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Radar based Object Detector using Arduino Uno

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Abstract: *Radar technology has been the backbone of several applications, ranging from aviation to meteorology, offering extremely valuable capabilities for object detection and tracking. Conventional radar systems, though highly powerful, are very costly and complex, which makes them not easily accessible in many fields. To address these issues, this research attempts to design and implement a radar system using Arduino micro controllers and ultrasonic sensors. This innovative approach relies on the flexibility and cost-effectiveness of the Arduino platform and the accuracy of ultrasonic sensors for distance measurement to build a radar-like system. The work addresses the development of the hardware, acquisition of data, processing of the signal, and real-time visualization, thus offering an accessible and costeffective alternative for applications of radar. The research will integrate Arduino technology with ultrasonic sensors into a radar system; it focuses on simplicity, affordability, and practicality, achieving The area it covers is between traditional radar and do-it-yourself systems, and then application windows open up as robotics, smart cities, industrial automation, and eventually into the education sector as well. The results outline above are opening new visions to designs in radar systems while pointing radar innovations to newer avenues of work.*

Keywords: Radar technology

I. INTRODUCTION

Radar technology have become increasingly crucial to human life in recent times. Radar technology have made it possible to identify obstacles and other items in the surrounding figured out, and they give details regarding their size and range. Through the use of these technologies, they positively impact both vehicle parking and the advancement of robot technology. Using radar technology from autonomous self moving cars in they detect obstacles and do not get stuck. The ambient radar technology for the blind enables them to live safely by preventing them from running into adjacent objects or barriers. Radar systems often utilize technologies like infrared light, solar sound signals and radio waves. Despite the many forms of signals used, the core calculating process is the same. They are all based on the principle that when a signal is sent, an obstruction is met and reflected back. It is difficult to maintain a constant eye on forbidden regions to prevent people from passing. Although keeping an eye on an area with manual support is more costly, it is also more reliable. The answer to the problem is the PIC Based Ultrasonic Radar System. Any illegal person or animal in the surrounding environment is detected by this device. By alarming the security personnel and by sounding the bell, this system monitors the region surrounding its range. Once the ultrasonic sensor placed over the circuit or a servo motor is connected for the purpose of monitoring, the PIC micro controller in the circuit activate a buzzer to sound warning to the LCD screen that there has been an illegal identity . To care for the echo of ultrasonic sensor, the radar runs a scan continuously of all the surroundings. The Ultrasonic Radar System is innovative solution provides to the difficult task of supervising forbidden territories day and night without trespassing, as well as ensuring security. In its reliability and at reasonable effective design, this system proves to be a game changer in maintaining surveillance over restricted zones .One of the system's key features is its ability to detect any unauthorized human or animal presence in its surroundings. Through the integration of a PIC micro controller, an ultrasonic sensor, a servo motor, an LCD screen, and data processing capabilities, it effectively safeguards against potential breaches. The system works on a feedback mechanism of constantly scanning its surroundings. The ultrasonic sensor, mounted on a servomotor, transmits the ultrasonic waves which revert back when it hits the object. With the feedback of the returning

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echoes, it can precisely identify the existence of some unauthorized entity. After a target is identified, PIC micro controller processes the data acquired and sends instant alerts to the user. An alarm is sounded through the buzzer to attract the attention of authorities, while the LCD screen displays relevant information regarding the detected object. This constant vigilance ensures that any unauthorized presence is promptly reported, allowing authorities to swiftly respond and take appropriate action. In addition to detection, the system delivers accurate information about where the object was detected. By capturing and processing this data, This enables the authorities to pinpoint the actual location of potential breaches, thereby enhancing security measures.

II. LITERATURE SURVEY

Radar technology is ever more crucial for monitoring and image detection in disaster management, military operations, security, and other environmental monitoring applications. Having special advantages, such as all-weather working capability, day-and-night operation, and the capability to see through obstructions like cloud, fog, and foliage, radar systems use electromagnetic waves to spot and locate objects. RADAR based image surveillance and detection have Recently, these advancements have been advanced, and this literature review gives an overview of those developments. High-resolution images are the most significant challenges in radar imaging. The conventional radar systems suffer from poor resolution due to several factors such as antenna size and signal processing methods. However, with the advancement of recent radar technology, particularly SAR and ISAR, image resolution has significantly improved SAR systems produce a large aperture by moving the radar platform, which generates images with higher resolution. ISAR techniques are particularly useful for imaging moving objects such as ships and airplanes since they exploit the rotational motion of targets to generate high resolution images. The detection and classification of targets is an essential part of radar based image surveillance. Targets can be located and classified depending on their size, shape, and material properties due to the special characteristics of radar signals that bounce back from different objects. Performance in detecting and classifying targets has been improved with the use of several signal processing techniques, including waveform modulation, pulse compression, and machine learning algorithms. Adaptive waveform modulation techniques, for example, ptimize detection performance in various environments by changing the waveforms in real time based on the received signals radar waveform parameters. Advances in multi-sensor fusion methods, signal processing algorithms and radar technology have contributed to a significant advancement in the radar-based image surveillance and detection systems during recent years. Thanks to these developments, radar is now an essential instrument in many different types of surveillance applications through which high-resolution imaging, reliable target detection and Classification, and real-time data processing. Lingering issues need to be solved for the promise of radar-based image surveillance and detection systems to be fully realized.

III. METHODOLOGY

Experimental Setup

This is an experimental setup of a far-object detection using an ultrasonic sensor, known as HC-SR04.This is a cost effective RADAR alternative. The sensor lets out sound waves that rebound whenever they hit an object and are used to detect an object. A servo motor,SG90 makes the sensor rotate by 180°,while Arduino Uno processes the data into digital form from analog. It sends an SMS notification whenever it detects an object, and for the control and output verification, it uses Raspberry Pi 3.All hardware components including HCSR04, servo motor, and SIM808 are connected to Arduino Uno which is connected to the Pi 3. All the input devices such as keyboard, mouse, monitor are connected to the Pi 3 with jumper wires connecting between them. Software plays a very crucial role in the monitoring and results display. The Raspberry Pi 3 requires Raspbian or Noobs OS to interface. Arduino IDE is C/C++ programming that directly programs the hardware. Processing IDE of Java creates GUI for display results of detections and an SMS notification through SIM808.

Hardware Analogy

Put an SD card with Raspbian or Noobs OS inside the Pi 3.Mount a monitor, keyboard, and mouse. Put a 4G SIM card into the SIM808,with internet and SMS enabled. Connect the GPS and GSM antennas. Connect components in this order SIM808 GND to Uno GND,TX(8) to RX,RX(7) to TX.HC-

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SR04 GND to Uno GND, Trigger/Echo to pins 11/12,Vcc to 5V.Servo Motor Connect wires to pins 9, 5V, and GND on Uno. Connect all of them using jumper wires. Connect the Pi 3 to the Uno using a USB cable, and connect both the Pi 3 and SIM808 using adapters. This provides an integration-free hardware and software environment for object detection, SMS notification, and results display via GUI.

IV. OVER VIEW OF RADAR SYSTEM

The abbreviation of radar is Radio Detection and Ranging. It is a technique used for the location and detection of near objects by the use of electromagnetic radiation. A radar system functions on the principle of the emission of radio waves or microwaves that bounce off objects and return as echoes. A radar system determines distance, speed, and direction by characteristics and time of return and sometimes, even the composition of objects in their direct view. Forms of radar systems are diverse and range as follows: each with its application, Primary Surveillance Radar (PSR). This is the basic form of a radar system.PSR generally is applied in air traffic control.PSR mainly reports on the position and trajectory of aircraft within its radar coverage. PSR tracking is essential when the aircraft flies past a given station's coverage secondary surveillance radar (SSR). SSR is used along with PSR for better aircraft identification and tracking. It gives position data and identification through transponders as well as other information like the identity and height of the aircraft. Radar systems in weather are applied for monitoring precipitation, severe phenomena of weather, and the atmospheric conditions. These have become very important for the Weather Fore-casting, Storm tracking, Monitoring Movement of Weather Systems, SAR is often used in applications of Remote Sensing, Image Acquisition. As an it application, where it uses Radar Waves with high-resolution pictures of Earth's surfaces and, this is especially crucial for Earth Observation, Crop Inspection, Disaster Management, Radar Systems Play Very Important functions in almost each field due to distinct characteristic features it possesses, Among aviation functions, this radar system will function the following Aviation radar serves numerous critical functions of Aviation to ensure that air traffic movement is safe and efficient. It supports the monitoring of the aircraft location, speed, and altitude for collision avoidance, routing, and landing operations. Defense and Military Applications, Radar plays a great deal in any military since it provides information for surveillance, target detection, tracking, missile guidance, and defense systems. against airborne threats, it forms an integral part of national security 11-13.Weather radar gives direct information on precipitation, storm development, and wind patterns. The information helps in weather forecasting, early warning systems, and disaster preparedness. Radar helps in navigation at sea by detection of other vessels, obstacles, and landmasses especially in bad visibility conditions such as fog or darkness. It ensures safety in navigating busy waterways. Remote Sensing and Earth Observation SAR and Other radar systems are used for monitoring environmental changes, land use, agriculture, and disaster response. They Provides precious information about resource management and science. The application of radar technology in different fields of science such as astronomy, geophysics, oceanography, etc. for studying celestial bodies, the dynamics of the Earth's subsurface, and ocean, can be mentioned. In short, the radar system is highly essential in various multi-purpose fields to ensure safety in aviation and ocean navigation, further scientific researches in weather forecasting, etc. and object detection with its characteristics and movement, has come with the radar technology as one of the most necessary tools for a contemporary society.

Problem Statement

The principal aim of this paper is the design and development of the radar system along with Arduino and an ultrasonic sensor, as well as analyzing the effectiveness and capabilities of the system.

Radar Modules in Trains

Ultrasonic modules can be a great supporting tool for train movement in relation to fog conditions, very common for the delay time in Indian Railways, by fitting the sensors around the track clearances will ensure smooth, timely training. The object or obstacle under the tracks would be perceived by the sensor, thus increasing their safety and efficiency.

Parking Ultrasonic Sensors

Ultrasonic sensors are essential for improving efficiency in parking, especially in tight spots where the risk of damage is very high. Therefore, they are able to detect several forms of obstacles such as walls,kids,poles, and barrier, thus ensuring that parking space is safe and easier with congested places.

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V. RESULTS AND DISCUSSION

Basic Principles of Radar

Radar work on simple principle of transmission and receiving electromagnetic waves. Major stages involved in the working of the radar are, Transmission Radar sends electromagnetic waves, mainly radio waves or microwaves from a transmitter 14-15.The waves propagate through space until they hit an object. Reflection, When the radar wave hits the object, the energy reflected back Towards the Radar System, The back reflections of radar echoes are caught by the receiver within the radar system. Signal Processing, Within the radar system, signal processing occurs for deciding distance (range), direction, and speed in regard to the object concerning received echoes. Display and Interpretation, Data from echoes is displayed on a screen or used as input for decisions. Types of Radar Systems, There are types for different usages, PSR holds lesser information regarding the location of an object and its speed. It is majorly used for air traffic control, which tracks the aircraft. SSR was incorporated in addition to the data provided by PSR as the latter also held more information than the former as in the case of the identity of an airplane and altitude level. Weather radar systems are the backbone of any weather condition monitoring system or detecting rainfalls or observing storms.SAR is primarily used for Earth's surface remote sensing and image acquisition with a high resolution of the surface.

Ultrasonic Sensors

An ultrasonic sensor in category where ultrasonic waves are created, then calculated with time taken on round trip of waves on impact. Basic working, Transmitter, An emitting sensor that makes ultrasonic waves. Reflection, Hitting an object and fetching back the waves to the receiver of a sensor. Receiver, Catching waves by reception of a sensor by a receiver using time. Measurement, It calculates the distance of the object through the time period, which has been emitted and received considering the speed of the sound in the medium. Applications of Ultrasonic Sensors, Ultrasonic sensors are in abundance everywhere. Distance Measurement, The applications of ultrasonic sensors include a lot of measures of distances in various industrial works. In automation, it is utilized in robotics applications and the automobile application too. Obstacle detection feature is also very important in obstacle detection and collision avoidance systems in robotics and automotive. Liquid level sensing Ultrasonic sensors have an application in liquid level measurement in holding tanks and tanks. Presence detection An ultrasonic sensor can monitor whether or not there is an object present or absent are also applied in security systems. Proximity detection, Ultrasonic sensors It can be used in object proximity detection of touch less interfaces or gesture recognition.

Arduino in Sensor-Based Systems

Arduino platform The Arduino platform is open source and based on hardware and software. The Arduino platform provides a relatively easy development environment for applications in micro controllers. Its features include, Micro controller Boards The Arduino boards are the type of micro controllers which are programmable to do almost everything. Arduino IDE The Arduino Integrated Development Environment (IDE) provides an easy-to-write programming using a friendly code editor along with a vast library of pre-built functions. Extensibility, The Arduino system is very extensible for a sensor based system since it supports different types of sensors, actuators, and shields. How Arduino Can Be Integrated with Radar Systems, Arduino may be integrated with radar systems through several ways, but acting as the control unit or data processing platform or just as an interface for sensors is one of them. Based on the above, handling data acquisition, signal, Processing, and visualization. Applications of Arduino in radar Papers can make radar technology available and affordable. Very effective and adaptable toward some applications

VI. PRESENT AND FUTURE SCOPE

Applications in Sky

Ultrasonic RADAR system originated from the security technologies in military, fleet, and air force segments. It has been developed thereafter to be used in vehicles due to its automatic parking and collision avoidance features. The technology is presently being adopted by AUDI and FORD for automated car parking purposes and self-driving cars for example, those of Google's Prius and Lexus. Multiple Applications, The gadget developed can be used with different equipment, such as automatic cars, cycles, mountain bikes, and so on. The Arduino board in the system

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ensures flexibility and customization based on specific requirements. Applications in Aviation, Airship Monitoring, Radar systems alert about nearby airships or objects, thus preventing collision. Elevation and Weather, It gives the exact reading of altitude and weather conditions. Airfield, There is the integration of radar equipped airships with ground systems for monitoring flights, and landing instructions to the pilots over the radio.

Submarine (Under Water) Applications

It is one of the factors used in determining obstacles in marine environments and therefore a means to ensure safe navigation. Radar systems determine the bearing and distance objects near a vessel, whether ships, islands, buoys, or lightships, to prevent collision.

Applications in Army Fields

Military fields benefit from the capability of radar systems complementing video surveillance with the heightened detection and tracking capability that it offers. Since the cameras are restricted to activities, the radar systems would be able to identify moving activity, distance, and angles, hence offering a robust solution towards enhancing security and accurate targeting of the enemy.

VII. CONCLUSION

In a nutshell, it is very possible and innovative to design and implement a radar system using Arduino and coupled with an ultrasonic sensor. Developing on the main idea of this paper takes advantage of the fact that Arduino micro controllers are very accessible with flexibility in making it appropriately multidisciplinary. Coupling Arduino with the ultrasonic sensor enables development into a cost-effective radar that may measure and detect objects. At best probably this system will never be compared or equated with state-ofthe art systems. It is thus a good learning and experimentation base but retains the ability of the traditional radar systems. Possibilities of its development and refinement mean the possibilities of application in various fields that further show the possibility of having the low-cost, customizable type of radar technology.

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