Design and Implementation of Ultra Sonic Range and Object Detection

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Abstract
Ultrasonic sensor HC-SR04 is used here to measure distance in range of 2cm-400cm with accuracy of 3mm. The sensor module consists of ultrasonic transmitter, receiver and the control circuit. The working principle of ultrasonic sensor is as follows: High level signal is sent for 10us using Trigger. The module sends eight 40 KHz signals automatically, and then detects whether pulse is received or not. If the signal is received, then it is through high level. The time of high duration is the time gap between sending and receiving the signal. Distance= (Time x Speed of Sound in Air (340 m/s))/2.

Keywords - *Ultra Sonic, Radar, Servomotor*

I. INTRODUCTION

RADAR is an object detection system which uses radio waves to determine the range, altitude, direction, or speed of objects. Radar systems come in a variety of sizes and have different performance specifications. Some radar systems are used for air-traffic control at airports and others are used for long range surveillance and early-warning systems. A radar system is the heart of a missile guidance system. Small portable radar systems that can be maintained and operated by one person are available as well as systems that occupy several large rooms.

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.

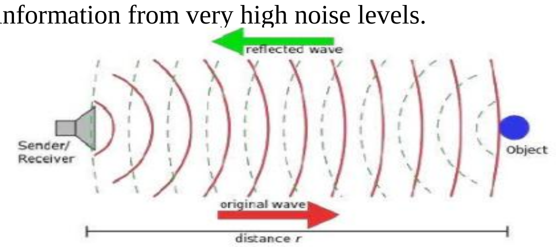


Fig:-radar signal range

II. COMPONENTS

A. Introduction to Arduino Uno

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital Input /Output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16MHz ceramic resonator, USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 programmed as a USB-to-serial converter Changes in Uno R3.

B. AVR ATmega328

The ATmega328 is a single chip micro-controller created by Atmel and belongs to the mega AVR series. The high-performance Atmel 8-bit AVR RISC-based microcontroller combines 32 KB ISP flash memory with read-while-write capabilities, 1 KB EEPROM, 2 KB SRAM, 23 general purpose I/O lines, 32 general purpose working registers, three flexible timer/counters with compare modes, internal and external interrupts, serial programmable us art, a byte-oriented 2-wire serial interface, spi serial-port, a 6-channel 10 bit Analog to Digital converter (8-channels)in TqFp and qfn/mlf packages),programmab le watchdog timer with internal oscillator and five software selectable power saving modes. The device operates between 1.8-5.5 volts.

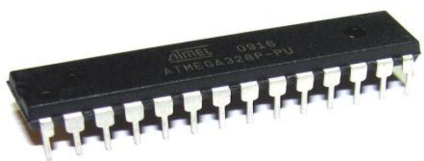


Figure 3.2 ATmega328

C. Crystal Oscillator

A crystal oscillator is an electronic oscillator circuit that uses the mechanical resonance of a vibrating crystal of piezoelectric material to create an electrical signal with a very precise frequency. This frequency is commonly used to keep track of time (as in quartz wristwatches), to provide a stable clock signal for digital integrated circuits, and to stabilize frequencies for radio transmitters and receivers. The most common type of piezoelectric resonator used is the quartz crystal, so oscillator circuits incorporating them became known as crystal oscillators, but other piezoelectric materials including polycrystalline ceramics are used in similar circuits.

Crystal Oscillator (16 MHz)

D. Servo Motor

A servomotor is a rotary actuator that allows for precise control of angular position, velocity and acceleration. It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

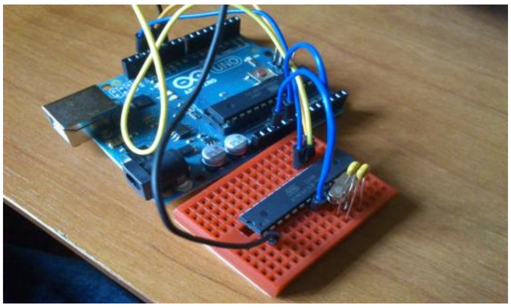
E. Voltage Regulator

A voltage regulator is an electrical regulator designed to automatically maintain a constant voltage level. With the exception of shunt regulators, all modern electronic voltage regulators operate by comparing the actual output voltage to some internal fixed reference voltage. Any difference is amplified and used to control the regulation element. This forms a negative feedback servo control loop. If the output voltage is too low, the regulation element is commanded to produce a higher voltage.

F. Ultrasonic Sensor

Ultrasonic sensors (also known as transceivers when they both send and receive, but more generally called transducers) 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.

III. MAKING OWN ARDUINO UNO BOARD/BOOT LOADING THE ATMEGA328



Since, we believe in learning by doing. So, we decided to make our own arduino board instead of using the readymade board. So, the steps required to make an arduino board [8] are as follows:

Boot loading an Atmega328 using the Arduino board by uploading the boot loader program to the Microcontroller.

Make the connections on a general purpose PCB and connecting to the crystal oscillator, capacitors, connectors to Arduino board etc. Provide the power supply, usually 5 volts. Now Arduino is ready for use.

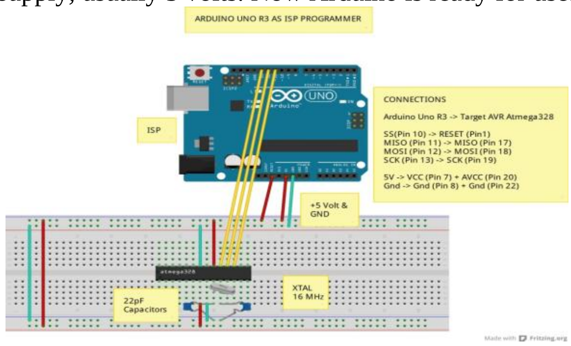


Fig: Circuit diagram for Boot Loading ATmeg328

After you have done all this, then only the minimum circuitry like crystal oscillator, capacitors, connectors, power supply is required to complete the board. The same circuit can be made on the PCB, either designed or general purpose. Since, Arduino is an Open-Source. Hence, it is easy to make and can have any enhancements as per the requirements.

A servomotor is a rotary actuator that allows for precise control of angular position, velocity and acceleration.

A normal servo motor has three terminals:

1. VCC
2. GND
3. PULSE

A servo motor works at normally 4.8 to 6 volts. Gnd is provided by connecting it to the Ground of the Arduino. The total time for a servo motor pulse is usually 20ms. To move it to one end of say 0 degree angle, a 1ms pulse is used and to move it to other end i.e. 180 degree, a 2ms pulse is applied. Hence, according to this to move the axis of the servo motor to the center, a pulse of time 1.5 ms should be applied. For this, the pulse wire of the servo motor is connected to the Arduino that provides the digital pulses for pulse width modulation of the pulse. Hence, by programming for a particular pulse interval the servo motor can be controlled easily.

Connecting the Ultrasonic Sensor :

An Ultrasonic Sensor consists of three wires. Connect one for Vcc, second for Gnd and the third for pulse signal.

The ultrasonic sensor is mounted on the servo motor and both of them further connected to the Arduino board. The ultrasonic sensor uses the reflection principle for its working. When connected to the Arduino, the Arduino provides the pulse signal to the ultrasonic sensor which then sends the ultrasonic wave in forward direction. Hence, whenever there is any obstacle detected or present in front, it reflects the waves which are received by the ultrasonic sensor. If detected, the signal is sent to the arduino and hence to the PC/laptop to the processing software that shows the presence of the obstacle on the rotating RADAR screen with distance and the angle at which it has been detected.

IV. CONSOLE OF SOFTWARE

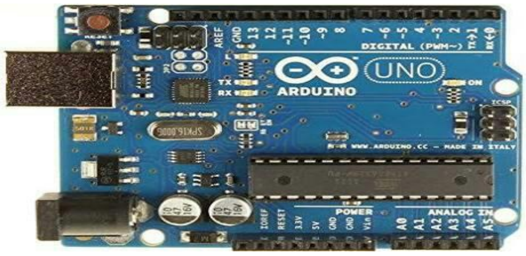
The Arduino boards are available readily in the electronics market, but we decided to make our own Arduino board instead of buying one. So, the first problem was where to start from to achieve this goal. Since, all parts on an Arduino board are SMD's, so we had to find a way to replace the SMD's with DIP IC's and also had to make an AVR programmer in order to pursue our further work. Hence, it took us some days to determine and plan our course of action. After that we had to boot load the AVR chip so as to make it compatible with the Arduino IDE software. Hence, we had to find a way to boot load the Arduino using the AVR programmer. It took us a long time to make the AVR programmer by researching on the type of communication and architecture of the AVR as it is not as same as a 8051 microcontroller

Programming the Arduino to display the RADAR screen:

The next part of the project was to be able to display the RADAR screen. For this we used VB.NET to form the RADAR screen but interfacing it with the Arduino input was a little bit of a problem and not synchronized with the Arduino input. After a lot of trials, we came to know about the Processing software (Version 2.0). So, we had to go through a lot of programs to finally program it to form the RADAR screen.

A. Arduino uno

The Arduino UNO is a widely used open-source microcontroller board based on the ATmega328P microcontroller and developed by u. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board features 14 Digital pins and 6 Analog pins. It is programmable with the Arduino IDE (Integrated Development Environment) via a type B USB cable. It can be powered by a USB cable or by an external 9 volt battery, though it accepts voltages between 7 and 20 volts. It is also similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0.



The Uno board and version 1.0 of Arduino Software (IDE) were the reference versions of Arduino, now evolved to newer releases. The Uno board is the first in a series of USB Arduino boards, and the reference model for the Arduino platform. The ATmega328 on the Arduino Uno comes preprogrammed with a boot loader that allows uploading new code to it without the use of an external hardware programmer.

It communicates using the original STK500 protocol. The Uno also differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter. The Arduino UNO is generally considered the most user-friendly and popular board, with boards being sold worldwide for less than 5$.

The Arduino can input and output analog signals as well as digital signals. An analog signal is one that can take on any number of values, unlike a digital signal which has only two values: HIGH and LOW. To measure the value of analog signals, the Arduino has a built-in analog-to-digital converter (ADC). The ADC turns the analog voltage into a digital value. The function that you use to obtain the value of an analog signal is analog Read (pin). This function converts the value of the voltage on an analog input pin and returns a digital value from 0 to 1023, relative to the reference value. The reference is 5V on most Arduinos, 7V on the Arduino Mini and Nano, and 15V on Arduino Mega. It has one parameter which is the pin number

B. Servo Motor

Because servo motors use feedback to determine the position of the shaft, you can control that position very precisely. As a result, servo motors are used to control the position of objects, rotate objects, move legs, arms or hands of robots, move sensors etc. with high precision. Servo motors are small in size, and because they have built-in circuitry to control their movement, they can be connected directly to an Arduino.

Most servo motors have the following three connections:

- Red power wire (around 5V).
- Yellow or White PWM wire.

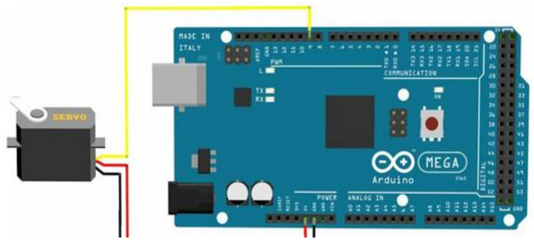


FIG:- circuit connection of Arduino UNO

C. Ultrasonic sensor

An Ultrasonic sensor is a device that can measure the distance to an object by using sound waves. It measures distance by sending out a sound wave at a specific frequency and listening for that sound wave to bounce back. By recording the elapsed time between the sound wave being generated and the sound wave bouncing back, it is possible to calculate the distance between the sonar sensor and the object.
Since it is known that sound travels through air at about 344 m/s (1129 ft/s), you can take the time for the sound wave to return and multiply it by 344 meters (or 1129 feet) to find the total round-trip distance of the sound wave. Round-trip means that the sound wave traveled 2 times the distance to the object before it was detected by the sensor; it includes the 'trip' from the sonar sensor to the object AND the 'trip' from the object to the Ultrasonic sensor (after the sound wave bounced off the object). To find the distance to the object, simply divide the round-trip distance in half.

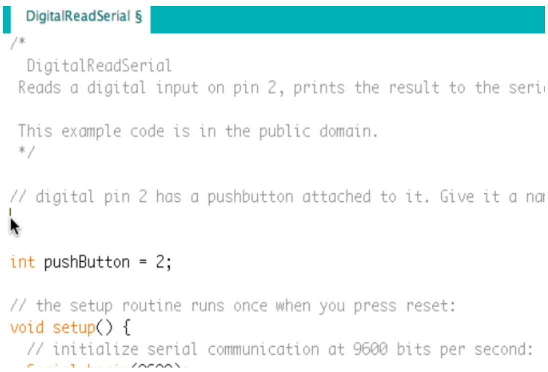
D. Arduino Programming

When you open the Arduino program, you are opening the IDE. It is intentionally streamlined to keep things as simple and straightforward as possible. When you save a file in Arduino, the file is called a sketch – a sketch is where you save the computer code you have written.

The coding language that Arduino uses is very much like C++ ("see plus plus"), which is a common language in the world of computing. The code you learn to write for Arduino will be very similar to the code you write in any other computer language – all the basic concepts remain the same – it is just a matter of learning a new dialect should you pursue other programming languages.

The process of compiling is seamless to the user. All you have to do is press a button. If you have errors in your computer code, the compiler will display an error message at the bottom of the IDE and highlight the line of code that seems to be the issue. The error message is meant to help you identify what you might have done wrong – sometimes the message is very explicit, like saying, "Hey – you forget a semicolon", sometimes the error message is vague.

Why be concerned with a semicolon you ask? A semicolon is part of the Arduino language syntax, the rules that govern how the code is written. It is like grammar in writing. Say for example we didn't use periods when we wrote – everyone would have a heck of a time trying to figure out when sentences started and ended. Or if we didn't employ the comma, how would we convey a dramatic pause to the reader?
And let me tell you, if you ever had an English teacher with an overactive red pen, the compiler is ten times worse. In fact – your programs WILL NOT compile without perfect syntax. This might drive you crazy at first because it is very natural to forget syntax. As you gain experience programming you will learn to be assiduous about coding grammar.



Let's get our hands dirty and introduce some syntax.

V. APPLICATIONS

The idea of making an Ultrasonic RADAR appeared to us while viewing the technology used in defense, be it Army, Navy or Air Force and now even used in the automobiles employing features like automatic/driverless parking systems, accident prevention during driving etc. The applications of such have 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 you may want to use like in a car, a bicycle or anything else. The use of Arduino in the project provides the flexibility of usage of the above-said module according to the requirements.

A. Applications in Air Force

In aviation, aircraft are equipped with radar devices that warn of aircraft or other obstacles in or approaching their path, display weather information, and give accurate altitude readings. The first commercial device fitted to aircraft was a 1938 Bell Lab unit on some United Air Lines aircraft. Such aircraft can land in fog at airports equipped with radar-assisted ground-controlled approach systems in which the plane's flight is observed on radar screens while operators radio landing directions to the pilot.

B. Naval Applications

Marine radars are used to measure the bearing and distance of ships to prevent collision with other ships, to navigate, and to fix their position at sea when within range of shore or other fixed references such as islands, buoys, and lightships. In port or in harbor, vessel traffic service radar systems are used to monitor and regulate ship movements in busy waters.

C. Applications in Army

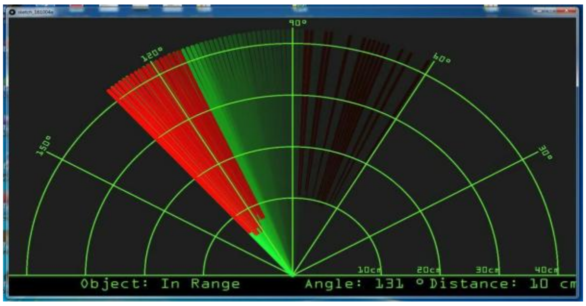
Two video cameras automatically detect and track individuals walking anywhere near the system, within the range of a soccer field. Low-level radar beams are aimed at them and then reflected back to a computer, which analyzes the signals in a series of algorithms. It does this by comparing the radar return signal (which emits less than a cell phone) to an extensive library of "normal responses." Those responses are modeled after people of all different shapes and sizes (SET got around to adding females in 2009). It then compares the signal to another set of "anomalous responses" – any anomaly, and horns go off. Literally, when the computer detects a threat, it shows a red symbol and sounds a horn. No threat and the symbol turn green, greeting the operators with a pleasant piano riff.

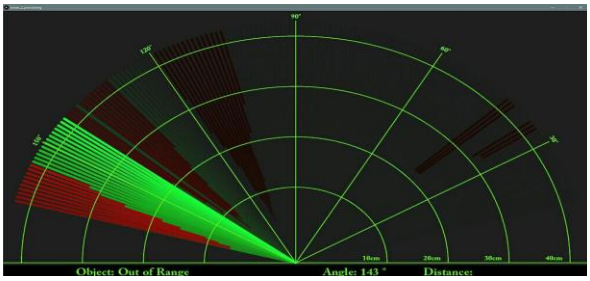
D. Meteorological Applications

Meteorologists use radar to monitor precipitation and wind. It has become the primary tool for short-term weather forecasting and watching for severe weather such as thunderstorms, tornadoes, winter storms, precipitation types, etc. Geologists use specialized ground-penetrating radars to map the composition of Earth's crust.

VI. RESULTS AND CONCLUSION

In this system we have detect any moving and fixed object/ person by using transmitting a ultrasonic echo sound .Also to calculate a distance of that object, if this object is moving then to calculate the speed of the that moving object which is then show on real time PPI display on desktop.





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