IJCRT.ORG ISSN : 2320-2882

INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)

An International Open Access, Peer-reviewed, Refereed Journal

UGV ROVER FOR HAZARD MANAGEMENT IN POWER AND FUEL SECTOR

[1]Ravisimha B N, [2]Jhansi V Jain, [3]Harish S N, [4]Manu P Gowda

[1]Assistant Professor, [2]UG Student, [3]UG Student, [4]UG Student

[1]Electronics and Communication Engineering,

[1]Sri Siddhartha Institute of Technology SSAHE, Tumkur, India

Abstract: The power and fuel sectors face critical safety hazards like gas leaks, fires, and toxic spills, endangering human life and the environment. To address these risks, this project presents a semi-automated Unmanned Ground Vehicle (UGV) for hazard detection and management. Equipped with a live-streaming camera, Receiver, ESP, DC gear motors, and rubber-treaded wheels, the rover enables real-time navigation and monitoring. Controlled remotely via a user-operated transmitter. Integrated sensors for gas, temperature and humidity expand its environmental monitoring capabilities. The system is designed using 3D-printer for durability and robust motor mounts, ensures mobility over uneven terrain. Powered by a rechargeable battery, this solution reduces human exposure to danger, supporting safer and more efficient operations in the power and fuel industries.

***Index Terms* - Hazard Detection, Unmanned Ground Vehicle (UGV), Real-time Monitoring, User-operated.**

I. INTRODUCTION

The power and fuel industries, vital to modern infrastructure and economic growth, often face hazardous conditions such as gas leaks, fires, and toxic spills. These incidents threaten human safety, disrupt operations, and harm the environment. Traditional safety methods, relying on manual inspections, expose personnel to significant risks. With growing industrial complexity, there is an increasing need for intelligent, remotely operated solutions to monitor and manage hazards effectively.To overcome the challenge, the proposed project presents a semi-automated Unmanned Ground Vehicle (UGV) designed for hazard detection and management in high-risk environments. Combining real-time monitoring with intelligent sensing, the UGV enhances situational awareness and supports proactive risk management. Operated remotely, it minimizes human exposure, enables continuous environmental monitoring, and is suitable for applications such as industrial inspection, hazardous material detection, and search and rescue. The system offers a safer, more efficient approach to managing industrial safety challenges.

II. MOTIVATION

Oil, gas refineries, and chemical plants face significant safety hazards, including leaks, explosions, and equipment failures, which pose severe risks to personnel and operations. Implementing automated safety protocols and maintenance systems helps minimize human exposure in hazardous areas by ensuring continuous monitoring and accident prevention. Advanced monitoring solutions further enhance safety by detecting hazards early, improving operational efficiency, and reducing risks in these high-risk industrial environments.

III. OBJECTIVES

- Design a UGV for hazardous environments: Create a durable vehicle capable of performing maintenance tasks safely in high-risk, challenging areas.
- Suitable for multiple industries: Adapt the UGV for use in oil refineries, chemical plants, fuel industries, and power plants, ensuring versatility.
- Equipped with advanced sensors: Integrate modern sensors for monitoring gas levels, temperature, and structural conditions, providing real-time data in hazardous zones.

IV.PROBLEM STATEMENT

Maintenance in hazardous environments exposes workers to risks such as toxic gases, radiation, and extreme temperatures. While Unmanned Ground Vehicles (UGVs) help reduce human exposure, they still face operational challenges. Many existing UGVs lack the durability needed for industrial settings, making them vulnerable to wear and damage caused by harsh conditions, including high temperatures, constant vibrations, and debris.

V.PROPOSED SYSTEM

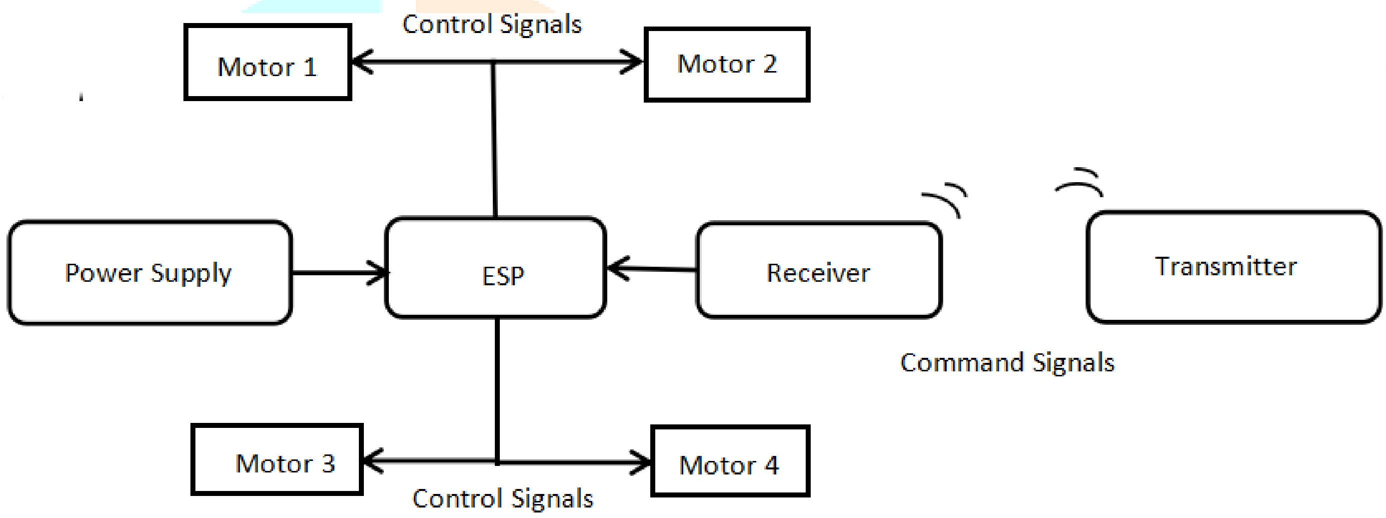

Fig.1: Rover Control system

The rover control system is illustrated in Fig.1, the transmitter sends control signals wirelessly to the receiver, which then forwards these signal to the ESP (microcontroller). The ESP processes these signals and uses them to control four motors: Motor 1, Motor 2, Motor 3, and Motor 4. A power supply is connected to the ESP, supplying it with the required voltage for functioning. The receiver derives its power from the ESP. The ESP acts as the central control unit, coordinating motor movements based on the received instructions. Each motor responds according to the specific command delivered through the transmitter.

The hazard detection system in the rover integrates environmental monitoring and video surveillance in a compact setup as shown in Fig.2. The gas sensor (MQ135) and the temperature-humidity sensor (DTH11) send its data to the ESP8266 microcontroller. The ESP8266 processes this data and transmits it wirelessly to a display for monitoring. The Blynk app is used to view the sensor readings remotely. A power bank is connected to supply power to both the ESP8266 and the Wi-Fi camera. The camera captures live video and sends it to a separate display. The video stream can be accessed using the Ezykam+ app.

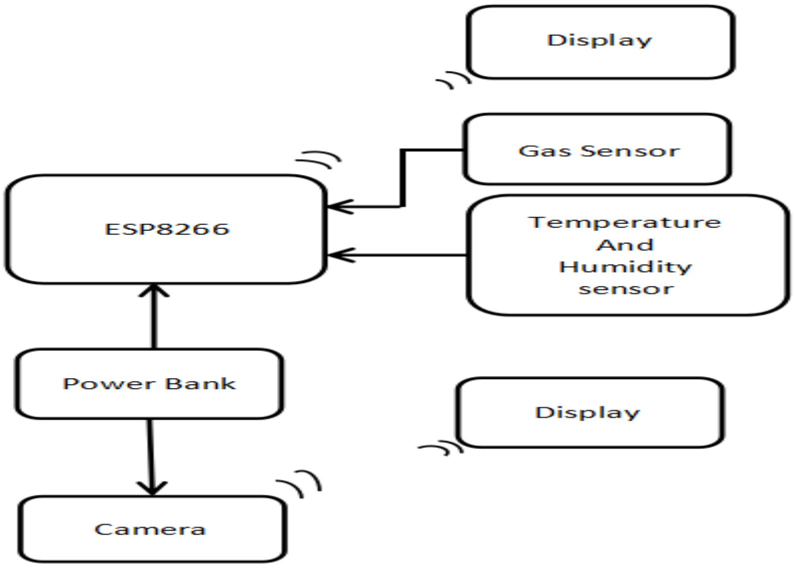

Fig.2: Hazard Detection System

VI. METHODOLOGY

The methodology involves utilizing a microcontroller to integrate wireless communication, data collection from sensors, actuator control, and real-time transmission of information for monitoring and automation.

- **Signal Transmission:**The process begins with signal transmission. A transmitter sends wireless control signals to a receiver connected to the ESP.
- **Motor Control:** The ESP processes these signals and controls four motors accordingly, powered by a battery.
- **Sensor Monitoring:** The ESP8266 collects data from gas sensor (MQ135), temperature, and humidity sensor (DTH11).
- **Power Management:** A power bank supplies power to the ESP8266 and a Wi-Fi camera module.
- **Data and Video Output:** The ESP8266 transmits sensor data wirelessly to a display, while the camera feed is shown on a separate display.

VII. SYSTEM REQUIREMENTS

Hardware Requirements

- **ESP:** A low-cost microcontroller with Wi-Fi and Bluetooth capabilities.
- **Power Supply:** A device that provides electrical power to circuits or electronic devices.
- **Receiver:** A device that receives signals, typically radio or wireless, and converts them into usable data.
- **Transmitter:** A device that sends out signals or data wirelessly over a communication medium.
- **Power Bank:** A portable battery device used to charge electronic gadgets on the go.
- **ESP8266:** Microcontroller chips with built-in Wi-Fi and Bluetooth.
- **Gas Sensor** (MQ135)**:** A sensor that detects the presence and concentration of gases in the environment.
- **Temperature and Humidity sensor** (DTH11)**:** It simultaneously measures the ambient heat level (temperature) and moisture content (humidity) in the air.
- **Display** (Laptop and mobile): It is used to monitor the situation visually.

Software Requirements

- **Blynk:** Blynk is an IoT platform that allows real-time control and monitoring of hardware using a mobile app with a drag-and-drop interface.
- **EZYKAM+:** EZYKAM+ is a surveillance app for streaming live video from Wi-Fi cameras, used for remote monitoring and security.
- **Arduino IDE:** Arduino IDE is a software platform used to write, compile, and upload code to Arduino-compatible boards like the ESP8266.

VIII. SYSTEM IMPLEMENTATION

The system begins by powering on the components. A power bank is used to supply power to the ESP8266 microcontroller and the Wi-Fi-enabled camera, while a separate LiPo battery provides power to the DC motors through a motor driver module. The movement of the rover is controlled manually using an transmitter, which sends directional commands like forward, backward, left, right, and stop. These commands are received by an receiver on the rover, which forwards the signals to the ESP module. The ESP processes these control inputs and sends appropriate signals to the motor driver module, which in turn drives the motors accordingly. As the rover moves, the ESP8266 continuously reads data from two sensors: a gas sensor for detecting hazardous gases and a temperature & humidity sensor for monitoring environmental conditions. The collected sensor data is transmitted in real time to the Blynk mobile application, allowing the user to remotely observe gas levels and atmospheric conditions. Simultaneously, the Wi-Fi camera, powered by the power bank, captures live video or images. This video feed is wirelessly transmitted through the Ezykam+ app, enabling the user to visually monitor the rover's surroundings from a remote location. The rover continues moving while transmitting both environmental and visual data until the user sends a stop command through the transmitter. Upon receiving the stop signal, the ESP halts the motors through the motor driver, and the system stops all operations. This process ensures safe and effective remote navigation, environmental sensing, and visual surveillance in real-world conditions. The detailed flow of this operation is presented in Fig.3.

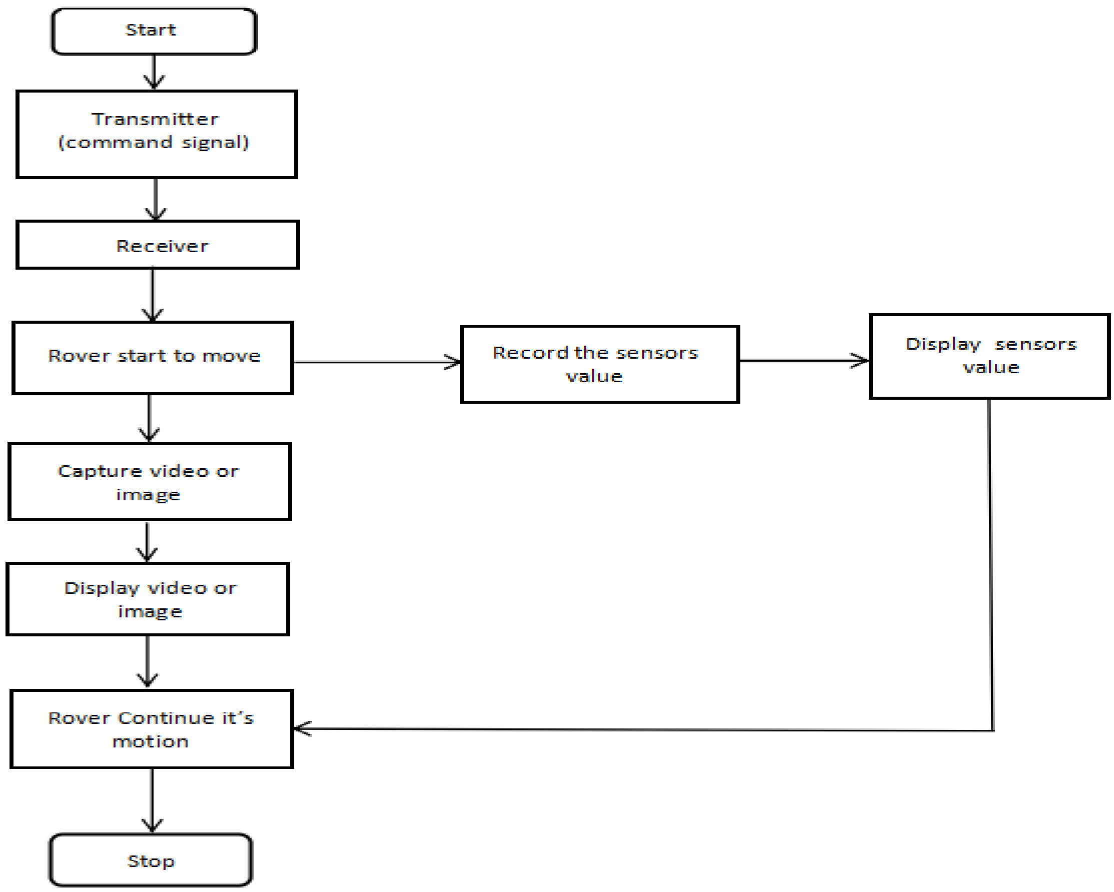

Fig.3: Flowchart of the rover

IX. RESULTS AND DISCUSSION

Fig.4: Snapshot of the proposed system

The proposed system has been successfully developed, integrating a Wi-Fi camera for real-time monitoring, along with gas, temperature, and humidity sensors to capture environmental data. It is equipped with rubber-treaded wheels for navigating complex spaces, and the structure is designed using a 3D printer to ensure durability, as shown in Fig.4.

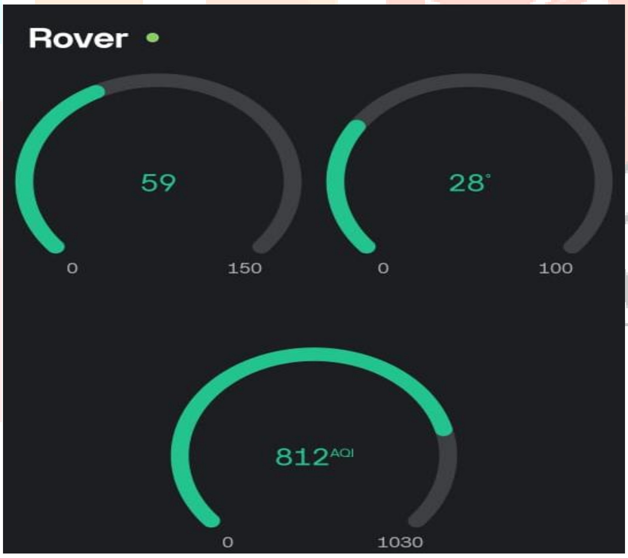

Fig.5: Sensors reading in blynk app

Real-time environmental data from the rover sensors is displayed through the blynk application as shown in Fig.5. In figure first reading shows gas sensor value in the range of 0 to 150, it shows 59. Second reading shows temperature value in the range of 0 to 100, it shows 28 degree and third reading shows humidity value in the range of 0 to 1030, it shows 812AQI.

Fig.6: Real-time video captured by Wi-Fi

Fig.7: Video recorded during night vision

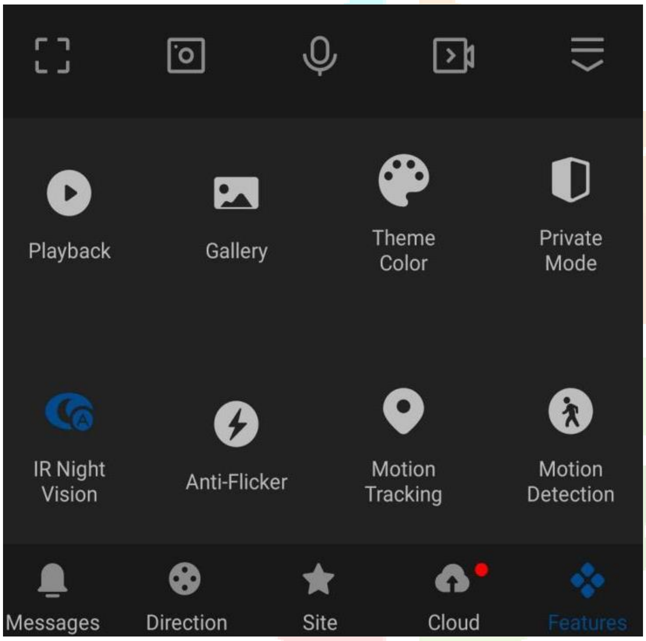

Fig.8: Features in EZYKAM+ app

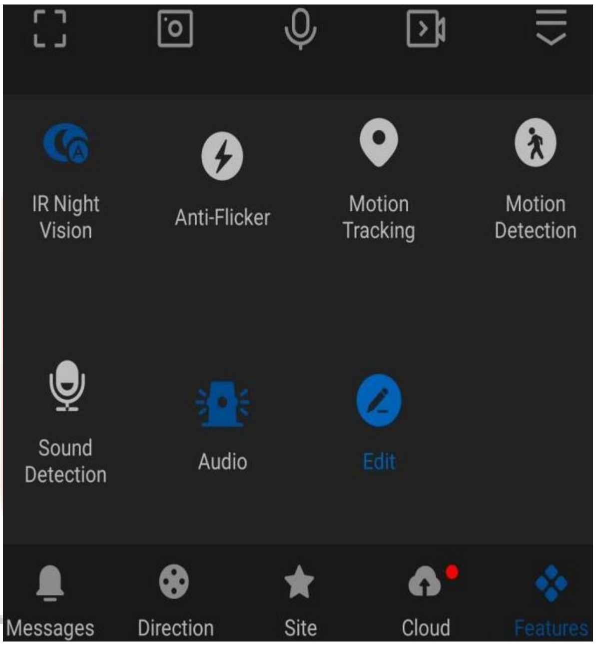

Fig.9: Features in EZYKAM+ app

In Fig.6,it shows the real-time video captured by the Wi-Fi camera. The camera is capable of rotating 360 degrees to provide a comprehensive view, with a video resolution of 1080p. It also supports night-time operation through IR night vision, as illustrated in Fig.7. Video monitoring is performed using the Ezykam+ app, which offers various features such as audio support and motion detection, as shown in Fig.8 and 9. The results demonstrate that the proposed system effectively enables real-time environmental monitoring and surveillance, combining reliable sensor data with robust camera functionality.

X. MERITS

- **Enhanced Safety:** Avoids human exposure to hazards.
- **Real-time Monitoring & Data Collection:** By continuous data via cameras and sensors monitors the situation.
- **Proactive Risk Management:** Detects hazards before accidents occur.
- **Remote Operation:** UGV controlled remotely with feedback.

XI. DEMERITS

- **Signal Interference Issues:** Wireless signals may face disruptions.

XII. CONCLUSION

The proposed system has been successfully developed and demonstrated as an effective solution for real-time environmental monitoring and hazard detection in high-risk industrial environments. By integrating gas, temperature, and humidity sensors along with a 360-degree Wi-Fi camera equipped with night vision, the system ensures enhanced situational awareness, reduced human risk, and efficient remote operation. Real-time data visualization through the Blynk and Ezykam+ apps further supports proactive decision-making and safety management.

Future Enhancement

Future developments may include the integration of advanced AI algorithms for autonomous navigation and hazard classification, long-range communication modules for extended remote operation, and the addition of robotic arms for material handling or emergency response tasks, thereby broadening its applicability in disaster management and industrial automation.

XIII. REFERENCES

[1] Krupakar, C. Sankeerth, M. Akash, D. Velamala and H. B. Valiveti, "Design and Analysis of Dual Mobility Drone-Rover System for Disaster Management Scenarios," Fourth International Conference on Advances in Electrical, Computing, Communication and Sustainable Technologies (ICAECT), Bhilai, India, 2024.
[2] C. Makkena, P. P S, P. Tammana, P. Chandrahas and R. Pachamuthu, "Real-Time Object Detection as a Service for UGVs Using Edge Cloud," 2024 16th International Conference on COMmunication Systems & NETworkS (COMSNETS), Bengaluru, India, 2024.
[3] Althani, R. Salim, M. M. Anzil, P. Subramaniam, K. Almaeeni and A. Shukla, "Design and Implementation of a Locomotion Suspension System for a Desert Terrain UGV," 2023 9th International Conference on Automation, Robotics and Applications (ICARA), Abu Dhabi, United Arab Emirates.
[4] Design of Autonomous Unmanned Ground Vehicles (UGVs) in Smart Agriculture Yogesh Gangurde, S Syam Narayanan, P Rajalakshmi, Naga Praveen Babu MannamPredictive Analytics in Smart Agriculture, 275-298, 2023.
[5] Pasini, C. Jiang and M. -P. Jolly, "UAV and UGV Autonomous Cooperation for Wildfire Hotspot Surveillance," 2022 IEEE MIT Undergraduate Research Technology Conference (URTC), Cambridge, MA, USA, 2022.
[6] “Mini Rover-Object Detecting Ground Vehicle (UGV)”, Syed Hadi Hussain, Arif Hussain, Raza Hussain Shah,Safdar Ali Abro,University of Sindh Journal of Information and Communication Technology 3 (2), 104-108, 2019.
[7] “Unmanned and autonomous ground vehicle”, S George Fernandez, K Vijayakumar, R Palanisamy, K Selvakumar,D Karthikeyan, D Selvabharathi, S Vidyasagar, V Kalyanasundhram, International Journal of Electrical and Computer Engineering 9 (5), 4466, 2019.
[8] “Inspection robots in oil and gas industry: a review of current solutions and future trends”, Leijian Yu, Erfu Yang,Peng Ren, Cai Luo, Gordon Dobie, Dongbing Gu, Xiutian Yan 2019 25th International Conference on Automation and Computing (ICAC), 1-6, 2019.
[9] “Design & Implementation of an Unmanned Ground Vehicle (UGV) Surveillance Robot”, Md Ajijul Bin Zabbar, Chisty Nafiz Ahmed,International Journal of Electrical and Electronics Engineering (IJEEE) 5 (6), 2278-9944, 2016.
[10] “Mechatronics design of an unmanned ground vehicle for military applications”,Pekka Appelqvist, Jere Knuuttila, Juhana AhtiainenMechatronic Systems Applications, 237-262, 2010.