John. MSP430 Microcontroller Basics. Burlington: Newnes, 2008.

[9] Radar Basics. Web. 07 Dec. 2011. <<http://radartutorial.eu/02.basics/rp07.en.html>>.

[10] Exocortex DSP Open Source C# FFT <http://www.exocortex.org/dsp/>

[11] Direct X.Capture Open Source C# Library utilizing Direct Sound for Audio CaptureoverLineIn<http://www.codeproject.com/KB/directx/directxcapture.aspx>