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Design & Development of Multifunctional Robot for Surveillance Applications

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Abstract:- The recent digital revolution has resulted in more integration of robots than ever before in various domains such as agriculture, medicine, industry, military, police, and logistics. Autonomous robots are one of the most powerful fields. One of the most potent disciplines is autonomous robots. Numerous open-source communities, where the Raspberry Pi is primarily employed in multi-utility or multi-functional robotic projects, would benefit from this. The robot formerly had both a GSM modem and a GPS receiver. A robotic system powered by a Raspberry Pi has been proposed to identify intruders and alert the control panel.

Keywords:- *Raspberry Pi, ESP32, GPS, GSM, multifunctionalsurveillance application.*

I. INTRODUCTION

The latest digital rise has led robots to become integrated over ever into different domains. Robots are dedicated to serving, facilitating and enhancing human life. However, many incidents are occurring, resulting in serious injuries and devastating impacts like the unnecessary loss of human lives.

Single-purpose robots for specific tasks are ineffective, whereas multi-functional robots are effective in solving today's challenges, being cost-effective and increasing an organization's productivity. Autonomous robots are one in every of the foremost powerful fields. Several systems and techniques are examined are excecuted on the Raspberry Pi. This can help many open-source communities, where the Raspberry Pi is generally utilized in multi-utility or multi-functional robotic applications.

In the past, the robot was equipped with a GPS receiver and a GSM modem. Sensor data, GPS coordinates, and images captured are continuously transmitted to the control station. The real-time position of the robot can be seen on a webpage that is accessible from anywhere using Google maps API. To overcome the challenges, a robotic system based on Raspberry Pi has been developed to predict intruders and alert the control room. This system is proposed to usesensors for face recognition, metal detection, ground depth for robot mobility and fire detection. These autonomous robots have the added advantage of movement and direct interaction with the surrounding environment.

In addition, human detection of a missing person is proposed using GPS interfacing with the ESP32 microcontroller. Also, by implementing a setup of headphones to assist and decide the operation, the information can be reached to disable it.

II. LITERATURE SURVEY

The robot is constructed in such a manner that the user may controll wirelessly using Wi-Fi technology. A PIR sensor is being used to detect presence of personor obstacle, also a camera was linked to the robotic system in order to capture andidentify the intruder's face. As a result, the robot provides security in remote areaswhich significantly reduces human loss [1].

Sensors and cameras were accustomed detect and recognize humans, objects, and etc. The vehicle is being designed to figure productively in common spaces, like the military. This robot is use to spot the quantity of terrorists within the building, weapons used, bombs, etc. Raspberry Pi uses the Raspbian software system. The Pi board controls movement and gathers details via sensors and a camera, which was want to stream real-time video of the surroundings to the operator [2].

Instead of physical surveillance, the system [3] aids in the detection of any spy hiding inside the group. This is possible by utilizing an application that gathers data from surveillance cameras and then applies facial recognition. Algorithms for identification and recognition of strangers. When an intruder is discovered, officials are contacted quickly and necessary action is taken.

In [4] robot consists of five separate systems, including robotic arms for picking and placing items from conveyor belts. A fire sensor detects fires and sounds an alarm in the immediate area. GPS longitude and latitude values are used to pinpoint the exact location of the robotic system. Later robot, send the same data and transmitted across a network and it is displayed on the LCD. The system also sends a GSM message, which is delivered by mobile.

III. LITERATURE GAP

According to a review of the literature [1–4], the robot was equipped with a GPSreceiver and a GSM modem. Sensor data, GPS coordinates, and images capturedare continuously transmitted to the control station. The real-time position of the robot can be seen on a webpage that is accessible from anywhere using the Google Maps API. However, in this project, a multifunctional robot is constructed in such a

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manner that the registered person's precise location can be determined. A set of headphones for the disabled has been created to send alert messages in text and voice. To ensure complete security, the proposed robotalso describes various sensors that send alert messages.

IV. PROPOSED METHODOLOGY

The system is constantly scanning the surrounding area for human facial data. If the identified individual is known, the system shows his or her name. When the detected person is unknown, that is, when the database does not match, the robot sends an alert message in text and voice.

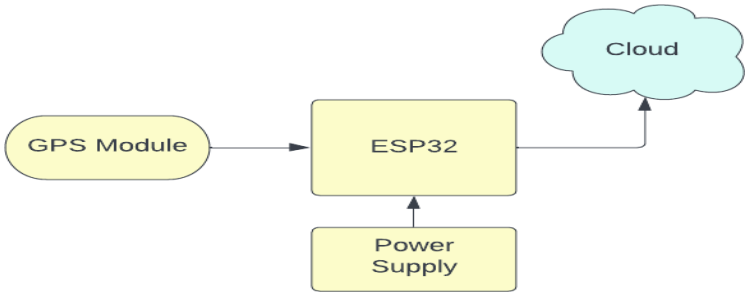

Fig. 1: Block diagram of smart rescue robot of military application

The schematic diagram of Smart Rescue robot for military applicationsystem is as shownin figure 1.

Metal sensor are used to determine whether an object in the environment contains metal or not. Ultrasonic sensors are used to measure the distance between obstacles and the robot's movement is determined based on the data collected.

The system senses the environment for gas and fire. When a temperature sensor detects a dangerous environment that resembles a fire, it raises its threshold level. If a gas or fire is detected, it notifies the operator with the terms "gas detected" or "fire detected".

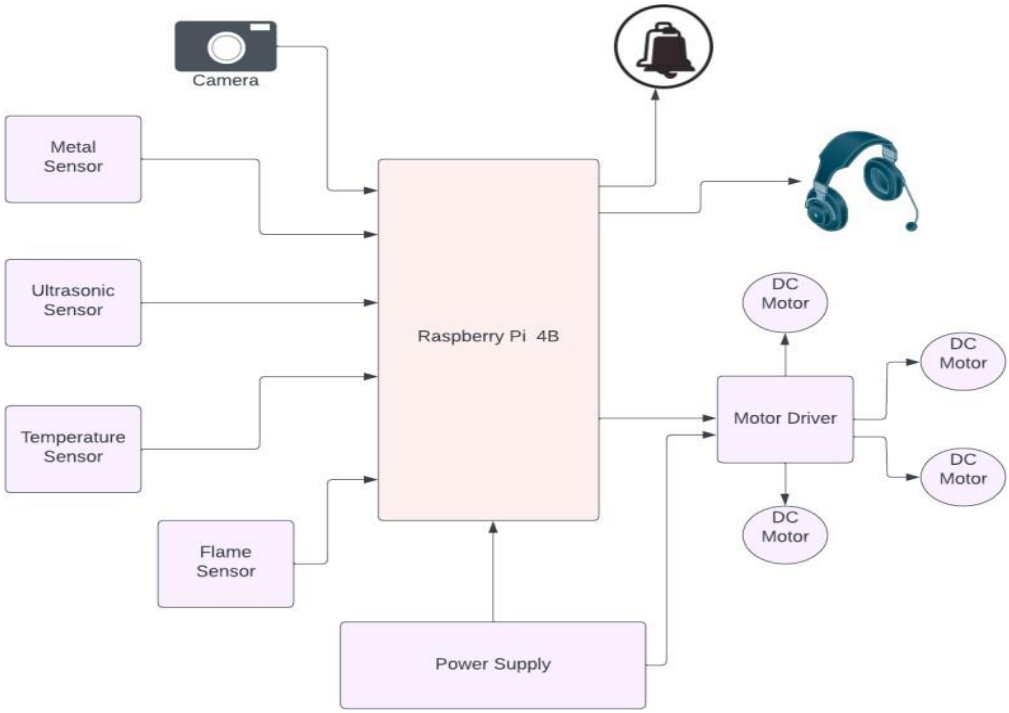

Fig. 2: Block diagram of location tracking Block Diagram of human interface is shown in the figure 2.

The rescue robot uses cloud communication to connect with an ESP32 microcontroller and a GPS module to pinpoint the precise location of a known registered person. The registered person's location is determined using the GPS (Global Positioning System), the longitude and latitude of the registered person are delivered.

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V. WORKING

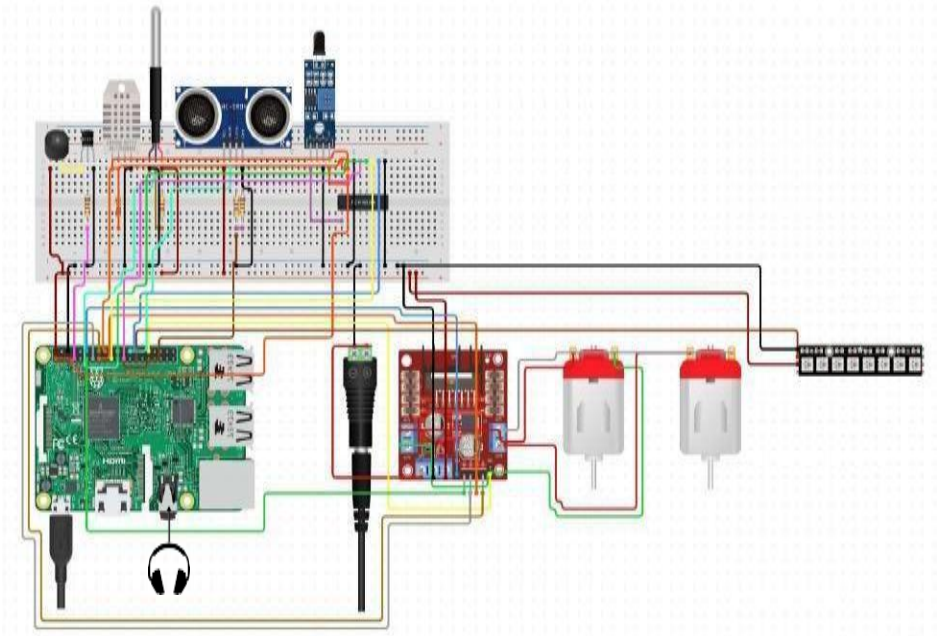

Fig. 3: Circuit Diagram of multifunctional robot for surveillance application

The circuit diagram of the multifunctional robot for surveillance applicationis shown in figure 3. It consists of the Raspberry Pi 4, Pi camera, headset, tube type metal detector, ultrasonic sensor, temperature sensor, IR flame sensor, L293D motor driver, power supplyconnected to the 12V, 2A adapter, and jumper cables.

A. Interfacing of Pi camera with raspberry Pi

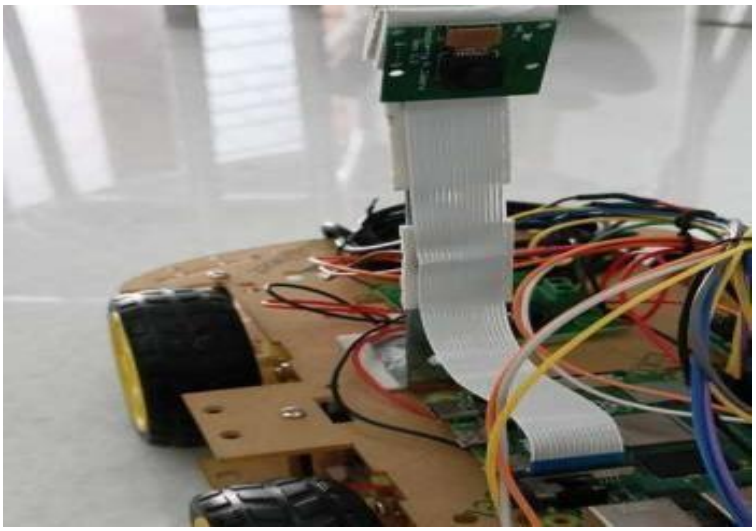

Fig. 4: Pi camera with Raspberry Pi

Figure 4 depicts the Pi camera nodes with connections to the Raspberry Pi.

Connect the ribbon connector on the camera module to the Raspberry Pi'sconnector first. Then camera is linked to the white connector located near the USB and Ethernet ports. The sensor has an 8-megapixel resolution and a focusing lens.

B. Interfacing of ultrasonic with raspberry Pi

The distance between two objects is measured using ultrasonic sensors. Ultrasonic sensors work in the same way as radar sensors do. They generate radio waves, which travel through the air and return when they encounter an object. Figure 5 shows the ultrasonic sensor interface with raspberry pi.

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Fig. 5: Ultrasonic sensor with raspberry Pi

C. Interfacing of DHT11 with raspberry Pi

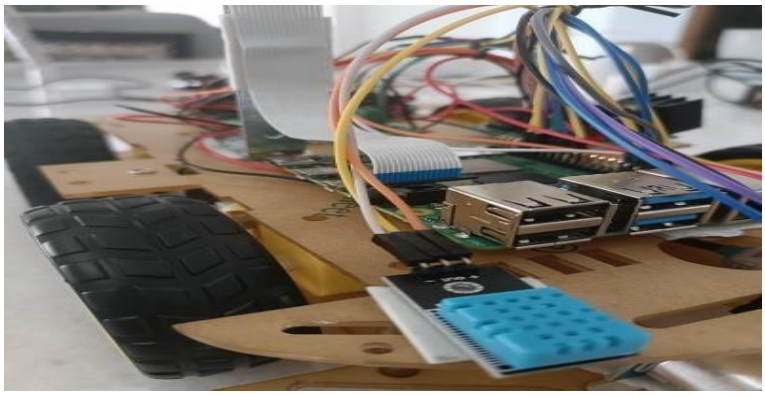

Fig. 6: DHT11 with Raspberry Pi

A DHT11 is a digital sensor that combines two different sensors into a single unit. The sensor is made up of an NTC (Negative Temperature Coefficient) Temperature Sensor and a Resistive-type Humidity Sensor. An 8- bit Microcontroller converts the analogue signalsfrom these sensors into digital output.Figure 6 shows the interfacing with raspberry pi.

D. Interfacing of m etal sensor with raspberry Pi

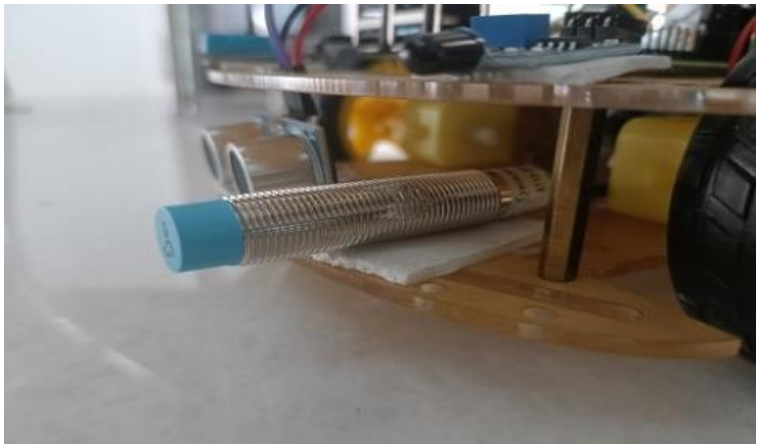

Fig. 7: Metal sensor with Raspberry Pi

The Raspberry Pi is connected to a metal detector by means of a specialised amplifier.The amplifier receives measurable input from the metal sensor. Data issent to the output pins by the sensor and picked up by the Pi's onboard transponders, amplifiers and other components. Figure 7 shows the metal sensorinterface with raspberry pi.

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E. Interfacing of Flame sensor with raspberry Pi

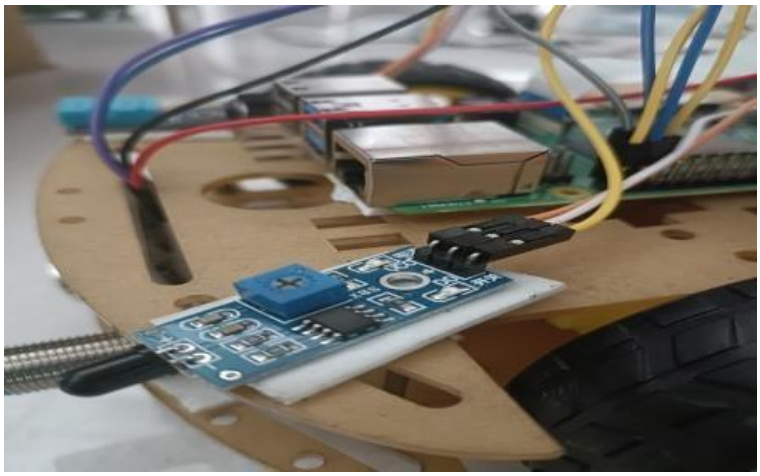

Fig. 8: Flame sensor with Raspberry P

Infrared flame sensors detect flames, fires, or lights with wavelengths ranging from 760nm to 1100nm. Because of their low power and low cost, ease of use,and wide detection range, the infrared flame sensor is very popular. The flame sensor connected to the RaspberryPi is shown in figure 8.

F. Interfacing of L293D with raspberry Pi

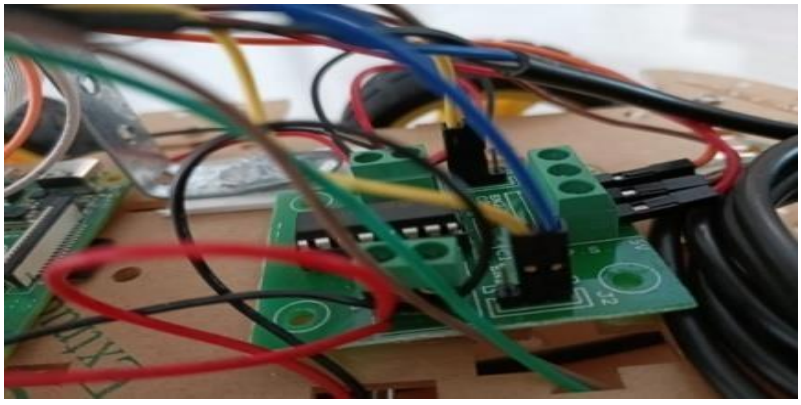

Fig. 9: L293D with Raspberry Pi

An H-bridge IC is another name for the L293D motor driver IC. It is made up oftwo H-bridges, one for each motor. They are used to change the polarity of the output, allowing DC motors to be controlled in both directions.

G. Interfacing of GPS with ESP32

GPS receivers determine their position in relation to a network of satellites.They are user defined to know where the GPS satellites are at any given time.

It makes use of u-low-power blox's NEO-6M GPS module, which is battery-powered and inexpensive.

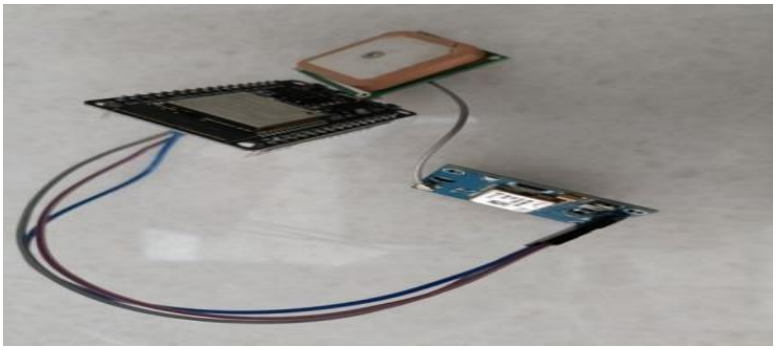

Fig. 10: GPS with ESP32

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VI. FLOWCHART

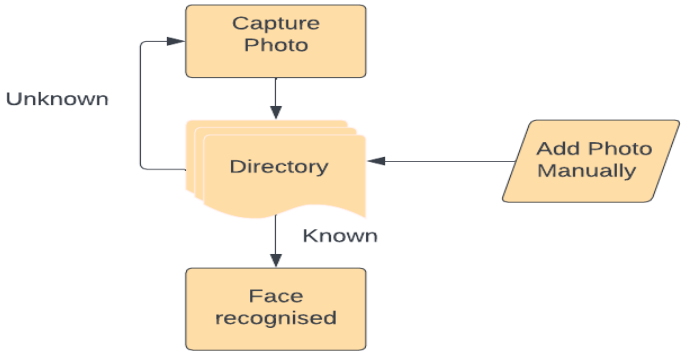

Fig. 11: Flowchart for Face Recognition

Figure 11 shows the flowchart for face recognition is implemented using a Python algorithm. At first, the face recognition process determines whether a person is known or unknown. If the individual is unknown, the system issues an alert message. In addition, to register a person into a directory, their face canbe manually added and recorded into the database.

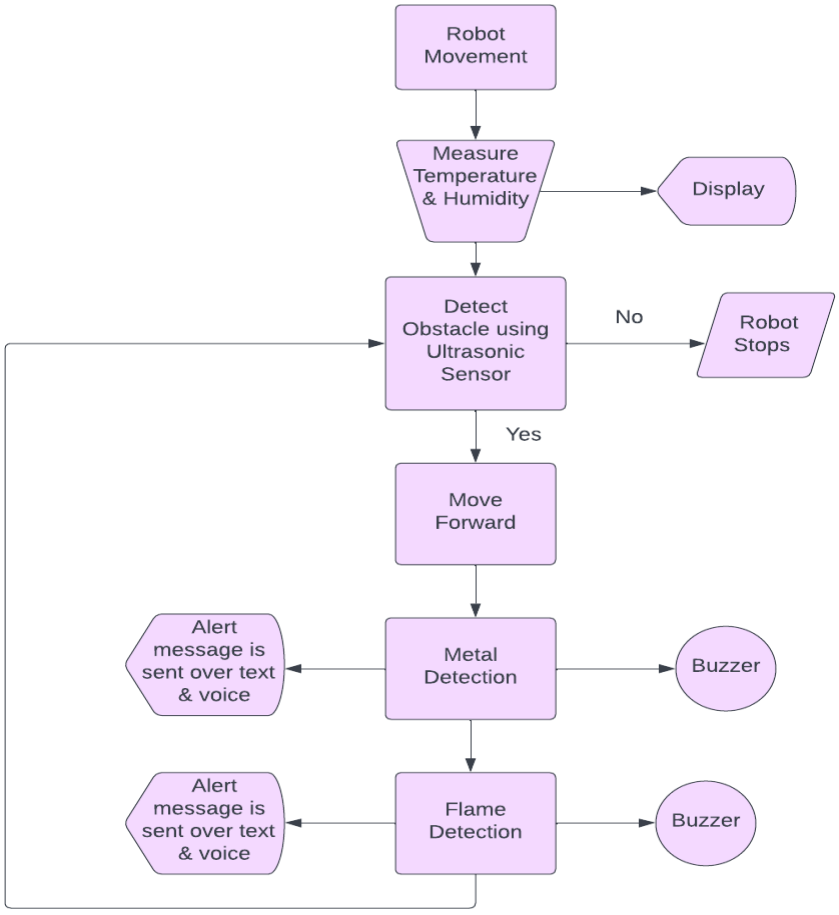

Fig. 12: Flowchart for entire Robotic System

Figure 12 shows the flow chart for entire robotic system Metal sensor are used to determinewhether an object in the environment contains metal or not. Ultrasonic sensors are used to measure the distance between obstacles and the robot's movement is determined based on the data collected.

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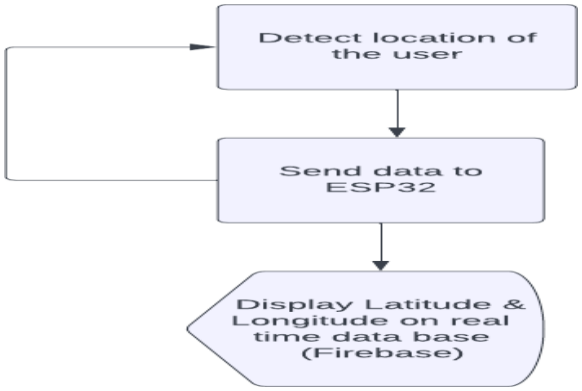

Fig. 13: Flowchart for human tracking

Figure 13 shows the flowchart for human tracking. The rescue robot uses cloud communication to connect with an ESP32 microcontroller and a GPS module. The longitude and latitude of the registered person are delivered using the Global Positioning System.

VII. RESULTS

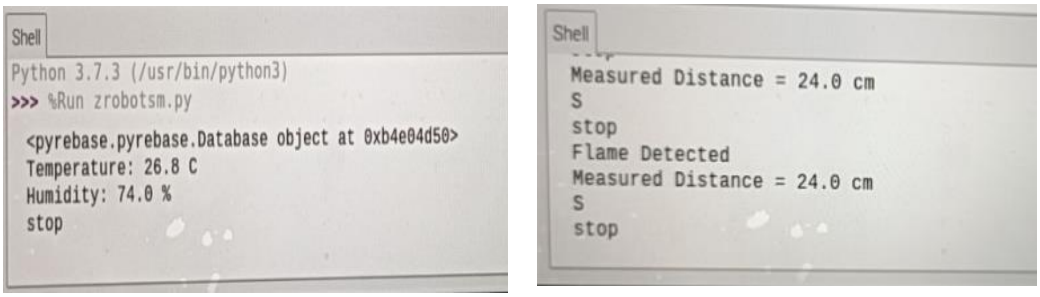

Fig. 14: Unusual event detects

Initially environment's temperature and humidity are first measured as shown in the figure 14. During the initial movement of the robot, an ultrasonic sensor is used to measure distance. Thesystem sends an alert message if an obstacle is detected. If the robot comes into contact with fire the system also sends an alert and voice message.

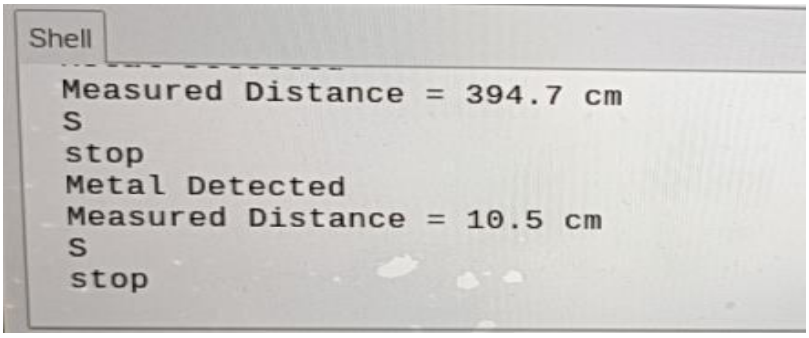

Fig. 15: Metal detected

Figure 15 shows when the robot comes into contact with metal. The system sendsa text and voice alert message. The voice message is used to help disabled people ,so that everyone can use it.

Fig. 16: Firebase Station Software

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In firebase realtime database distance measured from the ultrasonic sensor as well as the location is continously loop, it changes according to environment as shown in the figure 16. If there are any obstacle is detected the movement of the robot stops. The latitude and longitude values are displayed. The main reason for using Firebase is to observe the robot in action in real time.

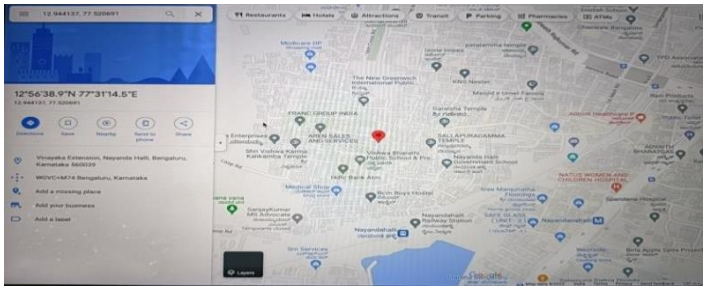

Fig. 19: Location tracked of ESP32 user

The degree of latitude and longitude is displayed on the realtime firebase station. The precise location of the ESP32 user can be traced using these degrees on an internet browser.

Figure 18 shows the detection of "Known" and " Unknown" people based on the directory created and stored in the data.

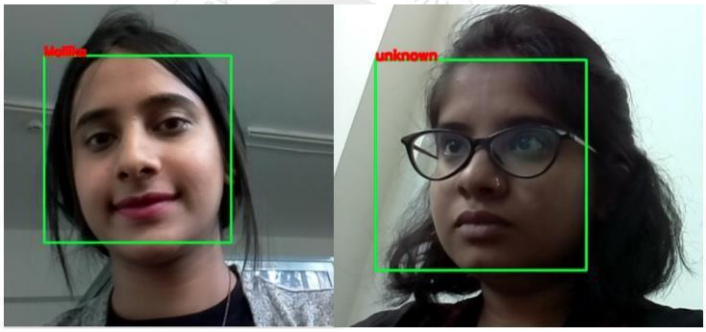

Fig. 18: Detection of known and unknown person

VIII. CONCLUSION

India's total number of missing children remained untraced increased from 48,972 to 1,08,234 during 2019-2020. Many incidents had occurred, resulting in serious injuries and devastating consequences such as the untimely death of person.

To overcome this issue, The precise location of the registered user is being tracked using gps module interfaced with ESP32.

The surveillance robot system with facial recognition is constantly examining the surrounding environment. When the robot detects the items, it overcomes them and continues forward. The robot can detect fire in its surroundings.

A robot platform with a hard and fast four wheel structure chassis and an electrical system supported the Raspberry Pi and Microcontroller. The created platform fits several basic design objectives for this stage of development, like being a low-cost solution, highly reliable and extendable application, but it also investigated alternative algorithms of mapping, navigation, obstacle detection.

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