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AI-BASED UNMANNED ROBOTIC SYSTEM FOR BATTLEFIELD RESCUE OPERATION

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Abstract

In modern warfare, real-time identification of injured soldiers and battlefield anomalies is crucial for efficient rescue operations and strategic decision-making. This project aims to develop an autonomous land rover- like robot equipped with advanced optical camera technology and artificial intelligence (AI) for war field surveillance. The system is designed to detect and identify injured soldiers, as well as recognize any unusual activity or threats in the environment.

The rover is controlled remotely over long distances using Wi-Fi technology, ensuring safe and effective operation from a secure location. AI-based image processing enables real-time detection and classification of individuals and objects, while machine learning algorithms enhance the accuracy of anomaly detection. The system can assist military personnel by providing live video feeds and alerts, reducing response time and increasing the chances of survival for wounded soldiers.

This robotic system offers a cost-effective and efficient solution for battlefield monitoring, minimizing human exposure to danger while maximizing situational awareness

1. Introduction

The project aims on developing modern warfare demands technology-driven solutions to minimize human casualties. And to identify the own country soldiers and enemy soldiers by using advanced recognition technology.it also helps in transport injured soldiers to the medical base to provide some medical aid such as CPR and blood loss prevention.

A robot is an intelligent and obedient, but impersonal machine. It is also a machine that does work on its own, automatically, after it is programmed by humans. 9/10 robots in existence today are Industrial Robots. This means that robots are working for people everywhere in factories, laboratories, warehouses, energy plants, hospitals, and many other industries.

Several years ago, the majority (90%) of robots that "worked" were used in car manufacturing companies. These robots worked on assembly lines doing a variety of tasks. Now, only half the robots in the world are busy building cars.

There are many benefits to using robots instead of humans. Can you imagine working in a factory all day, every day, doing the exact same thing over and over again? The good thing about robots is that they will never get bored, and they will do things more efficiently than people. Also, robots never get sick, or need to rest. This means they can work for 24 hours a day, 7 days a week. They will never need time off, or lunch breaks. Sometimes, when a task is too dangerous or difficult for a human, a robot will be able to do it without any risks or problems.

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2. Headings and Footnotes

AI-Robotics Systems Architecture

Robotic systems can be designed using a variety of architectural paradigms. In this section, we will explore these paradigms further. Murphy et al. describe a range of current architectures such as hierarchical, reactive, and hybrid deliberative-reactive in terms of the relationships between three primitives (i.e., sense, plan, and act) for organizing intelligence in robots. characterize these three fundamental building blocks based on their inputs and outputs. Hierarchical paradigms in robotics follow a top-down approach, where the robot first senses the world, then plans its next action and finally executes it. A hierarchical paradigm is also known as a deliberative architecture. Each layer in the hierarchy depends on the layer below it for information and guidance. Reactive paradigms prioritize immediate responses directly connected to sensor input, without extensive planning.

Hybrid deliberative-reactive paradigms strike a balance between reactive responses and higher-level decision-making, utilizing both immediate reactions and planned actions based on sensory information.

2.1 Robotic Perception

The perception stack of the robot architecture involves sensing and understanding relevant information about the state of the operating environment by leveraging several sensors, for example, GPS, accelerometer, inertial measurement unit (IMU),gyroscope,magnetometer,camera and tactile sensors among others The combination of multiple sensors as depicted in to make up perception stack. These sensors play a pivotal role in actively sensing the raw data that represent the physical state of robotics systems in the environment. Furthermore, this sensory data aids in planning and calculation of actuator signals in the subsequent stages.

Modern AI-Robotics systems require high-level sensing abilities, such as object detection, localization, positional information, and interaction with humans. An important aspect of achieving successful perception functions in robotics is gaining a deep understanding of the operating environment. One highly influential approach for environment understanding, especially in the context of mobile robots and autonomous vehicles, is the representation of the environment through 2D mappings known as occupancy grid mapping However, attention has now shifted towards 3D representations. Recent technological advancements, including Octomaps and the widespread use of RGBD sensors with depth capabilities have significantly enhanced the construction of larger and more detailed 3D maps for detailed 3D-like environment representations. Efforts have been focused on semantically labeling these maps by integrating them with Simultaneous Localization and Mapping (SLAM) frameworks.

2.2 Robotic Planning and Navigation

The input to the navigation stack is the sensory information and map obtained by the various sensors from the perception stack as depicted in Fig 1. Navigation algorithms are responsible for the generation of a series of waypoints, which are then passed on to the control stack .Classic robotic navigation and planning algorithms typically involve explicit rule-based methods and predefined algorithms for path planning and obstacle avoidance. These algorithms often rely on geometric models and predefined maps of the environment. They can be categorized into four groups, including graph search algorithms , sampling-based algorithms such as Rapidly-exploring Random Tree , interpolating curve algorithms and reaction-based algorithms such as Dynamic Window Approach .

AI/ML algorithms, on the other hand, offer a distinct advantage in object and environment identification as they can autonomously learn patterns and features directly from sensor data, eliminating the need for manual feature engineering or predefined models. This capability has resulted in remarkable enhancements in the performance of robotic navigation and planning, leading to its adoption for generating local cost maps as well as for both global and local planning tasks, thereby paving the way for more adaptive and efficient robotic systems.

2.3 Robotic Control

The input to the control stack is the waypoint information from the navigation and planning stack as illustrated in Fig. 1. The control stack is responsible for generating control signals by leveraging various algorithms to manipulate the behavior of robots. It involves designing control systems that enable robots to perform specific tasks such as moving actuators based on the planned path given by the planning and navigation stack. The goal of this is to develop algorithms that can effectively and efficiently command the robot's actuators based on sensor feedback.

Some of the classic control algorithms include Proportion Integral-Derivative (PID) control and Linear-Quadratic Regulator . PID adjusts control signals based on proportional, integral, and derivative terms. It provides stable and robust control by continuously comparing

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desired and actual states and minimizing the error. LQR on the other hand, is used to control non-linear dynamical systems by computing the optimal control signal needed to move the system to a desired state. These algorithms, while effective for many applications, often rely on explicit mathematical models and predefined control strategies.

Illustrations :

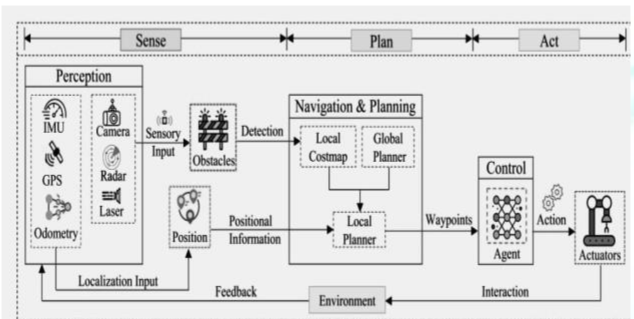
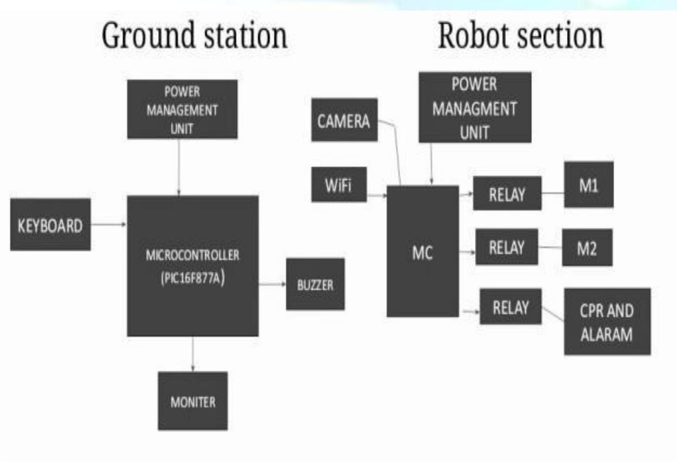


Figure 1: A generic robot architecture consisting of perception, navigation, and control stacks.

Block Diagram



3.Tables

Table 1: Robot primitives defined in terms of input and output.

Primitives	**Input**	Output
Sense	Sensor data from LIDAR, Cameras, GPS etc.	Sensed information such as obstacle location, occupancy grids etc.
Plan	Map Information	Waypoints, path, trajectory
Act	Waypoints	Actuator Commands

Table 2: Overview of attacks on input sensors along with defensive strategies.

Attack Surface	Medium	Attack Summary	Defensive Strategy
Jamming	Camera, GPS, LiDAR, Ultrasonic sensors	• Use of intense light to jam camera sensors. • Using bright light source (blinding light) to render LiDAR renders the sensor ineffective in perceiving objects.	• Incorporating a near-infrared-cut filter and photochromic lenses to selectively filter certain types of light.
Spoofing	GPS, LiDAR	• GPS spoofing attack designed to manipulate navigation system. • Adversary may spoof LiDAR sensors using techniques such as laser projection [74], [77], [78], shape manipulation [79], and object manipulation [80].	• Filtering [81], Randomization [74], and Fusion [82]. • Anomaly detection sytems [83]. • Spoofing detection systems for radars-based spoofing attacks [84].
Manipulation	IMUs	• Manipulate the gyroscope, accelerometer, and magnetometer sensors. • Disrupt the accurate measurement of linear and angular velocity and cause errors in control system.	• Inertial sensors safeguarding. • Sensor fusion techniques.
Software vulnerabilities	OpenCV, TensorFlow Image, Open3D	• Adversary may exploit software vulnerabilities within programs responsible for processing sensor data.	• Data verification and validation. • Data Sanitization. • Patching and updating for known vulnerabilities.

4. Conclusions

Human life is very precious and saving it is very important thing. In battle field there is lot of danger to soldiers life and to give safety for them large amount of cost is being spend. Usually robot simplifiers the human work but in battlefield it safeguards the human life. In this proposed system the robots in battlefield are operated through remote control which will reduce the risk to human soldier and works effectively to detect the landmines. In future by using pumping motor fluorescent dye is sprayed on the detected

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material based on change in color explosive material are accurately detected. This robot will work effectively at all conditions like marshy lands, night times.

By this project the effects of terrorist activities are reduced and world peace is maintained.

- The Unmanned Battlefield Robot will reduce soldier casualties by providing medical aid and safe evacuation.
- It integrates AI, robotics, and medical technologies to function effectively in war zones.
- Future improvements can include advanced diagnostics, weapon handling, and multi-unit coordination.
- This innovation is a step towards smart warfare, prioritizing human life and battlefield efficiency.

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