



SMART SURVEILLANCE ROBOT FOR HAZARDOUS AND RADIATION AFFECTED FIELDS

G. Rohith, K.Varun Kumar, G.Bharath, V.S.G. Naga Raju * ,

Assistant Professor, vsgnraju@gmail.com

Department of Electronics and Communication Engineering, SNIST, Hyderabad-501301, India.

Abstract:

There is a wide variety of robots used for different applications, ranging from simple to complex. The concept presented here focuses on acquiring data from hazardous places, specifically radiation-affected areas. These areas encompass various types of radiation, such as ultraviolet radiation, nuclear radiation, x-ray radiation, and electromagnetic radiation. These places are dangerous for humans to enter, making remote-controlled robotic vehicles ideal for gathering data on the surrounding environmental conditions. Although it is challenging to create other types of radiation for demonstration purposes, our project generates electromagnetic radiation to prove the concept practically.

Radiation refers to energy that originates from a source and travels through space. In our project, the source is created using a power transmitting coil, while a power receiving coil is arranged on the robotic vehicle to capture the electromagnetic radiation when the vehicle enters the radiation-affected area. Electromagnetic radiation is associated with an electric field and a magnetic field. When the vehicle approaches this field, the buzzer integrated into the moving mechanism automatically activates. The alarm in the form of a loud buzzer sound indicates the strength of the field or the proximity of the vehicle to the source. Additionally, our robotic vehicle is equipped with a DTH11 sensor, capable of measuring temperature and humidity, as well as a harmful gas sensor that can detect various toxic gases, including carbon dioxide. Furthermore, we have incorporated a live video monitoring system, featuring a 2D camera placed on the moving mechanism. This Wi-Fi camera enables the live video broadcast of the robot's surroundings. The innovative aspect of our design lies in the ability to control the camera through a remote control unit, allowing it to be transported as needed. Such cameras are highly beneficial for securing open land surrounded by buildings. Moreover, this robotic vehicle can also be employed in deep forests to collect environmental data while providing monitoring capabilities.

To transmit the live video, we use a V380 Wi-Fi camera, which establishes a wireless communication link to the corresponding smartphone through the V380 Pro app. These wireless cameras offer greater flexibility compared to wired cameras, as they are not limited by wires, enabling the equipped vehicle to move freely in the field. The robot or remote-controlled vehicle is controlled via an RF communication system, allowing movement in all directions, including reverse. The mechanism is driven by DC motors, independently controlled through an H-Bridge IC. The remote control unit is constructed using an 89c2051 microcontroller chip, while the vehicle control circuit and data acquisition system are built using an Arduino Uno board.

Note: One crucial aspect of this project is to hold the collected data until the robot returns to its home position, where it is controlled by the remote. This is essential to ensure accurate data from the radiation-affected area. To achieve this, a data hold key is provided, and the data remains unchanged until the release key is activated.

Major Building Blocks:

Moving mechanism, DC motors, RF transmitter, RF receiver, remote control unit constructed with 89c2051 controller chip, main processing unit built with Arduino Uno board, DTH11 sensor, toxic gasses detecting sensor, electromagnetic radiation circuit built with power transmitting coil with self oscillator circuit built with power Mosfets, power receiving coil, buzzer, LCD, rechargeable battery with charger, L293D H Bridge IC, V380 Wi-Fi camera and more.

Introduction:

In recent years, there has been a significant development in small intelligent robotic vehicles for various applications. These vehicles have become crucial in sectors such as defense, disaster management, wildlife studies, and data acquisition in hazardous areas. Our project focuses on designing a robotic vehicle specifically for collecting data from radiation-affected areas. Radiation encompasses a wide range of types, including nuclear radiation, toxic gas radiation, and electromagnetic radiation (e.g., radio waves, microwaves, infrared radiation, ultraviolet radiation). It also includes acoustic radiation such as ultrasound. Our project specifically considers the detection of electromagnetic radiation, where high-frequency electromagnetic pulses are generated and emitted into the air for demonstration purposes.

The objective of our project is to gather data on ambient parameters such as temperature, humidity, and coordinates of harmful gases. To achieve this, we utilize a DHT11 sensor, which is interfaced with an Arduino board. The parameter values are displayed on an LCD screen. Ambient temperature refers to the actual air temperature in the surrounding environment. The DHT11 sensor is capable of measuring both temperature and humidity. To detect harmful gases in the radiation-affected area, we use a universal gas sensor capable of detecting various toxic gases, including smoke. Additionally, we incorporate a GPS module to obtain the coordinates of the presence of harmful gases.

When the system detects the presence of harmful gases, an alarm is activated, and the LCD displays the information accordingly. By activating the hold button from the remote, the displayed information is retained until the robotic vehicle exits the affected area. Similarly, the system also detects electromagnetic field (EMF) levels, and the information remains displayed until the release key is activated. The Arduino Uno development board serves as the main processing unit, and the sensors are connected and interfaced with this processor. An independent LCD screen is used to display the parameter values. The DHT11 sensor, a low-cost digital temperature and humidity sensor, utilizes a capacitive humidity sensor and thermistor to measure the surrounding air's parameter values. Its digital output can be directly connected to the Arduino board's data pin.

Literature Survey:

In [1] project, the author describes a war field robot that uses an Arduino uno board, L293D motor driver, HC-05 Bluetooth module, and night vision wireless camera to monitor human movement in dangerous areas. An Android application, created through MIT app inventor, is used to control the robot's movements and navigate the terrain.

In the [2] project involves a robot designed for continuous surveillance in domestic areas. Controlled by a mobile device or laptop using Cayenne software and ESP-8266 Wi-Fi module, the robot features DC motors, ultrasonic and IR sensors, and a wireless camera for audio and video streaming. Arduino IDE is used for coding.

In the [3] project focuses on a cost-effective robot that can perform surveillance and rescue operations. Equipped with various sensors, including a GPS sensor, passive infrared sensor, and air quality sensor, as well as a robotic arm with gripper, the robot is controlled remotely by the end user and can even be charged with a solar panel.

In the [4] project describes a wireless mini robot for real-time video and audio streaming, controlled by an Android application called BLYNK. The robot features an Arduino UNO R3 control board and Node MCU ESP module, and is secured with a predefined username and password.

In the [5] project, the author proposes a monitoring and controlling system for a mobile robot via the internet, using Raspberry Pi and various sensors, including a PIR sensor and smoke sensor, to detect suspicious activities and potential terrorist attacks. HTML is used to create a web page for navigation control.

Finally, the [6] project discusses a spy robot based on the Raspbian operating system, featuring a Raspberry Pi 3 Model-B and Python programming language for client and server communication. H-Bridge IC L293D is used to control the robot's movements based on signals received from the end user.

Improvements:

With the advancements in communication technologies, researchers need to update their concepts for real-time applications. A proposed system aims to reduce costs and minimize human losses in hazardous areas by incorporating various benefits.

These include a webcam for surveillance, connectivity to Wi-Fi hotspots, the ability to function as a SMART ROBOT in areas where human entry is prohibited, a stealth coating, and the ability to collect information about the surrounding environment. Additionally, the system is designed to work effectively without requiring human intervention.

Hardware Requirement:

1. **DC motors:** These are commonly used electric motors that convert electrical energy into mechanical energy. They are widely used in various applications, including robotics, automation, and vehicles, to provide motion or rotate a shaft.
2. **RF transmitter:** An RF transmitter is a device that transmits radio signals wirelessly over a short or long distance. It is commonly used to transmit data or audio signals.
3. **RF receiver:** An RF receiver is a device that receives and decodes radio signals transmitted by an RF transmitter. It is commonly used to receive data or audio signals.
4. **Remote control unit constructed with 89c2051 controller chip:** It is a remote-control unit that uses an 89c2051 microcontroller chip to control devices wirelessly. The microcontroller chip acts as the brain of the remote-control unit, and it receives commands from the user and sends them to the main processing unit.
5. **Arduino Uno board:** It is a microcontroller board based on the Atmega328P microcontroller. It is commonly used in various applications, including robotics, automation, and IoT, to control and monitor devices.
6. **DTH11 sensor:** It is a digital temperature and humidity sensor that measures the surrounding temperature and humidity and provides digital output signals.
7. **MQ3 sensor:** It is a gas sensor that detects the presence of alcohol in the surrounding environment. It provides analog output signals that can be used to measure the alcohol concentration.
8. **Electromagnetic radiation circuit built with power transmitting coil with self-oscillator circuit built with power Z44 Mosfets:** It is a circuit that generates electromagnetic waves and transmits power wirelessly. It consists of a power transmitting coil and a self-oscillator circuit built with power Z44 Mosfets.
9. **Power receiving coil:** It is a coil that receives power wirelessly from the electromagnetic radiation circuit and converts it into electrical energy.
10. **Buzzer:** It is an electronic device that produces a buzzing or beeping sound when an electrical signal is applied.
11. **LCD:** It is a display device that uses liquid crystals to display information. It is commonly used in various applications, including digital watches, calculators, and electronic devices.
12. **Rechargeable battery with charger:** It is a battery that can be recharged and used multiple times. It is commonly used in various applications, including mobile phones, laptops, and electric vehicles.
13. **L293D H Bridge IC:** It is a motor driver IC that can control the speed and direction of DC motors. It is commonly used in various applications, including robotics and automation.
14. **GPS Tracker:** It is a device that uses Global Positioning System (GPS) technology to track the location of a person or object.
15. **V380 WIFI camera:** It is a wireless camera that can transmit video signals over Wi-Fi. It is commonly used for surveillance and security purposes.

Software Requirement:

1. **Arduino IDE:** We utilized the Arduino IDE to create the code functionality and upload it to the Arduino Uno. This software provides a text editor, toolbar, and menu bar to facilitate code writing and compiling. The text editor is referred to as a sketch, where the code is written, compiled, and uploaded to the Arduino. To establish a connection between the Arduino board and the IDE, the Genuine and Arduino board must be connected.
2. **Keil Software:** To dump code into a microcontroller using Keil software, one would need to create a new project and select the microcontroller. Write or import the code and build the project to generate a HEX file. Connect the microcontroller to the computer via a programmer or a serial port and configure the programmer settings in Keil. Load the HEX file into the programmer and program the microcontroller by clicking on the "Program" button. Once the programming is complete, disconnect the programmer from the microcontroller and power cycle the microcontroller.

Working of Proposed Model:

Electromagnetic Radiation Circuit:

In the electromagnetic circuit, a self-oscillator L-C tuned circuit is utilized to radiate electromagnetic pulses into the air through a power transmitting coil. This is achieved by constructing a self-oscillator circuit with Z44 power MOSFETs. These MOSFETs operate in a sequential manner, similar to a push-pull amplifier. When the circuit is

energized, it generates electromagnetic pulses with a frequency of 30 kHz, resulting in the generation and radiation of 30,000 magnetic pulses per second. The energy radiated from the power transmitting coil is unidirectional, and when the power receiving coil is positioned parallel to the transmitting coil, maximum energy can be acquired.

The power receiving coil is positioned on the bottom side of the vehicle. As the vehicle approaches the power transmitting coil, it receives electric energy in the form of high-frequency AC pulses. To rectify this noisy AC signal, a full wave bridge rectifier is employed. The rectified DC voltage is then filtered using a 1000 micro-Farad capacitor. Subsequently, the rectified DC voltage is fed to a buzzer, resulting in a loud sound when the vehicle is in close proximity to the power transmitting coil.

Toxic gases detecting circuit:

The circuit incorporates an MQ3 sensor, which is known as a universal sensor capable of detecting various toxic gases in the air, including petroleum and CO₂ (smoke). Its versatility in detecting different gases makes it referred to as a universal sensor. Primarily, the sensor is used to assess air quality, with an output voltage of approximately 1.5V indicating good air quality. In the case of poor air quality, the output voltage may exceed 1.5V, reaching up to 3.5V, depending on the air quality conditions.

The sensor's output is connected to the non-inverting input of an op-amp, utilizing the LM324 microcontroller. This microcontroller is a quad op-amp IC, housing four op-amps internally, but only one op-amp is utilized in this application. Op-amps typically consist of two inputs, namely the inverting and non-inverting inputs, and they find application in various circuits. In this project, the op-amp is employed as a voltage comparator.

The output from the sensor is compared to a reference voltage at the inverting input of the op-amp. When the sensor detects toxic gases in the air, its output voltage increases. Once this voltage surpasses the reference voltage, the output of the comparator automatically goes high. This high signal is then fed to an Arduino board programmed to store the data when it receives a high signal from the MQ3 sensor.

Remote Control Unit:

The circuit utilizes an 89c2051 microcontroller chip, which is an 8-bit IC with 2KB of internal ROM memory. To generate a high-frequency signal, an externally connected 11.0592 MHz crystal is used for frequency compensation of the internal oscillator. This enables the program stored in ROM to run at a high speed. Additionally, the microcontroller chip is interfaced with four control keys, allowing the generation of four different command codes. When a key is activated, an 8-bit digital code is generated from the output of the microcontroller chip. This digital code is then transmitted via an RF transmitter and receiver, both operating at a high frequency of 433MHz. Through the use of antennas, a communication link is established between the two devices. The digital code produced by the microcontroller chip is mixed with the 433MHz carrier frequency, resulting in the modulation of the signal before it is transmitted.

On the receiving end, another 89c2051 microcontroller decodes the received data. This microcontroller chip is programmed to independently control both motors through an H-Bridge IC, allowing the vehicle to move in all directions.

GPS Module Working:

We have used an Arduino Uno board as the main controller for the robot. The robot is equipped with a GPS module and an MQ3 sensor for detecting gases. The MQ3 sensor is a semiconductor sensor that can detect the presence of alcohol, benzene, propane, methane, and other gases. Whenever the MQ3 sensor detects the presence of gas, the buzzer will ring for 5 seconds, and the GPS coordinates will be displayed on the LCD screen.

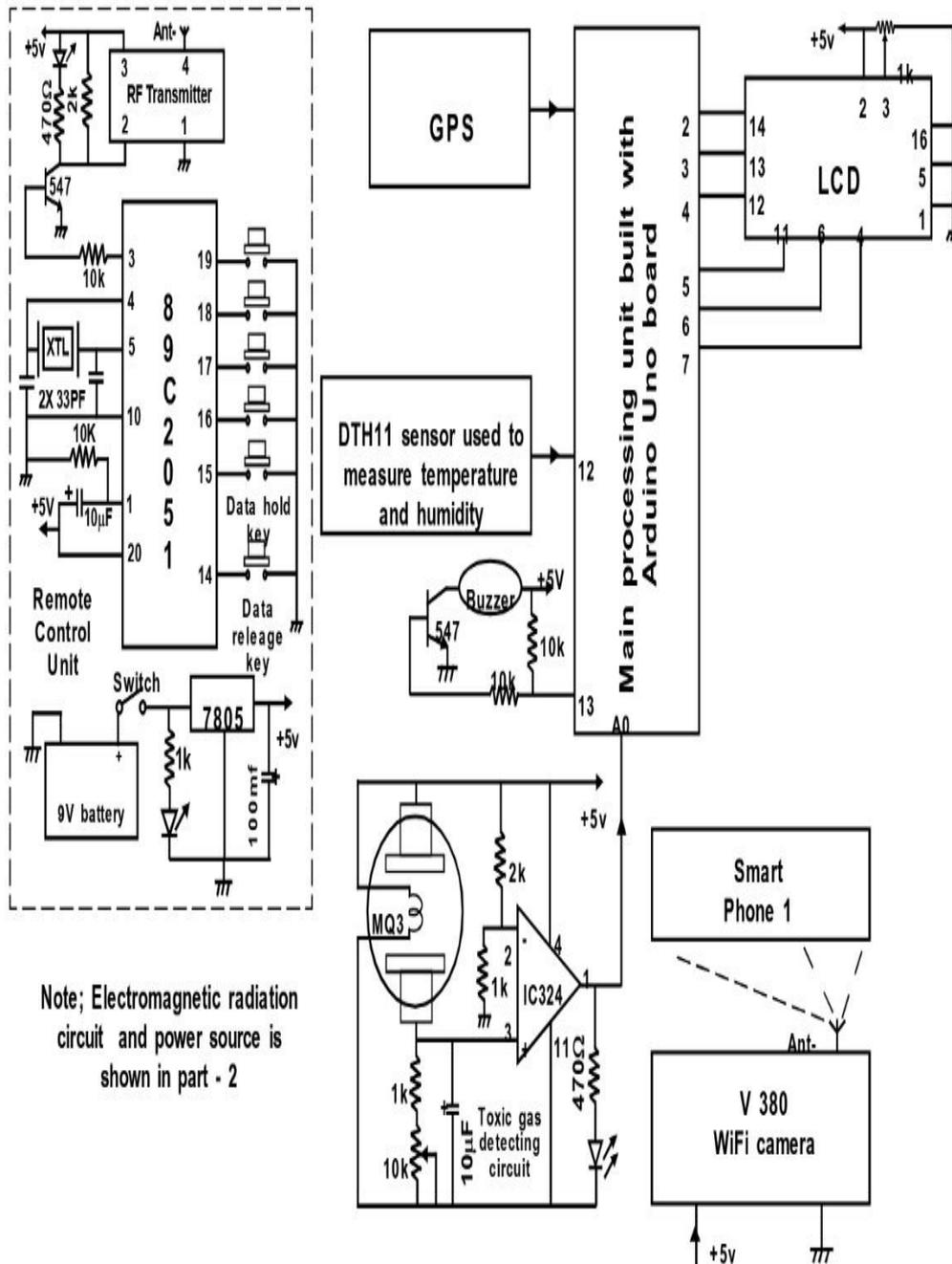
We have programmed the Arduino Uno board to store the GPS coordinates in the memory whenever the MQ3 sensor detects the presence of gas. The GPS coordinates will be displayed on the LCD screen until the user manually resets it. We have also designed the robot to be remotely controlled and monitored using a smartphone app called V380 pro. We can even take snapshot and record the surroundings with this wifi camera through V380 pro application connected with the camera.

WiFi Camera working:

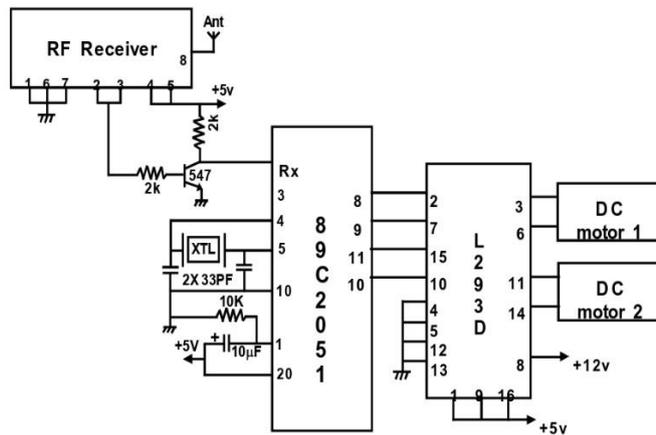
The V380 Pro camera needs to be connected to a power source for operation. After powering on, the camera initializes and goes into a setup mode. Using a smartphone or computer, you need to connect to the camera's WiFi network. The camera creates its own WiFi network, which you can join through the device's WiFi settings. Once connected to the camera's WiFi network, you can open the V380 Pro app on your smartphone or access the camera's web interface through a browser. Through the app or web interface, you can configure the camera's settings, including connecting it to your home or office WiFi network. After the camera is connected to your local WiFi network, you can access the live video feed from the camera through the V380 Pro app or web interface. The camera captures the video using its built-in lens and image sensor, and streams it over the WiFi network to your device.

The V380 Pro camera supports motion detection functionality. When enabled, the camera can detect movement in its field of view. If any motion is detected, the camera can send alerts to your smartphone, notifying you of the event. You can configure the sensitivity of the motion detection and customize the notification settings.

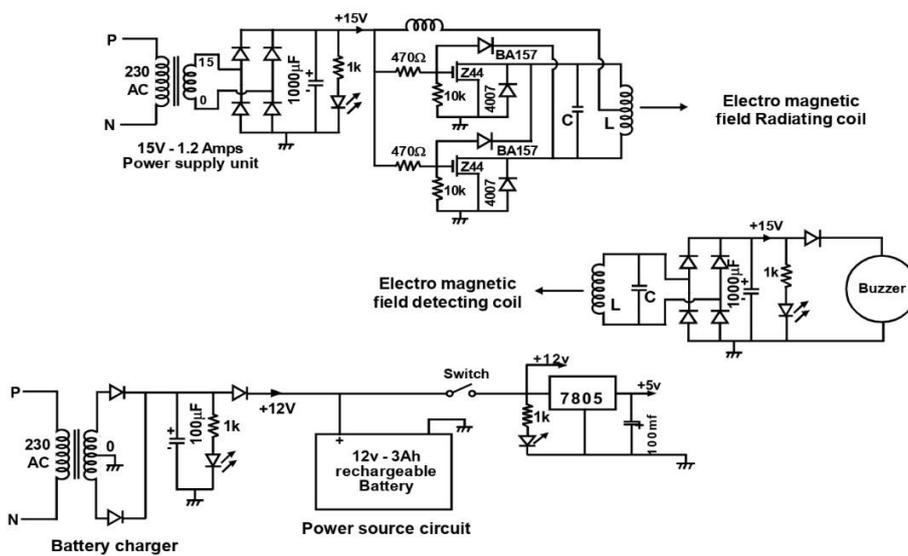




Intelligent Robot used to acquire data from radiation areas With WiFi camera - part 1



Robot control Circuit

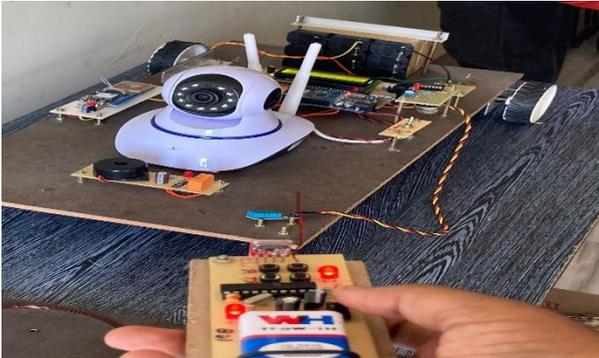
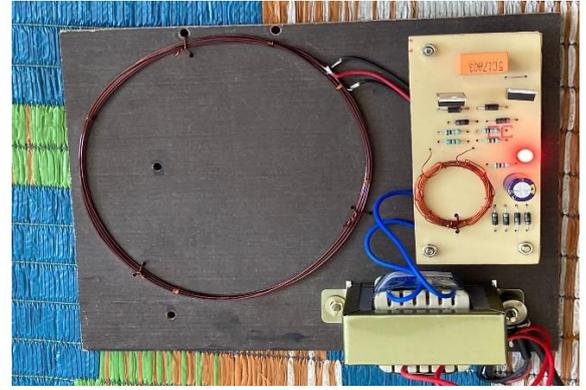
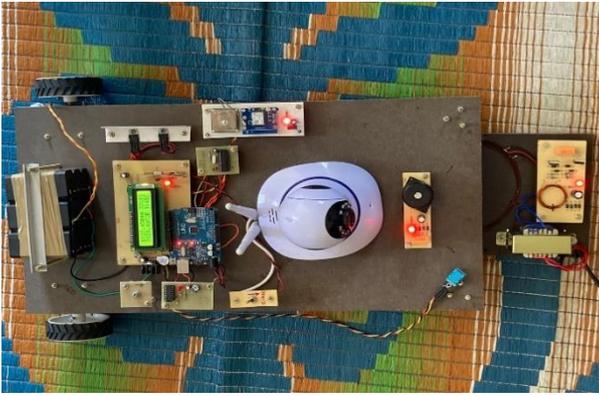


Intelligent Robot used to acquire data from radiation areas With WiFi camera - part 2

Result And Discussions:

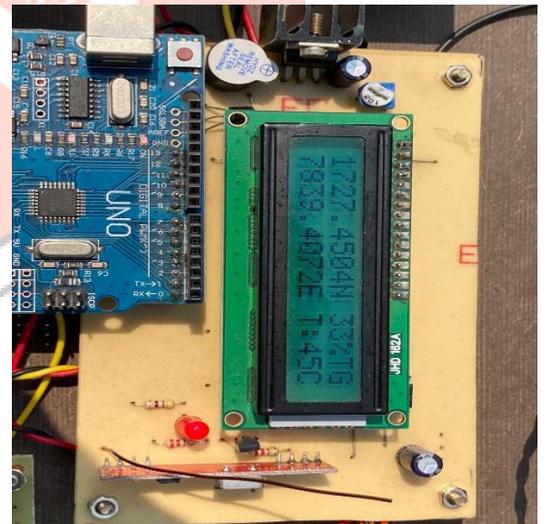
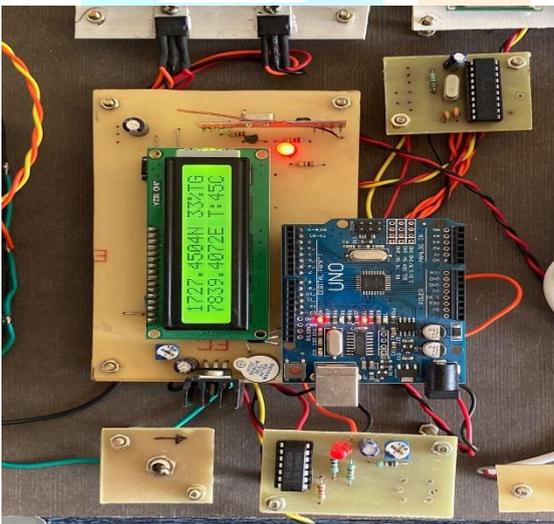
a. Electromagnetic Induction:

- Successfully implemented the concept of electromagnetic induction for prototype purposes.
- The circuit detects AC-induced current, which energizes the receiver circuit.
- Alert sound is generated through a buzzer upon detection of the induced current.



Environmental Sensing:

- Utilized DHT11 sensor to measure temperature and humidity of the surroundings.
- Incorporated MQ3 sensor to detect the presence of toxic gases in the environment.
- Obtained real-time data on temperature, humidity, and toxic gas percentage.

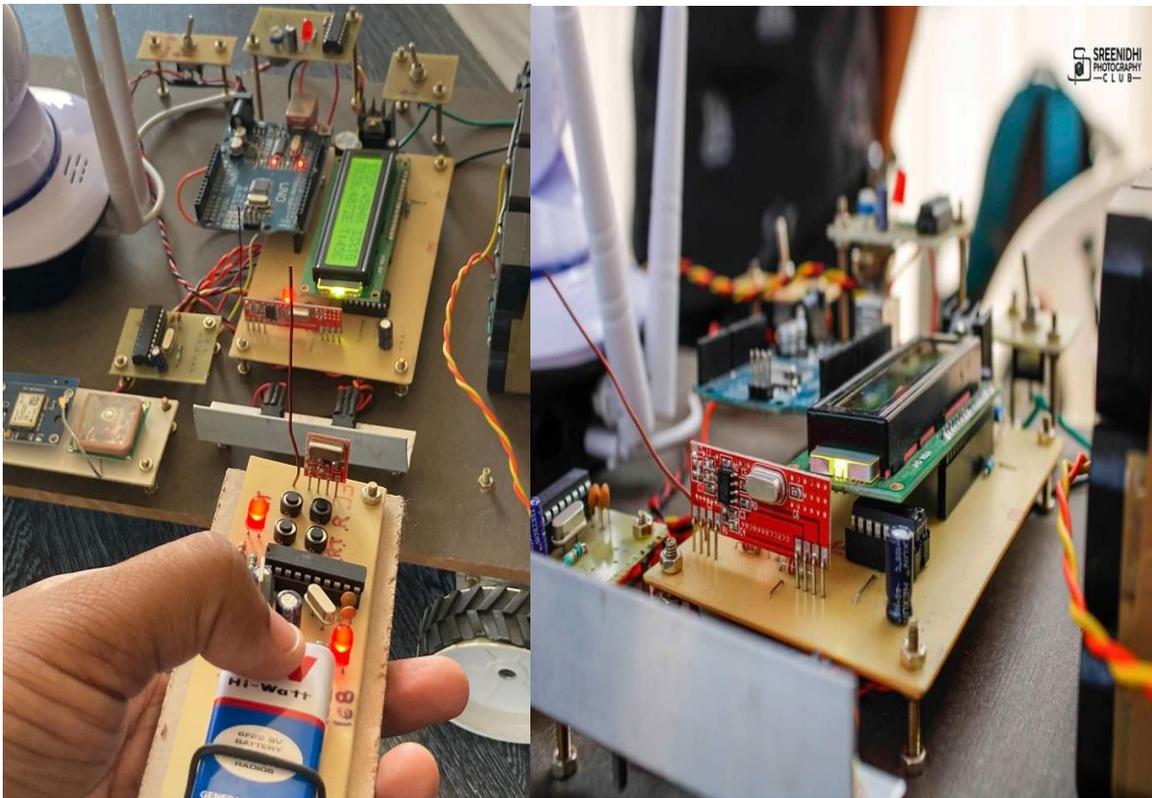


c. GPS Tracking:

- Integrated a GPS module to track the robot's location when it detects gas in the field.
- Captured and stored location coordinates corresponding to the detected gas points.
- Displayed location coordinates, humidity, and toxic gas percentage on an LCD board.

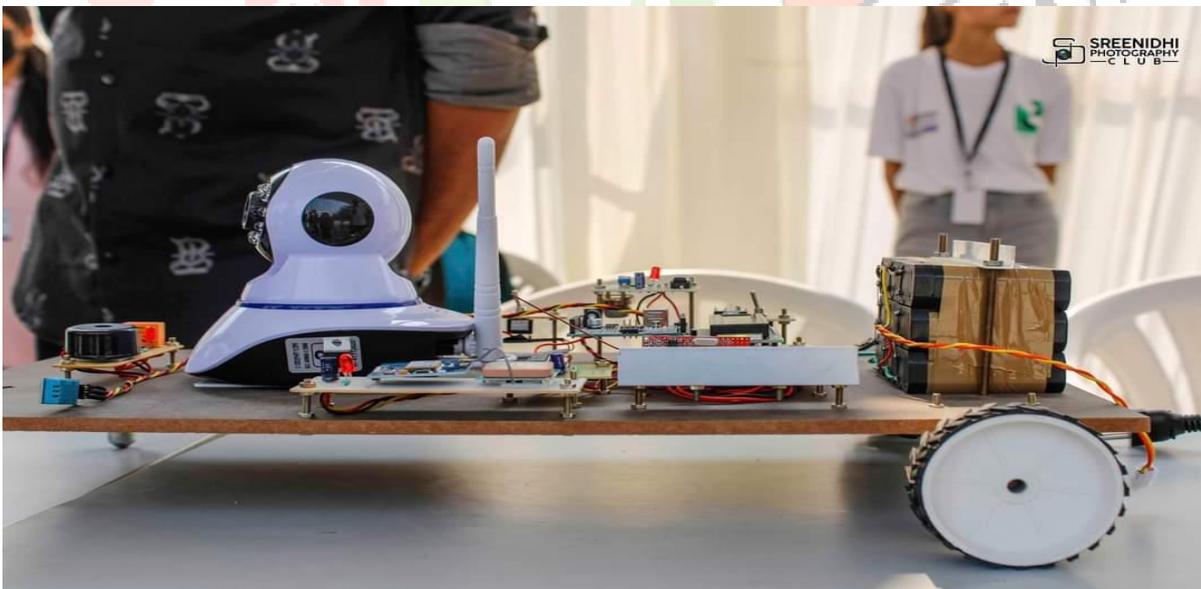
d. Remote Control and Monitoring:

- Employed RF technology with an 89c2051 microcontroller for remote control of the robot.
- Enabled independent control of DC motors through a microcontroller-driven H-bridge.
- Utilized a V380 Pro Wi-Fi camera connected to a smartphone for remote monitoring of the surrounding field.



Conclusion:

In conclusion, our project focused on developing a smart surveillance robot for use in hazardous fields and radiation-affected areas. We successfully implemented various technologies and components to enhance the robot's functionality and ensure operator safety. Our smart surveillance robot demonstrated its effectiveness in hazardous fields and radiation-affected areas. The implementation of electromagnetic induction, environmental sensors, GPS tracking, remote control via RF technology, and the Wi-Fi camera all contributed to its robust functionality. This project highlights the potential for intelligent robotic systems to improve safety and surveillance in high-risk environments. Further research and development could lead to even more advanced features and applications in the future.



Future Scope:

The future scope of our project "Intelligent Robot used to acquire data from Radiation areas with Wifi Camera" is vast and holds immense potential for advancements in safety and surveillance in high-risk environments. Some key areas for future development include enhanced sensor integration, autonomous navigation, machine learning and artificial intelligence, robotic arm integration, wireless communication and networking, energy efficiency and power management, data fusion and visualization, integration with cloud services, collaboration with emergency response

systems, and real-world deployment and testing. By incorporating these advancements, the smart surveillance robot can become a highly advanced tool capable of effectively navigating and monitoring hazardous environments, mitigating risks, and providing critical support to operators in real-time. These developments have the potential to revolutionize industries such as nuclear energy, chemical manufacturing, disaster response, and more, ultimately enhancing safety, efficiency, and effectiveness in high-risk settings.

References:

- [1] Jignesh Patolia, Haard Mehta, Hitesh Patel, Patel V. T. "Arduino Controlled War Field Spy Robot Using Night Vision Camera and Android Application," in 5th Nirma University International Conference on Engineering (NUiCONE), 2015.
- [2] G. Anandravisekar, A. Anto Clinton, T. Mukesh Raj, L. Naveen, M. Mahendran, "IOT based Surveillance Robot," International Journal of Engineering Research & Technology (IJERT), 2018.
- [3] Mohammad Shoeb Shah, P.B. Barole. "Surveillance and Rescue Robot Using Android Smart Phone and Internet," in International Conference on Communication and Signal Processing, India, 2016.
- [4] Diksha Singh, Pooja Zaware, Anil Nadgaonkar, "Wi-Fi Surveillance Bot with Real Time Audio & Video Streaming Through Android Mobile," in 2nd IEEE International Conference On Recent Trends in Electronics Information & Communication Technology" (RTEICT), May 19-20, 2017, India.
- [5] Vanitha, M. Selvalakshmi, R. Selvarasu, "Monitoring and Controlling of Mobile Robot Via Internet Through Raspberry PI Board," in Second International Conference on Science Technology Engineering and Management (ICONSTEM), 2016.
- [6] Ghanem Osman Elhaj Abdalla, T. Veeramanikandasamy, "Implementation of Spy Robot for A Surveillance System using Internet Protocol of Raspberry Pi," in 2017 2nd IEEE International Conference On Recent Trends in Electronics Information & Communication Technology, May 19-20, 2017.
- [7] V. Ramya and T. Akilan, "Embedded Controller for Intelligent Driver Assistant in Automatic System," International Journal of Applied Engineering Research, Vol. 10, No. 5, 2015, pp. 531-537.
- [8] V. Ramya, T. Akilan and N. Vignesh, "Designing an Embedded System for Autonomous Building Map Exploration Robot," International Journal of Computer Applications, Vol. 73, No. 10, July 2013, pp. 11-17.
- [9] Nazirah Ahmad Zaini, Norliza Zaini, Mohd Fuad Abdul Latip, Nabilah Hamzah, "Remote Monitoring System based on a Wi-Fi Controlled Car Using Raspberry Pi," in IEEE Conference on Systems, Process and Control (ICSPC 2016), 16-18, December 2016.
- [10] K. RajKumar, C. Saravana Kumar, C. Yuvashree, Senthil Murugan, "Portable Surveillance Robot using IoT," International Research Journal of Engineering and Technology (IRJET)", March 2019