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INVADER ALERT SECURITY SYSTEM FOR RESRICTED AREA USING ULTRASONIC SENSOR

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Abstract: In this paper we implement a smart security system using a camera via ip with an ultrasonic sensor module to enhance the intruder al The Ultrasonic Intruder Detector with ESP32 camera project is an upgraded version of the Ultrasonic Intruder Detector that integrates an ESP32 camera module to provide visual confirmation of intruder detection. The system is designed to detect motion using ultrasonic waves and then captures images of the detected intruder using the camera module. The captured images are then sent to the owner's smartphone for immediate notification of the intrusion. The ESP32 camera module also allows the owner to remotely monitor the security of their property via a mobile. The system is easy to install, and has high accuracy in detecting intruders. This project provides an efficient and reliable solution for enhancing the security by providing both audio and visual confirmation of intruder detection.

INDEX TERMS **– INTERNET OF THING, ESP32 CAM, MICROCONTROLLER, ULTRASONIC SENSOR**

I. INTRODUCTION

An ultrasonic sensor-based intruder detection system using the ESP32 Camera is a security system designed to detect and alert the presence of unauthorized individuals or objects within a specific area. This system combines the capabilities of an ultrasonic sensor, which measures distances using sound waves, with the ESP32 Camera module, a powerful microcontroller with integrated Wi-Fi and camera functionality.

The ultrasonic sensor emits high-frequency sound waves and measures the time it takes for the waves to bounce back after hitting an object. By analyzing the time difference, the sensor can calculate the distance to the object. In the context of an intruder detection system, the sensor is typically placed in a strategic location, such as near an entrance or a sensitive area.

The ESP32 Camera module, which integrates the ESP32 microcontroller with a camera module, provides the processing power and connectivity required for the system. It can capture images or video footage of the detected intruders and transmit the data over Wi-Fi to a connected device or a cloud server for further analysis or immediate notifications.

II. PROPOSED METHOD

In this project we will using IoT technology along with sensors and other components. The methodology will be following a process where a microcontroller (Arduino UNO) will act as our brain ofthe system, then will be using the Ultrasonic sensor to sense the movement. And we will be using a servomotor to rotate the ultrasonic sensor to cover maximum number of areas. And to this will be adding a ESP32 Camera to capture the image of the detected movement and it will send the image to the Admin. And, there will be a buzzer the alert the person.

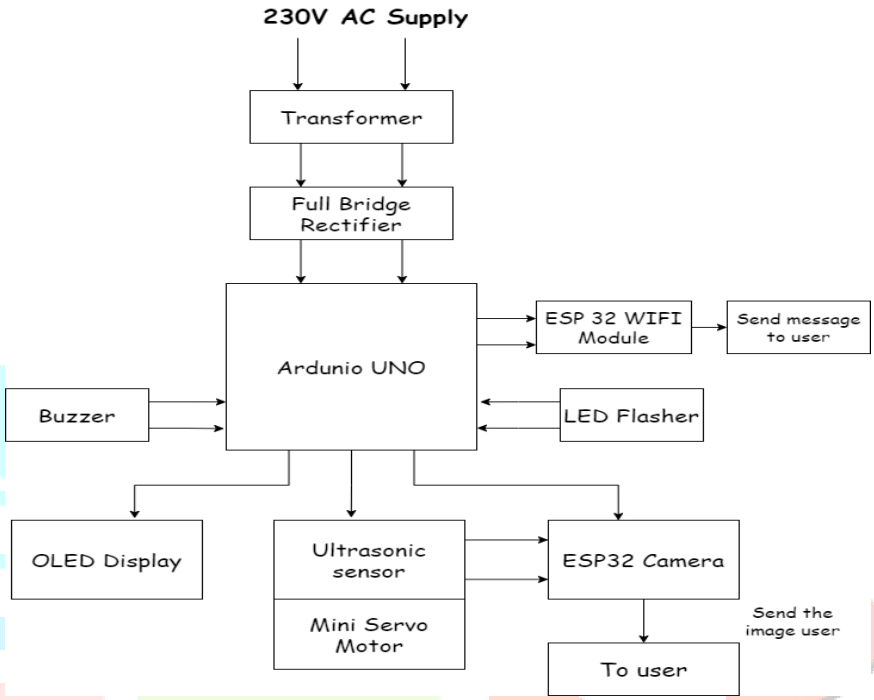

FIG.3.1 PROPOSED BLOCK DIAGRAM

III. MATERIALS & METHODS

4.1 ARDUINO UNO BOARD

In this chapter, we will learn about the different components on the Arduino board. We will study the Arduino UNO board becauseit is the most popular board in the Arduino board family. In addition, it is the best board to get started with electronics and coding. Some boards look a bit different from the one given below, but most Arduinos have majority of these components in common.

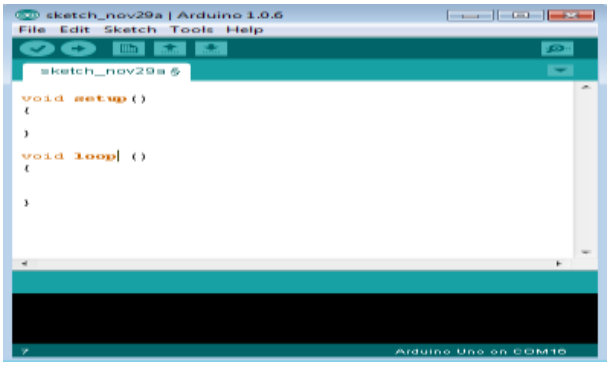

FIG.4.1(I) ARDUINO BOARD SOFTWARE

Arduino programs can be divided in three main parts: Structure, Values (variables and constants), and Functions. In this tutorial, we will learn about the Arduino software program, step by step, and how we can write the program without any syntax or compilation error.

Let us start with the Structure. Software structure consist of two main functions

−Setup( ) function

Loop( ) function

Void setup ( ) {

}

PURPOSE − The setup() function is called when a sketch starts. Use it to initialize the variables, pin modes, start using libraries,etc. The setup function will only run once, after each power up or reset of the Arduino board.

INPUT −

- OUTPUT −
- RETURN −
-

Void Loop ( ) {

}

PURPOSE − After creating a setup() function, which initializes and sets the initial values, the loop() function does precisely what its name suggests, and loops consecutively, allowing your program to change and respond. Use it to actively control the Arduino board.

INPUT −

- OUTPUT −
- RETURN −
-

Decision making structures require that the programmer specify one or more conditions to be evaluated or tested by the program. It should be along with a statement or statements to be executed if the condition is determined to be true, and optionally, other statementsto be executed if the condition is determined to be false.

Following is the general form of a typical decision-making structure found in most of the programming languages −

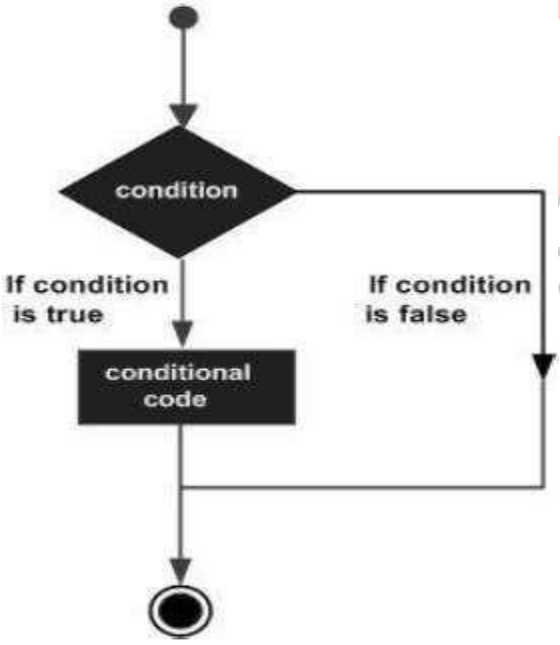

FIG.4.1(II) LOOP STRUCTURE

Control Statements are elements in Source Code that control the flow of program execution.

4.2 ARDUINO MICROCONTROLLER

Arduino is a single-board microcontroller meant to make the application more accessible which are interactive objects and its surroundings. The hardware features with an open-source hardware board designed around an 8-bit Atmel AVR microcontroller or a 32-bit Atmel ARM. Current models consists a USB interface, 6 analog input pins and 14 digital I/O pins that allows the user to attach various extension boards.

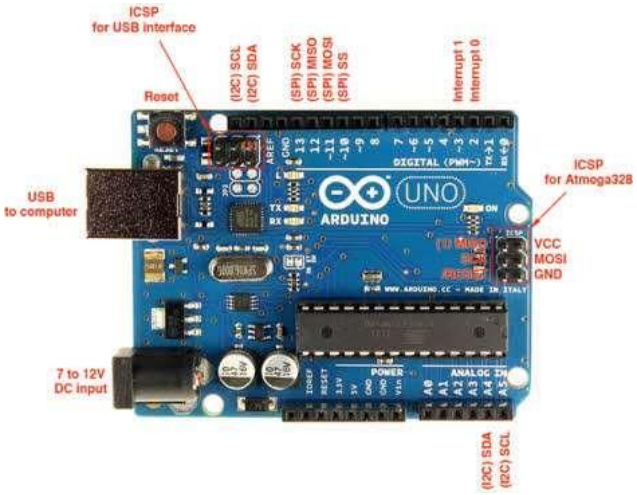

FIG.4.2 STRUCTURE OF ARDUINO MICROCONTROLLER

The Arduino Uno board is a microcontroller based on the ATmega328. It has 14 digital input/output pins in which 6 can be used as PWM outputs, a 16 MHz ceramic resonator, an ICSP header, a USB connection, 6 analog inputs, a power jack and a reset button. This contains all the required support needed for microcontroller. In order to get started, they are simply connected to a computer with a USB cable or with a AC-to-DC adapter or battery. Arduino Uno Board varies from all other boards and they will not use the FTDI USB-to-serial driver chip in them. It is featured by the Atmega16U2 (Atmega8U2 up to version R2) programmed as a USB-to-serial converter.

4.3 ESP32 CAMERA MODULE

The ESP32 Camera Module is a compact and versatile module that integrates a camera and Wi-Fi capabilities, based on the ESP32 system-on-a-chip (SoC) developed by Espressif Systems. It allows users to capture images, video streams, and perform various image processing tasks, all while leveraging the power and connectivity features of the ESP32 microcontroller. One of the key features of the ESP32 Camera Module is its built-in Wi-Fi capability. The ESP32 microcontroller supports Wi-Fi 802.11 b/g/n, allowing the module to connect to a wireless network and transmit captured images or stream video over the network. And it offers a flexible and cost-effective solution for projects involving image capture, computer vision, remote monitoring, and IoT applications.

FIG.4.4 STRUCTURE OF ESP32 CAM MODULE

4.4 ESP 8266(Wi-Fi Module)

ESP8266 offers a complete and self-contained Wi-Fi networking solution, allowing it to either host the application or to offload all Wi-Fi networking functions from another application processor.

When ESP8266 hosts the application, and when it is the only application processor in the device, it is able to boot up directly from an external flash. It has integrated cache to improve the performance of the system in such applications, and to minimize the memory requirements.

FIG.4.4 WI-FI MODULE

Alternately, serving as a Wi-Fi adapter, wireless internet access can be added to any microcontroller-based design with simple connectivity through UART interface or the CPU AHB bridge interface. ESP8266 on-board processing and storage capabilitiesallow it to be integrated with the sensors and other application specific devices through its GPIOs with minimal development up-front and minimal loading during runtime. With its high degree of on-chip integration, which includes the antenna switch balun, power management converters, it requires minimal external circuitry, and the entire solution, including front-end module, is designed to occupy minimal PCB area. Sophisticated system-level features include fast sleep/wake context switching for energy-efficient VoIP, adaptive radio biasing for low-power operation, advance signal processing, and spur cancellation and radio co-existence features for common cellular, Bluetooth,LCD interference mitigation.

4.5 MINI SERVO MOTOR

A mini servo motor is a small and compact electromechanical device used for precise control of angular position. It is commonly used in hobbyist projects, robotics, and various applications where precise motion control is required. And servo motor includes control circuitry that regulates the position of the motor shaft. This circuitry receives signals and commands from an external source and adjusts the motor's position accordingly. And it requires a stable power supply, typically ranging from 4.8V to 6V. It is usually powered by a separate power source or from the same power supply as the controlling device, depending on the specific application. a mini servo motor consists of a DC motor, gear train, control circuitry, potentiometer, and an output shaft. It operates based on closed-loop control, receiving control signals to accurately position the motor shaft. Its compact size and precise motion control make it popular in various applications requiring precise angular positioning.

FIG.4.5 SERVO MOTOR

4.6 ULTRASONIC SENSOR

An ultrasonic sensor is a device that uses sound waves of high frequency to detect objects, measure distances, and provide proximity sensing. It is commonly used in robotics, automation, and various applications where non-contact distance measurement is required. The sensor sends out ultrasonic sound waves at a frequency higher than the audible range of human hearing, typically around 40 kHz. The transducer converts electrical energy into mechanical vibrations, creating sound waves. When the emitted sound waves encounter an object in their path, they bounce off the object's surface. Some of these waves return to the sensor. The receiver transducer picks up the reflected sound waves and converts them back into electrical signals. The control circuitry measures the time it takes for the sound waves to travel from the transmitter to the object and back to the receiver. By knowing the speed of sound, the circuitry can calculate the distance between the sensor and the object. The distance can be calculated using the formula: distance = (speed of sound × time of flight) / 2. The time of flight is the round-trip time for the sound wave.

Fig.4.6 Ultrasonic sensor

Ultrasonic sensor consists of a transmitter, receiver, protective housing, and control circuitry. It operates by emitting ultrasonic sound waves and measuring the time it takes for the waves to travel and return. This enables distance measurement and object detection, making it a versatile sensor for various applications.

IV. HARDWARE RESULT

The hardware result of the proposed system is shown in fig. 5.1

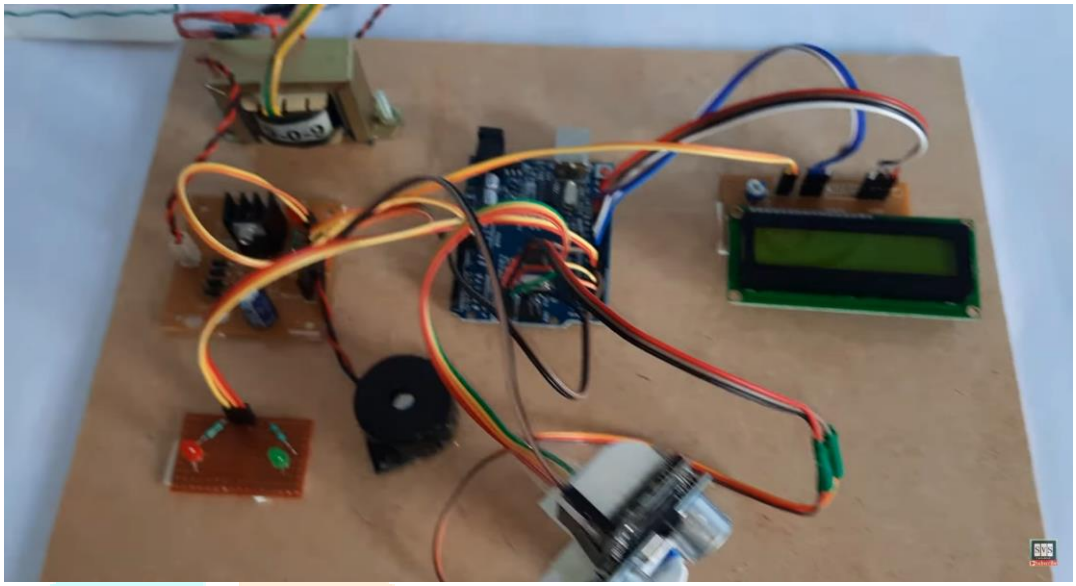

FIG.5.1 HARDWARE SETUP

V. CONCLUSION

In this paper intruder detection using ultrasonic radar system is successfully operated,this system is also integrated with internet of things hence real time monitoring and inspection during alert is possible. This system would provide the user with a alert message whenever a intruder is detected from which user could monitor or take necessary actions. This system would largely help in security sector and increases the safety parameters.

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