IoT-based Dual Technology Motion Detector

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Abstract. Home security has become a prime concern in recent years. As technology is emerging every second, abundant IoT-based smart surveillance systems have been developed and implemented with many modern features to keep the home safe. The proposed project is an extended approach to the existing home security system. The project aims to reduce false alarm rates of the existing home security system by using a Dual Technology motion sensor. Dual-technology sensors are sensors that combine two different types of technology. The dual-technology sensor uses both PIR and ultrasonic sensors, activating the trigger only when both sensors detect any motion of an object. The proposed setup effectively reduces false alarms caused by inanimate objects. The trigger caused by the Dual Technology sensor sends a message alert to the specified phone number through the Twilio Programmable Messaging API. Ultrasonic technology is sensitive to motion toward and away from the detector; passive infrared technology (PIR) is sensitive to motion across the field of view. The future implications of the project are great as it can also be used in the Automation of lighting in homes, offices, and libraries.

1 Introduction

The Internet of Things (IoT) refers to the growing network of physical objects that are equipped with sensors and connectivity to allow them to transmit and receive data. These connected devices can be found in a variety of settings, including homes, factories, and cities, and can be used for a wide range of purposes such as monitoring, control, and automation. IoT is made possible by advancement in technology such as the internet, wireless communication, and microelectromechanical systems (MEMS), which allow for the creation of small, low-power devices that can be connected to the internet and communicate with each other. The potential applications of the IoT are vast, and it has the potential to revolutionize the way we live and work.

IoT can play a significant role in a dual technology home security system. Dual technology refers to a system that uses two different types of sensors to detect intrusions. For example, a dual technology system might use both motion detectors and door/window sensors. The use of multiple sensors can improve the reliability and accuracy of the security system, as it is less likely that both types of sensors will be triggered by a false alarm. In an

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IoT-enabled dual technology home security system, the sensors would be connected to the internet and could transmit data about the status of the system and any detected intrusions to a central hub or a cloud-based server. This allows homeowners to monitor their security system remotely and receive alerts about any suspicious activity. The system could also be integrated with other smart home devices, such as smart locks, lighting, and appliances, to provide a more comprehensive and automated security solution.

2 Existing methods

There is now a global concern for security. When it comes to safeguarding people, the suggested way can be employed to make things smarter, safer, and more automated. Indranee Mondal and colleagues suggested a system that used the two sensors Flex and PIR. The system was designed to be activated both manually and automatically. Based on the sensor, the system turns on and locates the victim. After that, the position is shared with a select group of numbers and saved on the server. This project includes the collection of data using sensors. To transfer data to a centralised server and post files to a website, Raspberry Pi and GSM are employed. Anyone of any age can benefit from this method. When a person bends their fixed finger after being in danger of any type, the flex resistor value changes and the system turns on. Not only will SMS with the location be delivered at that time to the fixed numbers, but it will also be uploaded and saved as still photographs to the website [1].

The authors, Wingky R. Wickasno and Nico Surantha, suggested a PIR sensor-based smart home security system. The suggested concept seeks to alert users if any suspicious objects are present, which is something that the conventional home security system cannot do. The Raspberry Pi 3 and Arduino are used in the suggested project. The webcam is mounted on the Raspberry Pi 3 and the PIR sensor is fitted on the Arduino. The Raspberry Pi 3 is used to process images for human detection and input from received sensors. The movement surrounding the PIR sensor triggers the webcam, which then takes an image. Then, to identify suspicious objects, the histogram of gradient (HoG) and support vector machine (SVM) are used to recognise the objects. If a suspicious object is found, an alarm is set off to notify the homeowner that a burglar has broken in [2].

In most places, the number of unwanted security attacks on businesses, houses, banks, offices, etc. is rising. An efficient and dependable technique to identify the intruder using illumination and an alarm system has been put forth by Moe Myint Thu, Set Set Swe, and Tin Thandar Zaw. The idea behind the research is that any movement may be identified by observing changes in the environment's temperature or speed. The creation of a home security system employing a PIR motion detector is the main topic of this essay. By strengthening the surveillance method, which offers the essential control and alarming for the important security, the system can detect intruders. PIR sensors detect movement near the sensor if there is any suspicious activity in the specific area. The sensing pulse compels the light switch to turn on and the alarm to ring. The disadvantage of a security system using PIR sensors is that there is no way to alert the user about the suspicious object [3].

Even in enterprises and sectors that are frequently used to secure the home, existence security is becoming more important. A financially sound framework for home security put out by Matla Elimarteena and V Siva Nagaraju will raise the level of security in every area, including the ability to detect unauthorised access into residences, places of business, and laboratories. The project's concept is to alert the user if an intruder tries to enter your home using the sensors on each of the three walls. To deliver exact data, the cloud server employs a PIR sensor and a siren. When the gadget detects movement and the following circumstance, a GSM message is delivered. The project's key advantage is the installation of sensors on each wall, which can detect even the smallest motions. The system's only

flaw is that false alert rates could be rather high [4]. The Internet of Things (IoT) aids in the development of secure towns, businesses, and homes by enabling both public and private organisations to monitor infrastructure and public spaces remotely and securely in real-time. The monitoring system created in this study by Raja Raheel Ahmed, Muhammad Zeeshan Saeed, and their associates is low-cost, safe, fault-tolerant, and easy to set up and use. Microwave and PIR sensors are used in this experiment. Using the PIR and microwave sensors, heat signatures are found. These sensor nodes are joined together physically by an Arduino Mega Board. The Arduino Mega Board creates an alarm notice and transmits it to the 3G/GPRS Shield (SIM5215A) module if intrusion is detected. The user's cell phone and the online server are connected to each other twice, once through 3G/GPRS and once through GSM. Several test scenarios were used to validate the proposed system, and the results were excellent. The main advantage of the system is the backup communication configuration that it has in case the primary one fails [5].

3 Proposed method

3.1 Problem statement

Since crime is on the rise and everyone wants to take the necessary precautions to prevent intrusion, home security has become a big concern. In order to keep the home safe, several IoT-based smart surveillance systems have been created and put into use with a variety of contemporary features. The only sensor currently employed by home security systems is the PIR sensor, which requires a direct line of sight between the sensor and anyone inside a location. It can accurately specify the sensor's coverage under these circumstances. The efficiency of the current devices is between 80 and 90 percent, although they become less efficient when monitoring locations where people have been seated for a long time. The accuracy of the existing systems is taken based on the accuracy given in [6], [7], [8], [9], [10]. Intense sunlight from a window hitting a wall or hot air streaming from a vent are examples of issues that could potentially result in a significant enough shift in IR energy to trigger the PIR sensor. Additionally, there is no system in place to alert the home's owner when an intruder is detected.

The proposed project is an extended approach to the existing home security system. The problems cited above can be solved on using Dual Technology Motion Sensor. A dual-tech motion sensor tracks movement using passive infrared (PIR) and ultrasonic sensors. It will not turn on unless both sensors are in use. Because conditions like hot air streaming from a vent and harsh sunshine striking a wall can never trigger an ultrasonic sensor, the dual-tech motion sensor is so effective. Because of this, dual-tech motion sensors are less prone to trigger false alerts than conventional PIR ones. When both sensors are triggered, a SMS will be sent to the specified phone number through Twilio Programmable Messaging API.

3.2 Objectives

The project's goal is to create and introduce an automated home security system that uses Dual Technology Motion Sensor and is current, dependable, and user-friendly. The goal is to offer the highest level of protection feasible based on a detection system that automatically responds to emergencies. The following are the project's broad goals:

- To provide a higher level of accuracy and reliability in detecting intruders or other potential threats.

- To save energy and reduce costs by only activating when both technologies detect motion simultaneously.
- To reduce false alarm rate.
- To know the detection of intruder through SMS.
- To eliminate the need of being physically present in any location to know the status of their home.

3.3 Architecture diagram

With the help of an ESP32 Dev Kit, a PIR sensor, and an ultrasonic sensor, the project builds a motion sensor detector. A buzzer is activated and data is sent to firebase when an intruder is discovered by a PIR and Ultrasonic sensor. The dual technology motion sensor is used in this project to reduce the false alarms which are generated by the existing home security systems. The GISMO-VI IoT board is used in this project which already has an inbuilt ESP32 Devkit, PIR sensor, Buzzer, and an Ultrasonic Sensor. The data collected by the firebase is sent to the Twilio API, sends a message alert to the user. The project flow can be observed with the help of Figure 1.

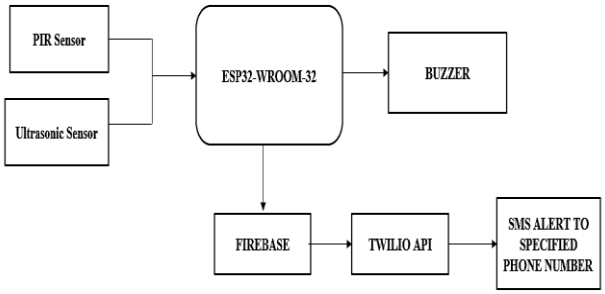

Fig. 1. Architecture diagram.

3.4 Modules - connectivity diagram

The sensors employed in the home monitoring and security system are used to gather information that will be used by the owner to identify intruders. To detect inhabitants, PIR sensors make a distinction between the heat emitted by moving people and the heat in the surrounding area. Projecting ultrasonic sound waves into a space and measuring how quickly they return are how ultrasonic sensors operate. They look for changes in frequency caused by moving objects. To coordinate and boost system security, many modules, including the ESP32 module and the Twilio API, communicate with one another.

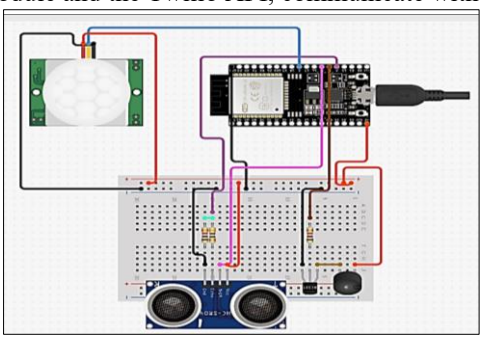

Fig. 2. Connectivity diagram.

The Arduino board is connected to the PIR and Ultrasonic Sensors in this system. The digital signal is transmitted to the board when motion is detected by both sensors. As soon as the digital signal is sent, the buzzer produces sound. The firebase then receives the signal, sends it to Twilio Programmable Messaging API, which alerts the house owner through text message. The ESP32 module can be turned off by the owner if he wants to silence the alert. After sending the message to the user, the Twilio API module will transmit the signal to the Arduino board. The serial monitor in the Arduino IDE allows you to view this data. The SMS is immediately sent to the home owner upon system activation. The Twilio API module includes the required phone number incorporated in it. The ESP32 microcontroller is a system on a chip (SoC) with built-in Wi-Fi and dual-mode Bluetooth. It is a low-cost, low-power microcontroller board. It is a powerful and versatile platform for developing a wide range of applications, including Internet of Things (IoT) applications. The ESP32 is equipped with a wide range of peripherals and features, including a high-speed Wi-Fi and Bluetooth radio, multiple low-power modes, and many I/O pins and peripherals.

3.5 Modules and its description

3.5.1 Module 1: ESP32 module

The ESP32 Dev Kit, PIR Sensor, and Ultrasonic Sensor are used in the project. PIR sensors in this module make a distinction between heat emitted by moving people and ambient heat to find people inside. Projecting ultrasonic sound waves into a space and measuring how quickly they return are how ultrasonic sensors operate. They can identify people around. They look for changes in frequency caused by moving objects. A buzzer is activated when an intruder is discovered by a PIR and Ultrasonic sensor. Dual technology concept is used in this project, which means to use two different types of sensors. The dual technology motion sensor is used in this project to reduce the false alarms which are produced by the existing home security systems. The GISMO-VI IoT board is used in this project which already has an inbuilt ESP32 Devkit, PIR sensor, Buzzer and Ultrasonic Sensor. When the motion is detected by both the sensors, it triggers the buzzer and sends the data to the Firebase.

3.5.2 Module 2: Twilio API module

The firebase receives the data from the ESP32 module and then sends a trigger to the Twilio API to send a message alert to the user. A SMS alert will be sent to a phone number that the Twilio API already has on file. The user's choice can affect how the embedded security system's phone number is altered. The user receives a message alert from the Twilio API, and the Arduino IDE's serial monitor displays the status of the message delivery.

4 Results and discussions

4.1 Description about dataset

The following formula is used to compute the distance measured by the ultrasonic sensor:

$$D = S*T/2 \quad (1)$$

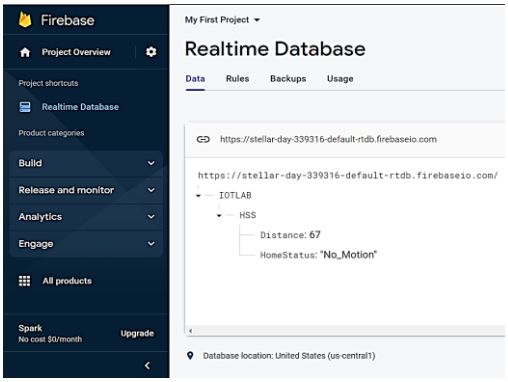

Fig. 3. Google firebase.

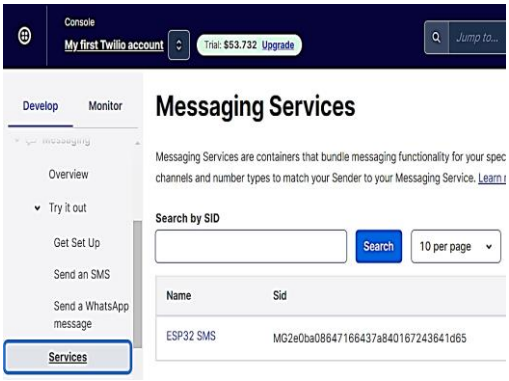

Fig. 4. Twilio API.

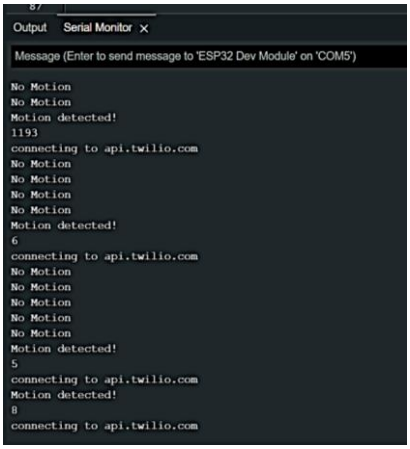

Fig. 5. Observations generated by system.

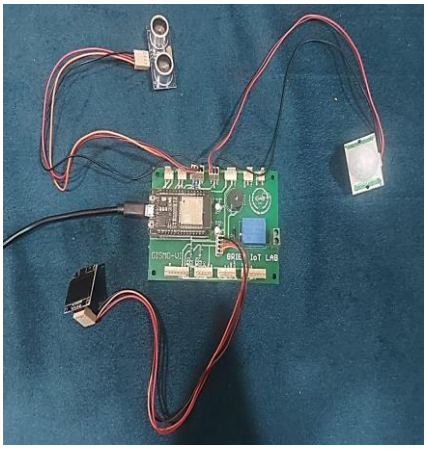

Fig. 6. Overview of Real-time prototype model.

The distance that the sound has travelled is calculated using the equation Distance = (Time x Speed of Sound) / 2. The "2" is added since the sound must be repeated in the formula. The sound first departs from the sensor, then moves away before coming back after striking a surface. The size of the area can be used to gauge the need for a particular distance. The output generated can be observed using Figure 8 given below.

4.2 Implementation of module 1

The Realtime data of the sensors is updated to Firebase is shown in Figures 7 and 8.

4.3 Implementation of module 2

If both the sensors are triggered according to the conditions, a SMS alert is sent to the specified phone number and is represented in Figure 9.

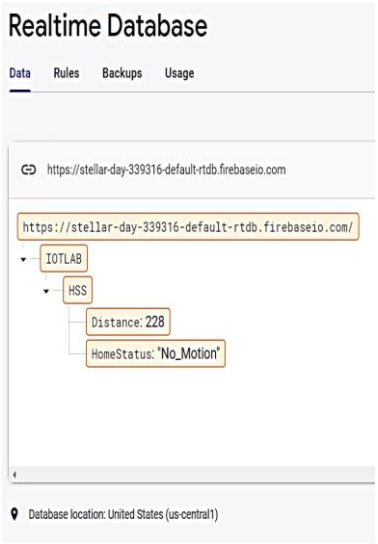

Fig. 7. Realtime firebase during no motion.

Fig. 8. Realtime firebase when motion detected.

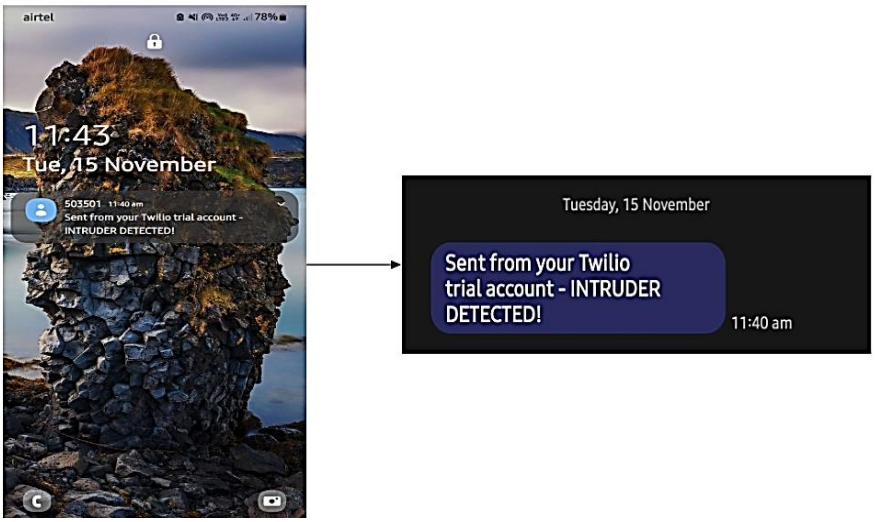

Fig. 9. Screenshot of the SMS alert sent.

4.4 Significance of proposed method with advantages

Motion sensors with Dual Technology are used in the proposed system. Most installation teams choose dual technology sensors for more difficult settings. They can detect even the smallest motions and are resilient enough to withstand sunlight, wind, and cold temperatures. All dual technology sensors incorporate two technologies that each have a different level of sensitivity to disturbance. In order to prevent false alarms, it is important to make sure that each sensor compensates for the shortcomings of the others. It functions because each of these 2 sensing technologies is what it is. The level of IRE is detected by PIR components as it shifts across zones during a predetermined time period and at a

predetermined speed. There are not many environmental disturbances that reflect this type of activity, but heat sources, especially warm air currents, can be problematic for PIRs.

Ultrasonic sensor technology has strong detection capability and can effectively detect anything moving. After covering a space with a signal, they compare differences between the signal sent and the signal reflected. The Doppler shift is the name of it. Strong detection performance is provided by ultrasonic sensor technology, which can very much detect anything moving. While ultrasonic devices require a Doppler shift moving either toward or away from the sensor in order to activate, PIRs must be sensitive to movement within their zones in order to function as a dual technology. Another aspect to consider is the possibility to fine-tune each sensor more with dual technology equipment than with a single sensor technology that must stand alone. A dual technology sensor will cost more, and prices will also vary depending on factors like range, signal processing, active IRE, lens design (mirror optic/Fresnel), and range gating.

5 Conclusion

The proposed system sounds an alarm and sends an SMS alert to the designated phone number when it detects an intruder. For parents who are too busy at work to watch their children between the ages of 2 and 5, you can use an interactive surveillance system. Older individuals require the same level of care as children when left at home alone. The project uses Dual Technology Motion Sensor. Dual Technology is that we use two different types of sensors. The PIR and ultrasonic sensors alert the Arduino Controller if they notice any movement. A buzzer is activated when motion is detected by either of the two sensors. Once Arduino has all the information it requires, it sends the information to Firebase. The Firebase will send the data to Twilio API which will send a message alert with the subject line "INTRUDER DETECTED!" to the specified phone number. Ultrasonic and passive infrared sensors are sensitive to two distinct types of disturbance. False alarms on a dual-tech motion sensor are significantly less likely to happen than on a conventional PIR motion sensor.

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