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PIC Based Ultrasonic Radar System

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ABSTRACT

We were inspired to build an ultrasonic security system for our final project by our housing situation this summer. Security is an important part of home, especially if we are going to share a house with prior strangers without a lock on our room door. Yes, that is the situation we are walking into in order to drive down the cost of living in NYC. And we anticipate that many college students could face a similar problem. What is not to love about a device that looks like WALL---E and scans around for possible intruders? In case of intruders, it sends off a sound alarm and alerts the owner via email. It is also password protected and could be disabled via the correct password.

Keywords-- Security is an important part of home, especially if we are going to share a house with prior strangers

I. 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 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.

II. METHODOLOGY

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 40 kHz. This was a major challenge as we required exact 40 kHz 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.

Switch An analog switch CD4066 is used to allow the sine wave from function generator to the gain amplifier. The excitation to the Transmitter is given from the Function generator through the switch which can be digitally controlled. As the switch can pass only positive voltages, the 40kHz, 1Vp-p, sine wave from the function generator is given a DC shift of 0.5V.

Microcontroller. This system of distance measurement does not require large amount of memory, hence a 20 pin 8051 based microcontroller AT89C2051, is

chosen as the controller with 12MHz clock. It performs the operation of giving the switching signal, computing the distance, converting the hex value to decimal and then to ASCII to be displayed in the LCD.

Gain Amplifier As the 40 kHz sine wave cannot be passed through the analog switch 4066, a gain amplifier with level shifter is required. Both are integrated and built using μA741 op amp.

RECEIVER CIRCUIT

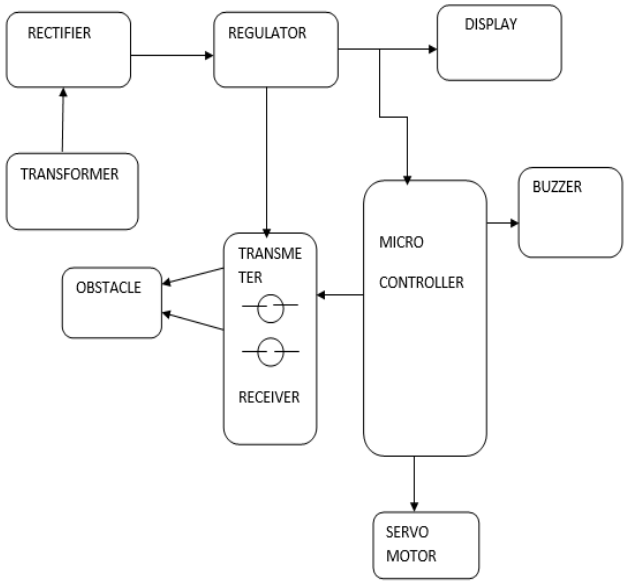
The Ultrasonic Receiver receives the sound waves if any and converts them into electrical pulses which are mostly sinusoids. The amplitude of the received signal is about 40 mVolts to 50 mVolts which is quite less to carry out any kind of processing with. The signal hence is amplified using to about 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.

Amplifier The frequency of the received pulse is of 40 kHz which requires amplifiers working at high frequency. TL084 is used, as it has good high frequency gain characteristics. The gain of the amplifier is set to 1000 in two stages with first being 100 and second being 10. The gain is set by taking into account the least magnitude (50mV) of the receiver output when sensing an object at distance of 2 meters.

Comparator The output signal from the amplifier is passed through the comparator which compares with a reference threshold level to weed out the noises and false triggering. The signal is a series of square pulses as shown in Fig.1 with amplitude of 15 volts. This is passed through the voltage limiter (zener regulator) to be fed to the microcontroller for counting the pulses.

Transducers 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. This technology can be used for measuring wind speed and direction (anemometer), tank or channel fluid level, 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 tank or channel level, the sensor measures the distance to the surface of the fluid. Further applications include: humidifiers, sonar, medical ultra sonography, burglar alarms, non-destructive testing and wireless charging. Ultrasonic sensors can detect movement of targets and measure the distance to them in many automated factories and process plants. Sensors can have an on or off digital output for detecting the movement of objects, or an analog output proportional to distance. They can sense the edge of material as part of a web guiding system.

The block diagram consists of microcontroller, buzzer, rectifier, regulator, display, transformer, ultrasonic sensor, servo motor etc. The input supply consists of a transformer, regulator and capacitors. The main component is microcontroller. Microcontroller is connected with ultrasonic sensor, servo motor and display to its different ports. Ultrasonic sensor is consists of a transmitter and receiver. Transmitter sends signals to environment and receives back by the use of receiver. A transducer is also there for converting electrical signal to non electrical signals and vice-versa.



III. PRIOR APPROACH

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.

Keeping watch 24*7 on prohibited areas to avoid trespassing is a difficult task.

Keeping manual help is cost effective and not reliable too for keeping a watch over a area. The PIC Based Ultrasonic Radar System solves the problem. This system detects any unauthorized human/animal in the surrounding. The system monitors the area in the range and alerts the authorities alarming the buzzer. The PIC microcontroller in the circuit which is connected to an ultrasonic sensor mounted or servo motor for monitoring, alarms the buzzer to notify the unauthorized identity on the LCD screen.

The radar keeps monitoring the environment checking the ultrasonic sensor echo. As soon as an object is detected the data of detection is processed and sent to authorities with an alert of where exactly the object was detected. Hence, this system proves to be a guard 24*7 monitoring the prohibited area.

The modern uses of radar are highly diverse, including air traffic control, radar astronomy, air-defense systems, antimissile systems; marine radars to locate landmarks and other ships; aircraft anti-collision systems; ocean surveillance systems outer space surveillance and rendezvous systems; meteorological precipitation monitoring; altimetry and flight control systems; guided missile target locating systems; and ground-penetrating radar for geological observations. High tech radar systems are associated with digital signal processing and are capable of extracting useful information from very high noise levels.

HISTORY OF RADAR:

The history of radar starts with experiments by Heinrich Hertz in the late 19th century that showed that radio waves were reflected by metallic objects. This possibility was suggested in James Clerk Maxwell's seminal work on electromagnetism. However, it was not until the early 20th century that systems able to use these principles were becoming widely available, and it was German inventor Christian Hülsmeyer who first used them to build a simple ship detection device intended to help avoid collisions in fog (Reichspatent Nr. 165546). Numerous similar systems, which provided directional information to objects over short ranges, were developed over the next two decades.

The development of systems able to produce short pulses of radio energy was the key advance that allowed modern radar systems to come into existence. By timing the pulses on an oscilloscope, the range could be determined and the direction of the antenna revealed the angular location of the targets. The two, combined, produced a "fix", locating the target relative to the antenna. In the 1934–1939 period, eight nations developed independently, and in great secrecy, systems of this type: the United Kingdom, Germany, the United States, the USSR, Japan, the Netherlands, France, and Italy. In addition, Britain shared their information with the United States and four Commonwealth countries: Australia, Canada, New Zealand, and South Africa, and these countries also developed their own radar systems. During the war, Hungary was added to this list. The term RADAR was coined in 1939 by the United States Signal Corps as it worked on these systems for the Navy.

IV. OUR APPROACH

Army, Navy and the Air Force make use of this technology. The use of such technology has been seen recently in the self parking car systems launched by AUDI, FORD etc. And even the upcoming driverless cars by Google like Prius and Lexus.

The project made by us can be used in any systems the customer may want to use like in a car, a bicycle or anything else. The use of microcontroller in the project provides even more flexibility of usage of the above-said module according to the requirements.

The idea of making an Ultrasonic RADAR came as a part of a study carried out on the working and mechanism of “Automobiles of Future”. Also, being students of EE, we have always been curious about the latest ongoing technology in the world like Arduino, Raspberry Pi, Beagle-Bone boards etc. An hence this time we were able to get a hold of one of the Arduino boards, Arduino UNO R3. So, knowing about the power and vast processing capabilities of the Arduino, we thought of making it big and a day to day application specific module that can be used and configured easily at any place and by anyone.

Moreover, in this fast moving world there is an immense need for the tools that can be used for the betterment of the mankind rather than devastating their lives. Hence, we decided to make some of the changes and taking the advantage of the processing capabilities of microcontroller, we decided to make up the module more application specific.

Hence, from the idea of the self driving cars came the idea of self parking cars. The main problem of the people in India and even most of the countries is safety while driving. So, we came up with a solution to that by making use of this project to continuously scan the area for traffic, population etc. and as well as protection of the vehicles at the same time to prevent accidents or minor scratches to the vehicles.

The highly directional characteristics of radar make it suited for directing fire control systems. Focusing the radar energy into a narrow beam enables it to display target position with a high degree of accuracy. At the same time, it also displays target range. The primary purpose of fire control radar is to determine the correct position and attitude the aircraft should be in to hit the specified target. Radar, in its early stages of development, was useful as an aid to the human eye under poor visibility conditions. It also provided a more accurate and faster means of range measurement. Presently, it provides a faster and more accurate method of directing fire control than is humanly possible. This feature is extremely important considering the high speeds of today's aircraft and missiles. The time available to launch an intercept weapon effectively is measured in fractions of a second.

Our radar technology is also used to control traffic light systems, and not just when red lights are run. The traffic light systems can be triggered depending on the measured volume of traffic, including temporary deactivation of the traffic lights when roads are quiet. Other radar applications that use Innocent technology

include vehicle distance measuring systems and systems that display the measured speeds on mobile signs ("You are driving" signs) e.g. in traffic-calmed zones. The traffic data collected with our radar technology is then used to analyze and control traffic volumes.

V. CONCLUSION

We come across situations where we need to keep a watch over prohibited areas to avoid trespassing. Now keeping human labor for this purpose is costly and also not reliable for keeping a watch over an area 24×7. So for this purpose an ultrasonic radar project for unauthorized human / animal or object detection system. The system can monitor an area of limited range and alerts authorities with a buzzer as an alarm. For this purpose we use a microcontroller circuit that is connected to an ultrasonic sensor mounted on a servo motor for monitoring.

We also interface a buzzer and LCD screen for monitoring the detection status. The radar keeps monitoring the environment checking the ultrasonic sensor echo. As soon as an object is detected the data of detection is processed and sent to authorities with an alert of where exactly the object was detected. Thus ultrasonic radar proves to be a very useful system for 24×7 monitoring of a particular area/region.

The main application of the project is to keep watch 24*7 on prohibited areas to avoid trespassing is a difficult task. Keeping manual help is cost effective and not reliable too for keeping a watch over a area. The PIC Based Ultrasonic Radar System solves the problem. This system detects any unauthorized human/animal in the surrounding. The system monitors the area in the range and alerts the authorities alarming the buzzer. The PIC microcontroller in the circuit which is connected to an ultrasonic sensor mounted or servo motor for monitoring, alarms the buzzer to notify the unauthorized identity on the LCD screen.

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