



VIT-AP  
UNIVERSITY

# PROJECT CERBERUS

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ROBOTICS COMPETITION



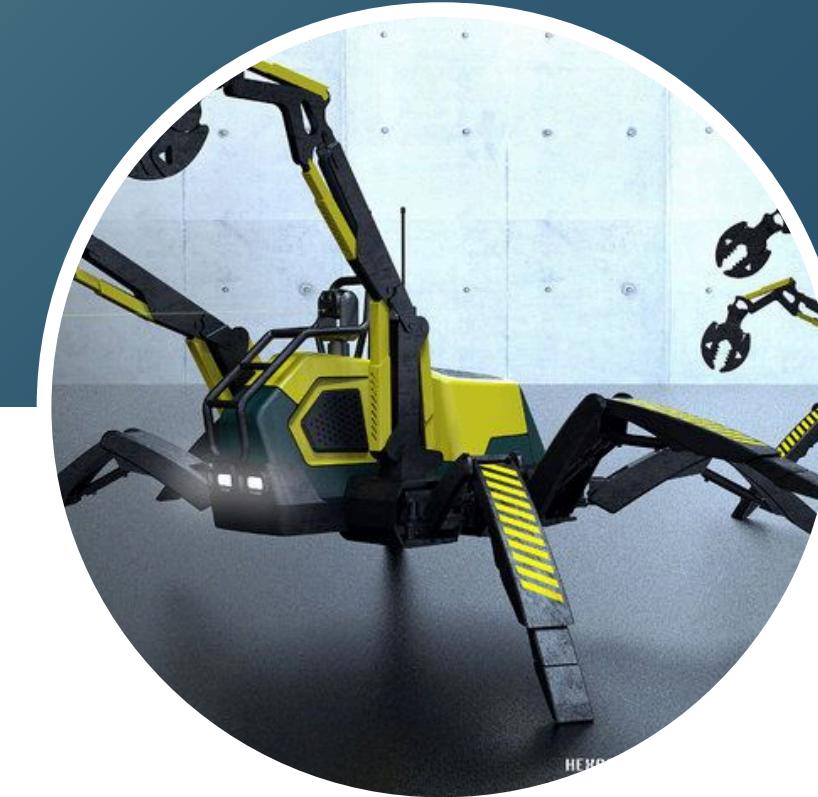
# Content

**Title - Project Cerberus:  
A Multi-Phase Robotics Solution for  
Disaster Management and Surveillance**

**Team - Khushi Mishra (22BME7015)  
Priyanshu Rituraj (22BME7017)**

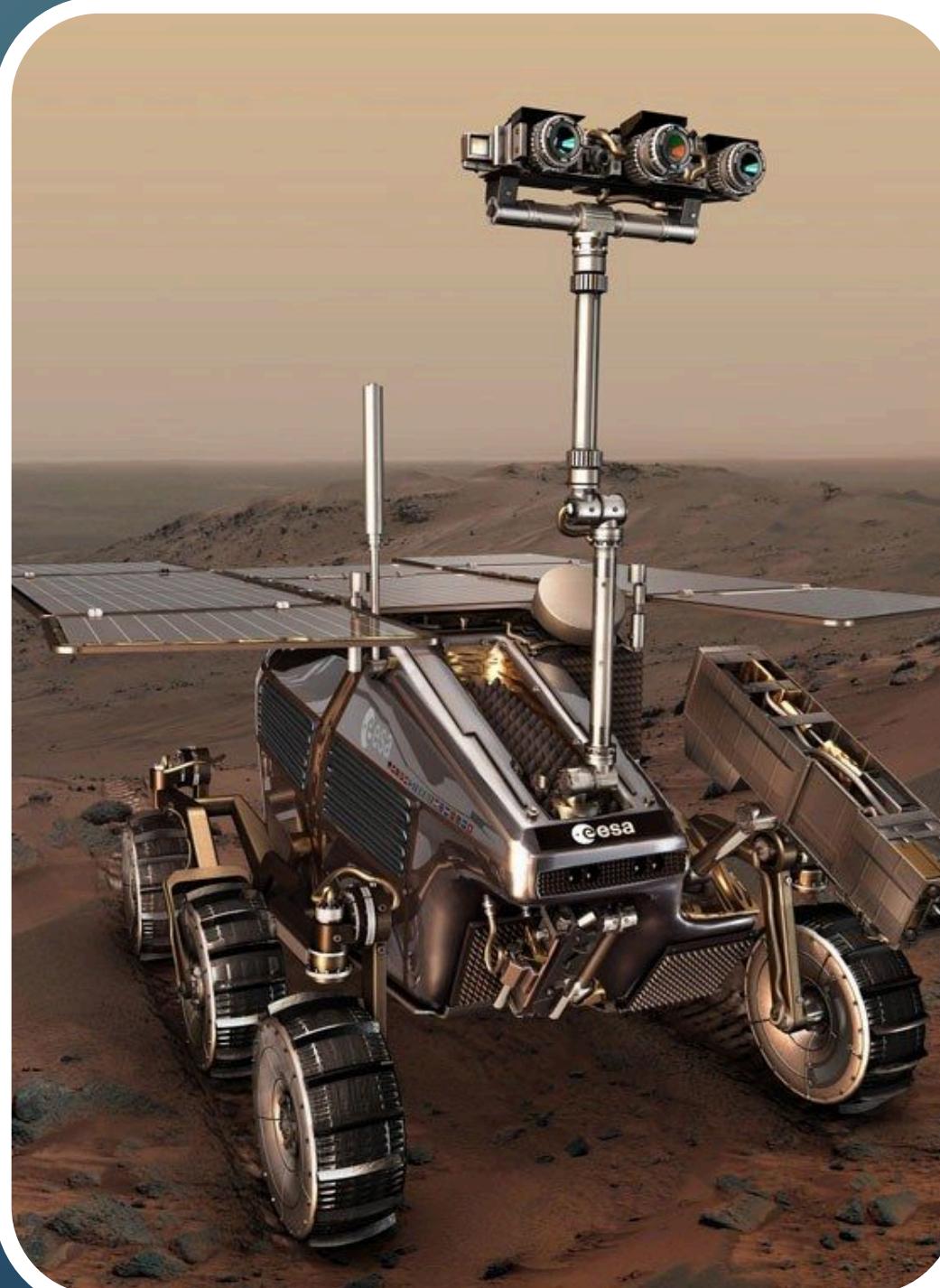
**Event - Robotics Competition**

**Date - 13th - 15th December**



## Problem Statement

Natural disasters, such as earthquakes and landslides, pose critical challenges to search-and-rescue operations. These challenges include inaccessibility of disaster zones, significant time delays in response, and high risks to human rescuers. Focus on developing ideas that can surpass these boundaries and improve current scenario.



# Our Vision

To address the challenges of disaster rescue operations, we propose a multi-phase robotic rescue system that leverages advanced drones and robotic technology to ensure efficient, timely, and safe rescue missions. The system is designed to operate in a coordinated manner across the following phases:

- Phase 1: Aerial Surveillance
- Phase 2: Land Robot Deployment
- Phase 3: Drone-Guided Navigation
- Phase 4: On-Site Medical Assistance
- Phase 5: Nursing Bots



# Phase 1: Aerial Surveillance

Aerial Surveillance with Drones – High-tech drones equipped with infrared (IR) sensors are deployed immediately after a disaster to survey the affected area. These drones identify high-population-density regions and provide real-time data for prioritizing rescue efforts.

# Phase 2: Deployment of Land Robots

Robust land robots are deployed through accessible paths or underground tunnels to navigate the disaster zone. These robots are equipped with sensors and communication systems to locate victims, relay their precise locations, and assess their conditions.



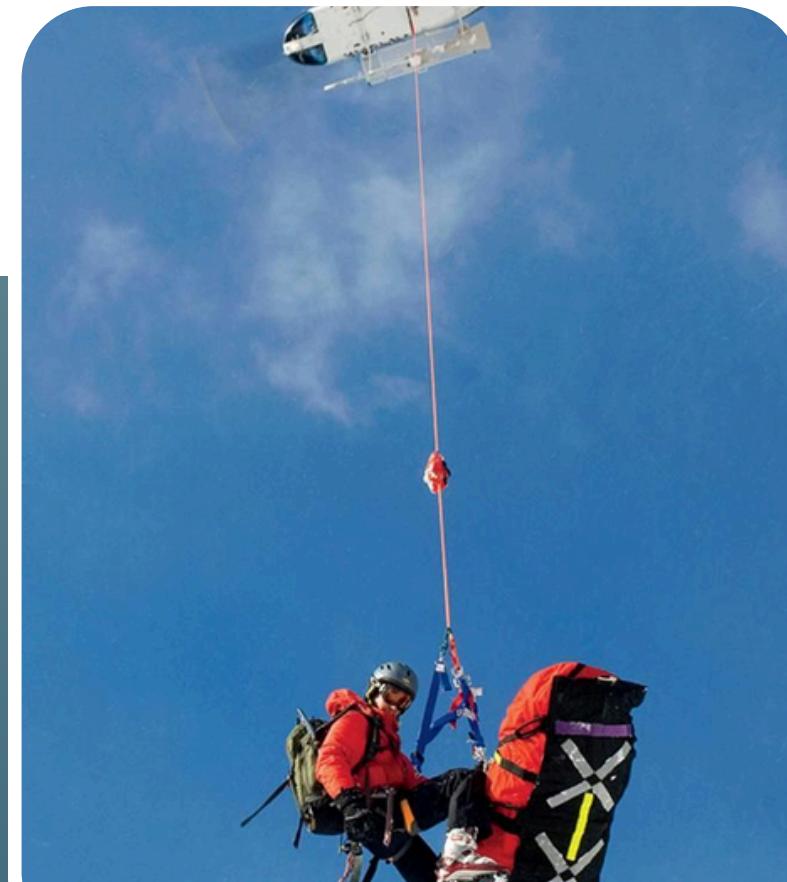
## Phase 3: Route Optimization by Drones

The drones assist land robots by providing efficient navigation routes based on aerial observations, helping the robots safely traverse debris and obstacles.



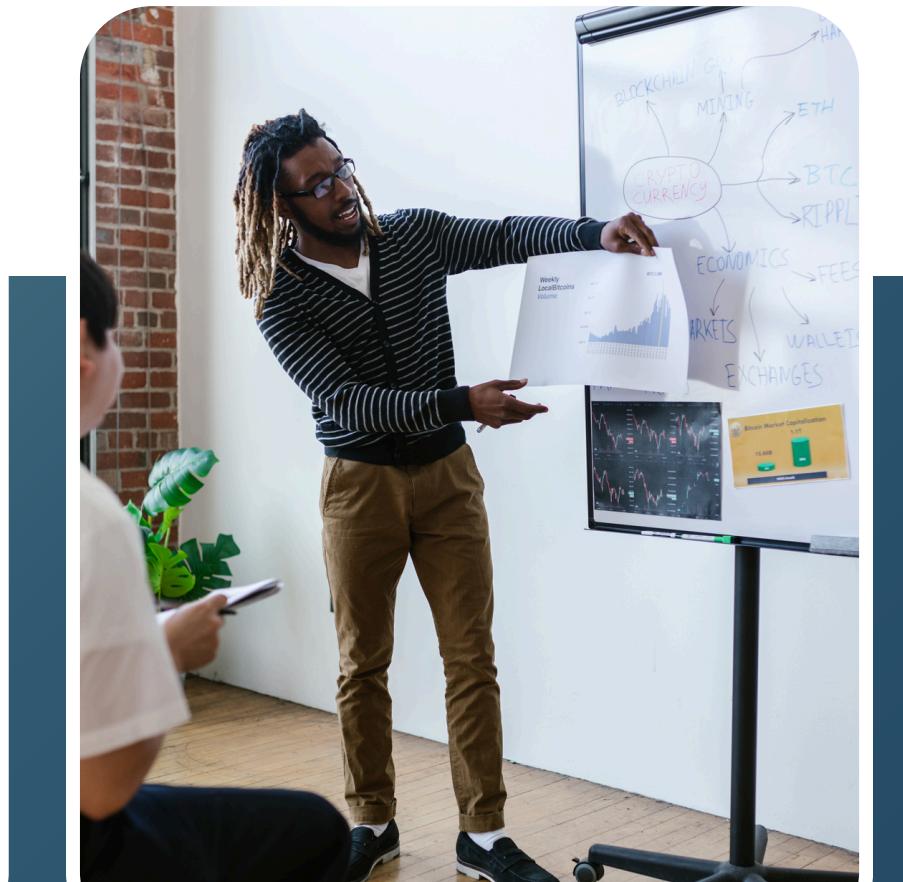
## Phase 4: On-Site Medical Assistance

Land robots, upon reaching victims, use onboard medical tools to evaluate their conditions and administer basic first aid, such as stopping bleeding or stabilizing fractures.



## Phase 5: Deployment of Nursing Robots

Smaller nursing robots are sent to locations inaccessible to larger robots. These nursing bots carry medical supplies like vaccines and antibiotics to deliver immediate care to critically injured individuals.



# Technical Design

## Aerial Plane Drones for Disaster Response:

The fixed-wing drones used in this project are designed for long-duration flights and large-area surveillance. Equipped with HD cameras, they provide real-time footage to the control center for assessing disaster zones. Integrated thermal sensors detect survivors through body heat, even in low visibility, and share this data with land robots.

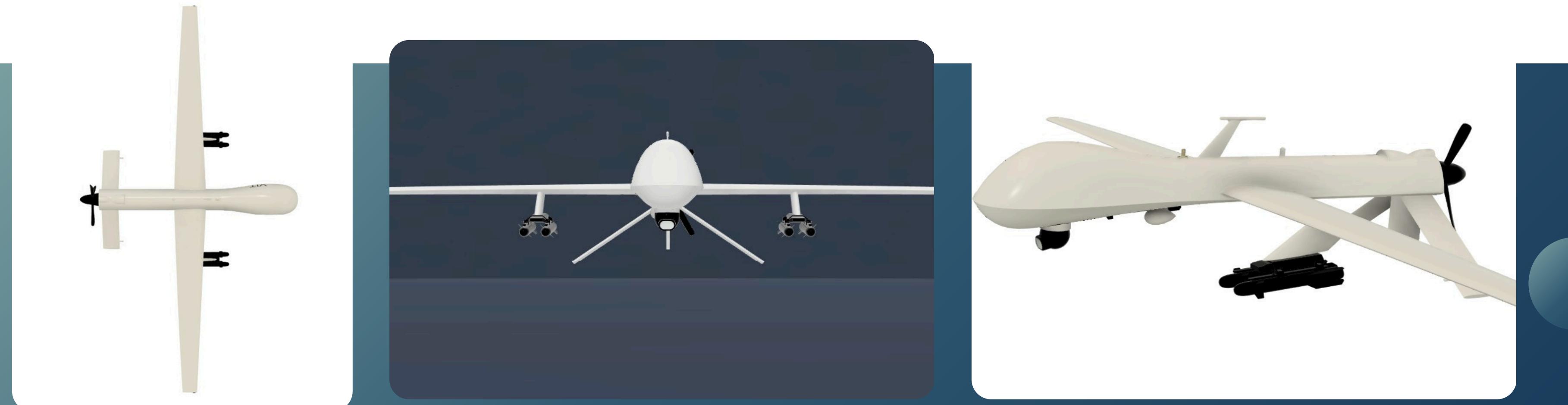
These drones use wireless communication to relay:

- Heat signature maps.
- Navigation paths for land robots.

Built with lightweight, durable materials, they are weather-resistant and capable of autonomous flight, ensuring precise coordination in rescue missions.

## SENSORS:

- Thermal Imaging Sensor
- LiDAR Sensor
- RGB Camera
- Ultrasonic Sensor
- GPS Module



## Land Robots for Disaster Response:

The land robots are rugged, all-terrain units inspired by Boston Dynamics' legged robot designs for enhanced mobility on uneven terrain. Equipped with advanced sensors, they locate and interact with stranded individuals, providing their exact location and condition to the headquarters.

These robots receive optimized paths from aerial drones and are equipped with medical tools to deliver basic first aid. Their durable, lightweight design and legged mobility make them highly effective in navigating complex disaster zones.

### **Batteries: 36V 20Ah Battery**

### **Estimate Functional Time: 6-7 Hrs**

#### Sensors for Land Robot

1. Lidar Sensor – For obstacle detection and navigation.
2. Infrared (IR) Sensor – For heat signature tracking.
3. Ultrasonic Sensor – For proximity detection.
4. GPS Module – For precise location tracking.
5. Camera Module – For visual assessment and live video feed.
6. Heart Rate Sensor – To monitor survivors' pulse.
7. Temperature Sensor – To measure body temperature.
8. SpO2 Sensor – To check oxygen saturation levels.
9. CO2 Sensor – To detect respiration in confined spaces.
10. Gas Sensor – To monitor toxic gases in the environment



## Nursing Bots for Disaster Response:

The nursing bots are compact, highly mobile robots designed for rescue operations in confined and hard-to-reach spaces. Inspired by Boston Dynamics' spider-like legged designs, these bots have a 6-inch diameter and are equipped with six articulated legs, enabling them to maneuver through collapsed structures, narrow passages, and uneven debris effectively.

### Key Features:

#### 1. Mobility and Design:

- Their spider-like legs offer enhanced stability and agility, allowing precise navigation in unstable environments.
- The lightweight frame is crafted from durable materials like carbon fiber and reinforced plastic, ensuring resilience under pressure while maintaining a low weight for ease of movement.

#### 2. Medical Delivery System:

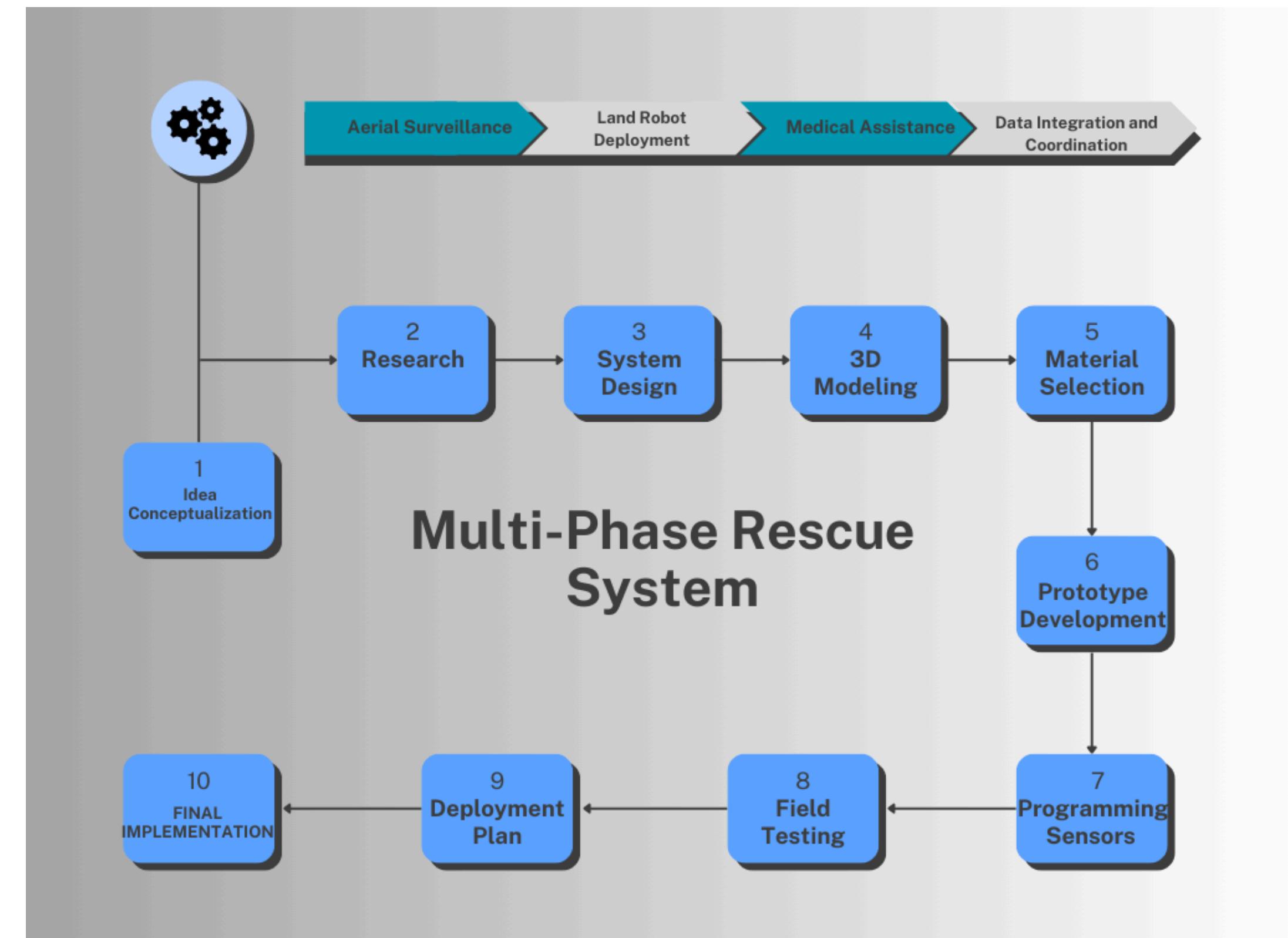
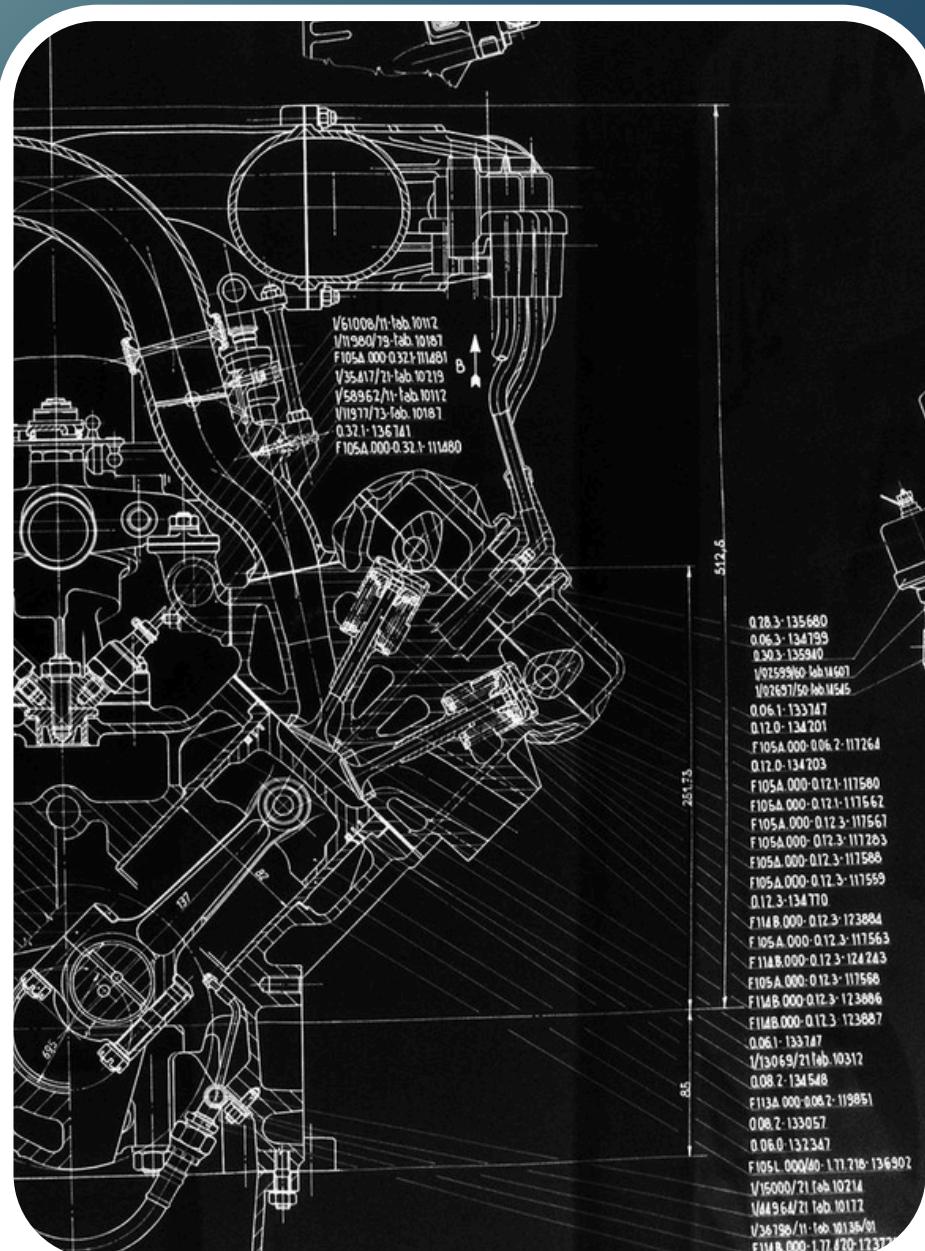
- Each nursing bot is equipped with a modular cartridge system to carry essential medical supplies such as vaccines, antibiotics, and pain relief medications.
- Using precision-controlled actuators, these bots can deliver injections or drop medical kits directly to trapped survivors.

**Batteries: 5.6V 500mAh**

**Estimate working time: 45-60 mins**

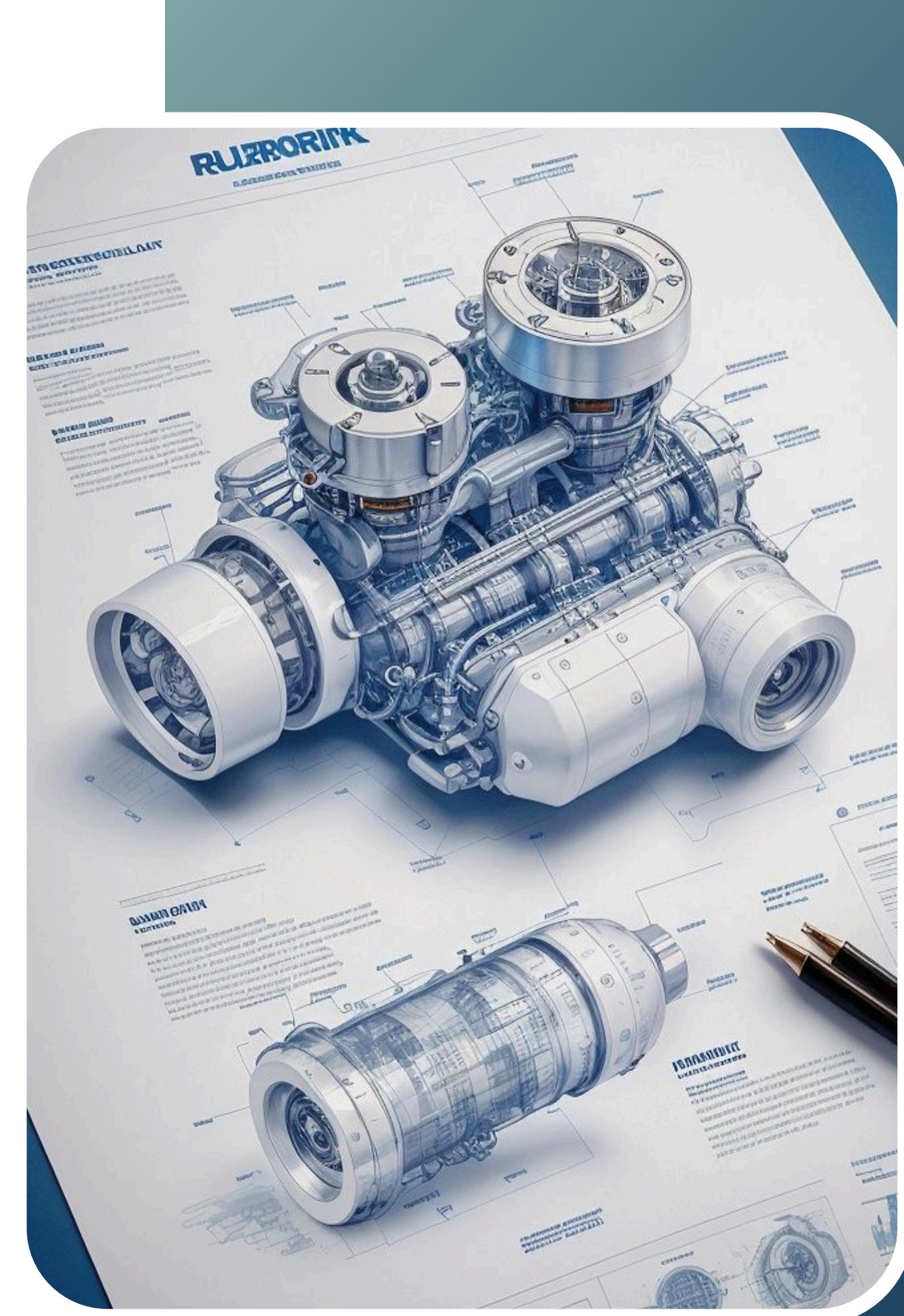


# FLOWCHART



# STEPS

- **Idea Conceptualization:** Initial brainstorming and defining the problem.
- **Research:** Gathering information on disaster scenarios, robotics requirements, and existing technologies.
- **System Design:** Defining the multi-phase system and breaking it into components (e.g., drones, land robots, nursing bots).
- **3D Modeling & CAD:** Creating digital prototypes of the robots and their components.
- **Material Selection:** Choosing lightweight and durable materials like carbon fiber and reinforced plastic.
- **Prototype Development:** Building physical prototypes of the robots.
- **Programming & Sensor Integration:** Developing software and integrating sensors for navigation, communication, and medical aid.
- **Testing (Simulations):** Running virtual simulations to test performance in disaster scenarios.
- **Field Testing:** Real-world testing of prototypes in controlled environments.
- **Deployment Plan:** Designing operational procedures for deploying the system in real disasters.
- **Multi-Phase Rescue System:** Final implementation.



# IMPACT AND BENEFITS

## Impacts

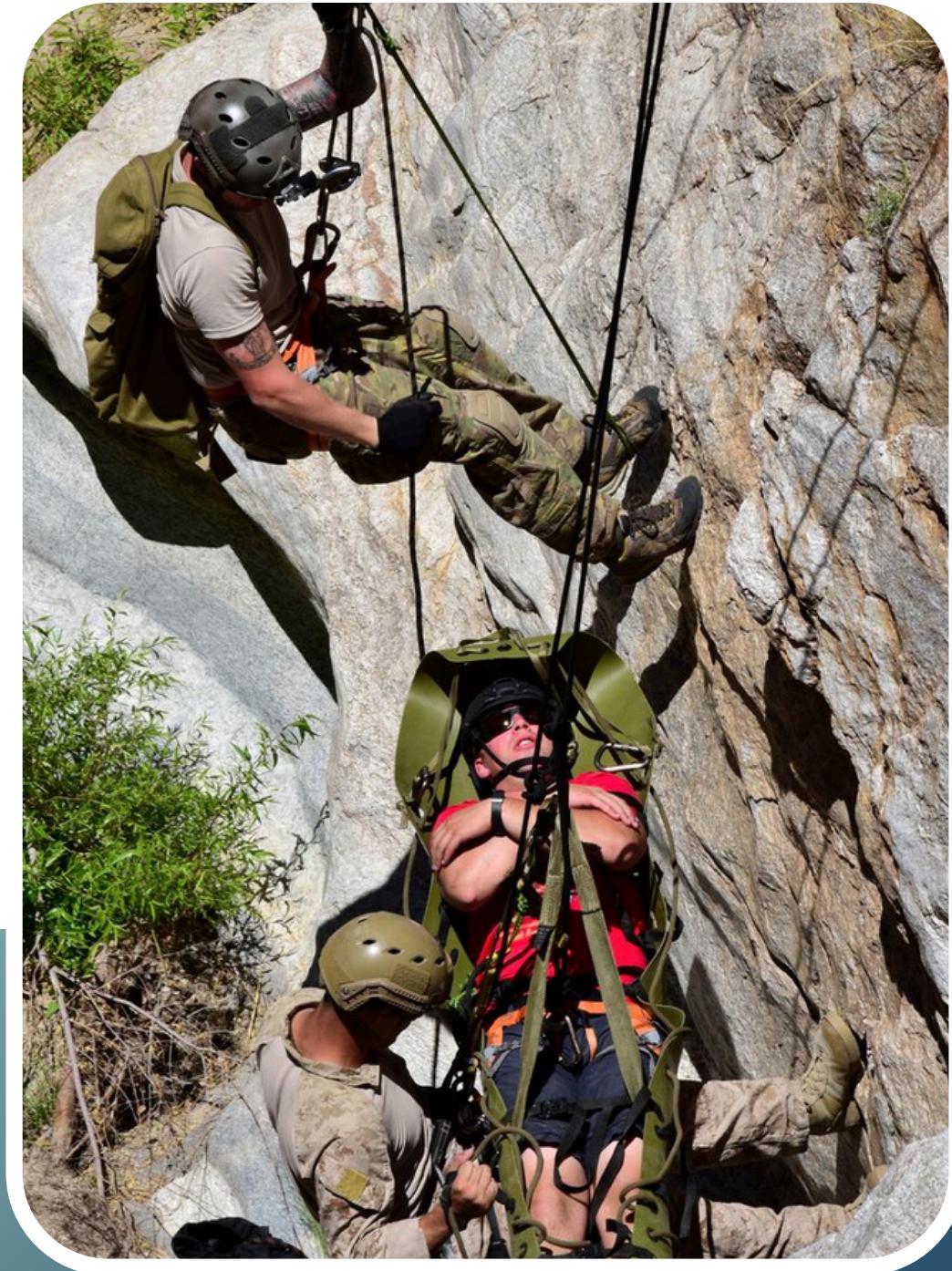
1. **Increased Efficiency:** Robots can quickly assess disaster sites, gather data, and perform tasks that would take humans much longer to accomplish, significantly speeding up response times.
2. **Enhanced Safety:** By deploying robots in hazardous environments, human responders are kept out of danger, reducing the risk of injury or fatalities during rescue operations.
3. **Continuous Operation:** Robots can operate continuously without fatigue, allowing for ongoing monitoring and assessment of disaster-affected areas, which is crucial for effective management.
4. **Data Collection and Analysis:** Equipped with advanced sensors and AI, robots can gather and analyze environmental data in real-time, providing critical information for decision-making during emergencies.
5. **Adaptability:** The design allows for modular and reconfigurable robots that can be tailored to specific tasks, making them versatile in various disaster scenarios.
6. **Predictive Capabilities:** Integration of AI enables robots to anticipate potential aftershocks or secondary disasters, improving preparedness and response strategies.



# IMPACT AND BENEFITS

## Benefits

- 1. Resource Optimization:** Robotics technology optimizes the allocation of resources by identifying affected areas and prioritizing response efforts, ensuring that help reaches those in need more effectively.
- 2. Improved Communication:** Advanced communication systems in robotic designs facilitate real-time data sharing among responders, enhancing coordination and collaboration during disaster response.
- 3. Cost-Effectiveness:** While initial investments in robotics may be high, the long-term savings from reduced human labor costs and improved efficiency can be substantial.
- 4. Innovative Solutions:** The use of robotics fosters innovation in disaster management, leading to the development of new technologies and methodologies that can be applied in future emergencies.
- 5. Public Confidence:** The visible use of advanced technology in disaster response can enhance public confidence in emergency services, knowing that effective measures are in place to handle crises.
- 6. Learning and Adaptation:** Robots equipped with machine learning capabilities can improve their performance over time by learning from past experiences, leading to better outcomes in future disaster scenarios.



# CHALLENGES AND FUTURE SCOPE

## Challenges Faced:

1. **Rugged Terrain:** Navigating uneven and debris-filled terrains can pose significant challenges to land robots.
2. **Battery Life:** Limited battery capacity for both drones and robots can restrict operation times, particularly in large-scale disaster zones.
3. **Communication Gaps:** Maintaining consistent communication in disaster-hit areas with damaged infrastructure is a persistent issue.
4. **Manufacturing Costs:** Developing advanced, robust robotic systems involves high initial costs, making scalability difficult for resource-constrained regions.
5. **Weather Conditions:** Adverse weather such as heavy rain, storms, or extreme temperatures can hinder robotic performance.



# CHALLENGES AND FUTURE SCOPE

Future Advancements:

- 1. AI for Better Decision-Making:** Integrating artificial intelligence to enable drones and robots to make autonomous decisions, like rerouting paths or prioritizing victims based on medical urgency.
- 2. Modular Designs:** Developing modular components for robots to adapt to varying terrains and tasks, enhancing versatility and cost-efficiency.
- 3. Improved Battery Technology:** Leveraging next-gen energy solutions, such as solid-state batteries or solar charging, to extend operational time.
- 4. Enhanced Durability:** Designing robots with more durable materials to withstand extreme weather and challenging conditions.
- 5. Global Coordination Systems:** Establishing a centralized disaster management network to deploy these systems effectively across the globe.
- 6. Mass Production:** Scaling manufacturing to lower costs and make the system accessible to developing countries



# CONCLUSION

Recap the Importance of the Project:

Natural disasters, such as earthquakes, floods, and landslides, leave thousands of people in critical need of timely assistance. Our multi-phase robotic rescue system addresses these challenges by combining aerial and ground robotics to save lives, reduce response times, and minimize risks to human rescuers. This innovative solution represents a significant step forward in disaster management.



We believe that this project has the potential to revolutionize disaster management globally. Your support—whether through funding, collaboration, or advocacy—can help us turn this vision into reality. Join us in creating a safer world, where advanced technology ensures timely and effective rescue for those in need.

## Why It Stands Out:

- **Innovation:** The integration of advanced drones, land robots, and nursing bots offers a comprehensive and technologically superior solution to current rescue challenges.
- **Practicality:** Each phase of the system is designed for maximum efficiency, ensuring effective operations even in the most challenging conditions.
- **Scalability:** The modular design of the system allows for customization and adaptation, making it suitable for disasters of varying scales across diverse geographies.

# THANK YOU

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