

RESCUE ROVER: ALL-TERRAIN EMERGENCY RESPONSE AND EXPLORATION VEHICLE

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Keywords:

Human-following robot, Arduino, Ultrasonic sensors, Infrared sensors, Assistive robotics, Automation, Object tracking.

Introduction: In emergencies, quick response is vital to save lives. Traditional rescue vehicles struggle in harsh terrains like rubble, mud, or floods. All-Terrain Rescue Vehicles (ATVs) are built to handle such extreme environments. They play a crucial role in disaster response, search-and-rescue, and evacuations. ATVs feature rugged builds, strong suspension, and high-grip tires for stability. Advanced tech like GPS, thermal imaging, and real-time communication enhance effectiveness. They ensure better coordination with command centers and help locate victims faster. This project aims to improve current ATV designs by addressing key limitations. Innovative upgrades will boost efficiency, adaptability, and resilience in rescue missions. Enhanced ATVs will set new benchmarks for emergency response standards.

Objectives:

1.Enhanced Emergency Response and Real-Time Communication

- Develop a rugged, remote-controlled rescue vehicle capable of navigating tough terrains in disaster zones.
- Enable real-time video, two-way audio, and GPS tracking to improve coordination, communication, and safety during rescue missions.

2. Autonomous Navigation and Power Efficiency

- Incorporate efficient power management (e.g., 18650 battery pack) for extended operation and remote control via Bluetooth.
- Lay the foundation for future autonomous features like obstacle avoidance and smart path planning.

3. Versatile Design and Broader Impact

- Build a durable, modular system adaptable to various missions and conditions.
- Promote education and cross-sector applications in defense, agriculture, infrastructure inspection, and more.

Methodology:

The **Rescue Rover** combines hardware and software systems to navigate tough terrains, stream real-time video, and support rescue operations. Its main features are:

1. **Power Supply:** Powered by a 18650 battery pack, regulated by an LP2983D driver for stable voltage across all components.
2. **Motor Control:** Uses six DC gear motors driven by an L298N motor driver. Controlled by the ESP32-CAM module based on received commands.
3. **Remote Operation:** Operated via Bluetooth (HC-05), allowing smartphone or controller-based input for movement, lights, and camera.
4. **Live Video Feed:** ESP32-CAM streams real-time video to the controller and saves footage to a memory card for later review.
5. **GPS Tracking:** The GPS module relays live location data to help navigate and track the vehicle in real-time.
6. **Two-Way Audio:** Equipped with a microphone and speaker to enable communication between rescuers and potential survivors.
7. **LED Lighting:** Remotely controlled LEDs provide visibility in dark areas and act as indicators during missions.

8. **Central Control:** Arduino Uno handles sensor input, command execution, and motor control, ensuring real-time decision-making.
9. **Terrain Adaptability:** Designed to move over rough, muddy, and uneven surfaces without losing stability or control.
10. **Safety Features:** Includes options for automatic shutdown or manual override to prevent danger or halt the rover in emergencies.

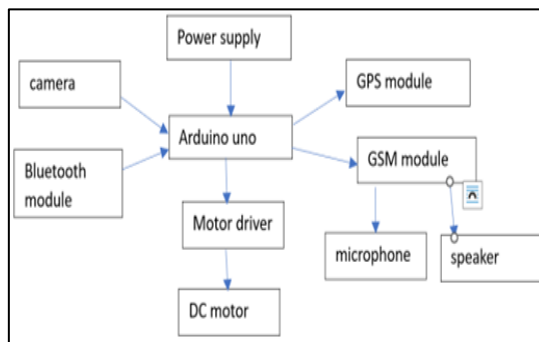


Fig 1. Block diagram

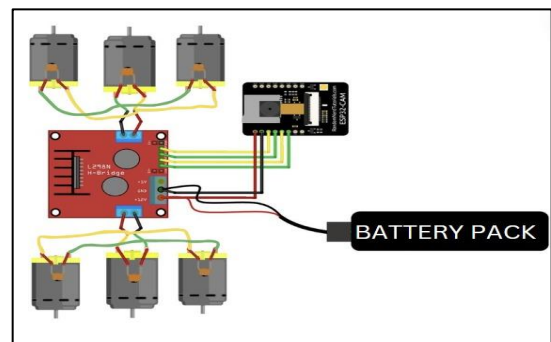


Fig 2. Circuit diagram

Result and Conclusion:

The all-terrain rescue vehicle (ATV) was developed to tackle key challenges in disaster relief. Early project phases faced software bugs and hardware issues that affected performance. Through iterative testing and improvements, the team created a reliable, efficient system. The ATV can now navigate rubble, mud, and steep terrains with strong mobility. Integrated sensors and communication systems enable quick victim detection and response. Stable communication ensures smooth coordination with rescue teams during emergencies. The ATV overcomes limitations of traditional rescue vehicles in critical situations. It enhances both speed and effectiveness in locating and reaching casualties. This project proves the ATV's value in strengthening disaster management strategies. Its success signals improved preparedness and quicker responses in future crises.

Future Scope:

The future scope of this project includes:

1. **Hydraulic Arm Integration:**

Add hydraulic arms for tasks like debris removal, object handling, and vehicle transfer, enhancing versatility.

2. **Autonomous Navigation:**

Use AI and machine learning for real-time decision-making, obstacle avoidance, and adaptive path planning in dynamic environments.

3. **Advanced Sensor Suite:**

Implement sensors for early warning, structural instability detection, hazardous material identification, and environmental monitoring (temperature, humidity, air quality).

4. **Humanitarian Support:**

Enable delivery of medical supplies, food, and essentials to remote/disaster-affected areas and assist in infrastructure assessment (e.g., bridges, roads).

5. **Environmental Adaptability:**

Improve performance in extreme weather and diverse terrains (rain, snow, heat, deserts, forests, mountains).

6. **Disaster Mitigation and Recovery:**

Enhance the ATV's role in disaster response, recovery, and community support, helping protect lives and infrastructure.