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ULTRASONIC RADAR USING ARDUINO WITH MATLAB

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Abstract: This report provides an overview of an Ultrasonic Radar system implemented using Arduino and MATLAB. Ultrasonic radar systems are widely used in a variety of applications for object detection, distance measurement. Combining Arduino microcontroller with MATLAB software allows for real-time data acquisition, signal processing, and visualization, as well as efficient radar operation. The implementation of an Ultrasonic Radar system using these two components has been proved to be a reliable and effective solution. Arduino microcontroller is used to detect and calculate the distance to the object. MATLAB software then processes the signal, displays the data, and visualizes the radar screen using this information. The Arduino can be used to detect objects within a certain range quickly and accurately when connected with MATLAB. The benefits of this system are its accuracy, reliability, and cost effectiveness. The combination of Arduino and MATLAB provides an efficient and reliable solution for Ultrasonic Radar system.

Keywords: Arduino UNO, MATLAB, Ultrasonic Sensor**,** Servo Motor, Jumper wire, led.

INTRODUCTION:

Ultrasonic radar systems have become increasing popular in applications such as robotics, automation, security systems, and navigation. Using electromagnetic waves, these systems can detect objects, measure distances, and provide valuable spatial data. This report presents an ultrasonic radar system implemented using an Arduino microcontroller and MATLAB software. High-frequency sound waves are emitted by the ultrasonic sensor and their echoes are received when they bounce off objects in their environment. It is possible to determine the distance from the sensor to the object detected by measuring the time it takes the echoes to return. The Arduino microcontroller acts as the receives data from the ultrasonic sensor, performs necessary calculations and decision-making processes, and controls the overall radar operation. Arduino ease of use make it a great choice for real-time data and processing tasks with MATLAB data analysis and visualization tools enables real-time monitoring and accurate analysis of radar data, opening possibilities for more improve in radar systems.

PRINCIPLE OF RADAR:

The technology of Radar was developed by the sensor and the measurement of the time it takes for these waves to travel to an Fig

Figure1: Radar System

Object and back. The Arduino microcontroller calculates the distance to the object using the known speed of sound. The distance measurements are then sent to MATLAB for further processing, including noise filtering and data analysis. MATLAB's graphical capabilities enable. The visualization of the radar's output, such as displaying detected objects on a plot or generating a real-time radar-like display. This combination of Arduino and MATLAB allows for accurate and efficient object detection and distance

Measurement in various applications.

METHODOLOGY:

In this proposed method, the embedded system is Arduino UNO. The UNO connected with ultrasonic sensor. Sensor will senses the distance of the object nearer to it. The sensed distance will be read by Arduino UNO with MATLAB, a monitor screen will be developed. In order to enable serial communication between the Arduino and MATLAB and facilitate data transfer, it is necessary to first install MATLAB and configure it to receive data from the Arduino through the serial port. Once MATLAB has been properly installed and configured, a MATLAB script can be created to continuously acquire distance measurements from the Arduino. Additionally, signal processing techniques can be implemented in MATLAB to filter and enhance the acquired distance data. Finally, MATLAB's graphical capabilities can be used to visualize the output data. This will provide an easy way to see the results of the data acquisition and signal processing.

MODELING AND ANALYSIS:

The Arduino UNO is a development board with six analogue pins and 14 digital i/o pins based on the AVR ATmega328P microcontroller. The board offers serial connection over UART, SPI, and I2C. The microcontroller has a 16 MHz clock frequency capability. Simple textual data can be sent to and from the board via the serial monitor. Any UNO digital pin can be used for serial communication allows to the serial library. The trig and echo pins of the ultrasonic sensor, which has four pins total (VCC, Trig, Echo, and Ground), are connected to Arduino digital pins 7 and 8. The HCSR04 produces ultrasonic waves at a frequency of 40KHz. Arduino and MATLAB have interfaces. In this work, distance of the object is measured through ultrasonic distance sensor and the sensor output is connected to signal conditioning unit and after that it is processed through Arduino UNO. The measured results are transferred to personal computer. The sensor is attached to servo motor to find the polar distance around the sensor up to 180 degree rotations.

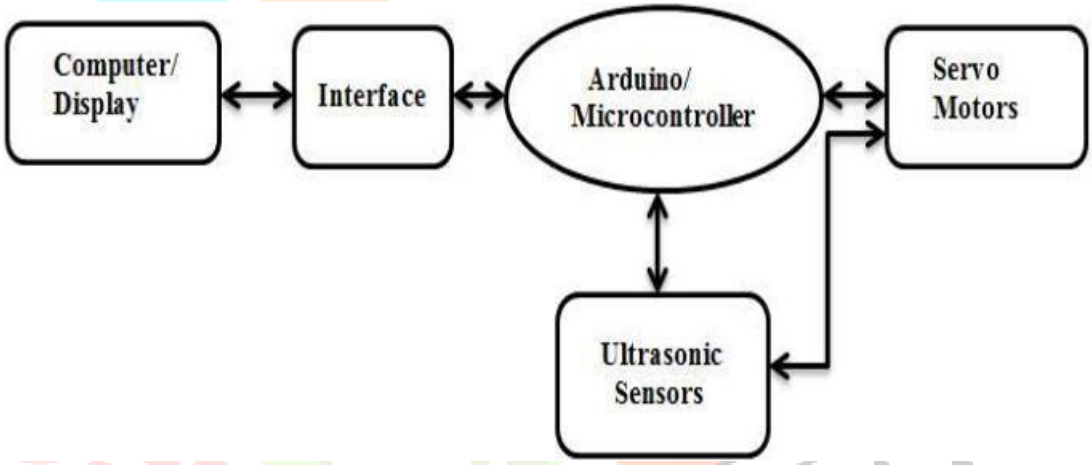

Fig 2: Block Diagram

ULTRASONIC MODULE:

Ultrasonic distance measurement module HC-SR04 provides 2cm to 100 cm non-contact measurement function, ranging accuracy of up to 3mm. The module consists of an ultrasonic transmitter, a receiver and a control circuit.

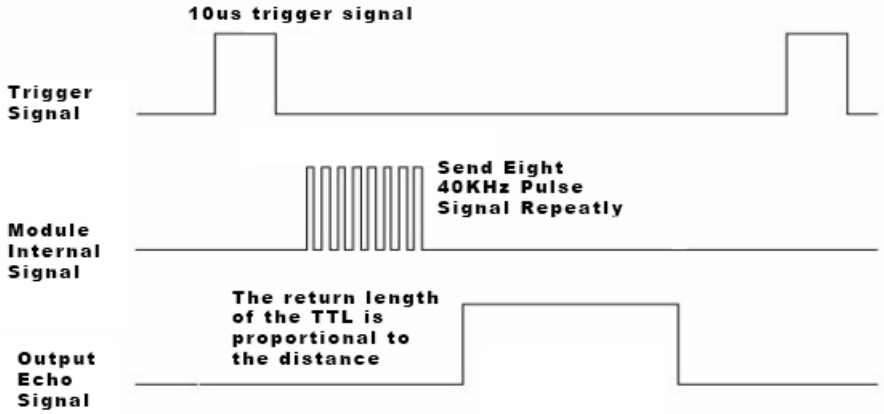

Fig 3: HC-SR 04 Timing Diagram

The basic working principle Use IO to trigger at least 10s high signal, the module automatically sends 8 40 kHz and detects whether there is a pulse signal return. If the signal returns, through the high level, the high output IO duration is from sending the ultrasonic wave to the return time.
Test distance = (high level x sound velocity (340m / sec) / 2

WORKING OF ULTRASONIC RADAR SYSTEM:
The process is initiated by sending a trigger pulse to the ultrasonic module. When the reset pulse is supplied to the processor, it generates a 15µs trigger pulse and sends it to the HC-SR04 ultrasonic module. The trigger signal must be a pulse of 10µS high time. When the module receives a valid trigger signal, it emits 8 pulses of 40 kHz ultrasonic from the transmitter. The echo of the sound is picked up by the receiver, and after the echo of the ultrasonic wave, the module generates a signal at the echo pin, which is proportional to the distance measuring.
Test distance = (high time × speed of sound (340M / s)) / 2
Distance cm = echo pulse width in us / 58
Distance in inches = echo pulse width in us / 148
Finally, the distance calculated based on the pulse width of the echo signal is sent to the LCD segment and the range is displayed in centimeters. This ultrasonic range finder can measure the distance of 2.5 meters, the accuracy of 0.1 cm.

ARDUINO:
The Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins (of which 15 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started.

ADVANTAGES& DISADVANTAGES OF ULTRASONIC RADAR SYSTEM:
The main advantages are that it can be used in stationary and moving mode. It has two directional modes and beam spread can incorporate many targets. It can often select fastest target, or best reflection. It is very reliable.
The main disadvantages in this, timer- radar can take up to 2 seconds to lock. Radar has wider beam. Its range only 200 ft. range. It cannot detect if deceleration is greater than one.

RESULT & ANALYSIS:
The result of the ultrasonic radar system is shown in the fig 3. The analysis of object detection is done with the help of MATLAB. The graph shows the two shaded regions i.e., red and green regions. Here, the green part shows that there is no object and the red part shows that there is an object in that particular region using this we can also trace the position and angle of that object.

Fig 3: Graphical Representation of an object detection

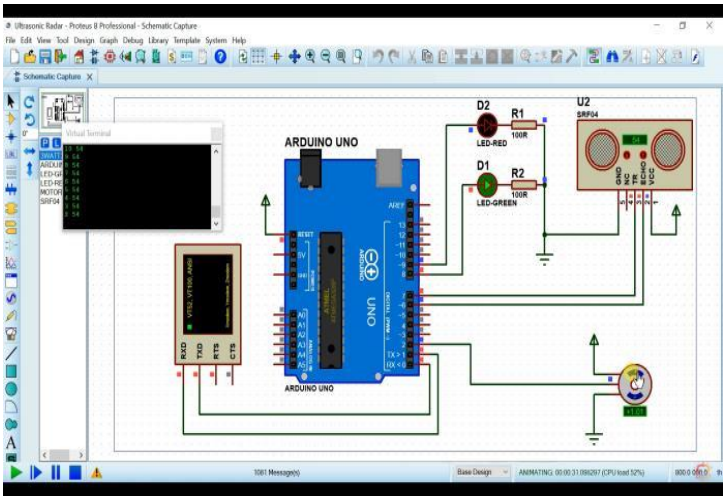

Fig 4: Simulation of Project using Proteus 8

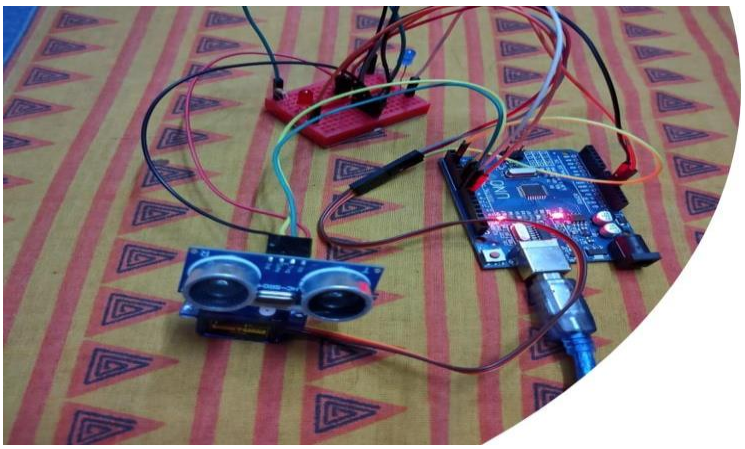

Fig 4: Model of Arduino based Ultrasonic Radar System

CONCLUSIONS:

The paper presents a low cost and low power system for the security of an unauthorized area by the help of radar system. The future modification may include addition of cameras, smart phones, etc. This is good radar system for security if image recognition system will be added so that image of object can be detected

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