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RAKSHAK-The Multipurpose Unmanned Ground Vehicle

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Abstract
RAKSHAK is the four-wheel drive unmanned ground vehicle which are capable of performing different task by both autonomous and remote control mode to serve in the field like defense, agriculture, and industrial and disaster management as well. Our defense model is equipped with a Remote Control Weapon Station to terminate enemies. It also does have a landmine detector and bomb defusing arm as well. It is also capable of transporting injured soldier to safe place. It ensures safety and full control over surrounding and to manage threats presented in the battlefield. It is equipped with various sensors and camera to give all visuals. Nowadays with the major advancement in the various field of the vehicle automation, several dangerous and crucial counter terrorist operations are being handled by sophisticated machines which are not only more efficient but are also responsible for saving several human lives. Our project "Unmanned Ground Vehicle" is built to undertake missions like border Surveillance and in the active combat both as a standalone unit for metal detection which can be used for the bomb detection as well (automatic) as well as in co-ordination with human soldiers (manual) wirelessly. It is a prototype illustrating with the ever-expanding need for sophisticated technology and precision driven vehicles catering to the present day needs for a first line of defense.

Keywords: *Autonomous; Remote Control Weapon Station; Bomb Diffusion, etc.*

1. Introduction
The background of the unmanned ground vehicle (UGV) systems emerged in response to the need for safer, more efficient, and cost-effective solutions across various sectors, including military operations, exploration, and industrial applications, particularly since the early 21st century. The primary objective of UGV systems is to perform tasks autonomously or semi-autonomously, thereby reducing the human exposure to the various hazardous environments while enhancing operational capabilities [1]. Through the integration of cutting-edge robotics, artificial intelligence, and sensor technologies, UGVs aim to execute a wide range of functions, from surveillance and reconnaissance to logistics and hazardous material handling, thereby augmenting human capabilities, improving mission success rates, and mitigating risks in challenging operational contexts [2-5]. Early developments in unmanned ground vehicle (UGV) systems date back to the mid-20th century, with military projects like the Goliath tracked mine in World War II. Throughout the late 20th century, remote-controlled and teleoperated vehicles were utilized for the military purposes, including reconnaissance and explosive disposal [6]. The 1990s and early 2000s saw significant advancements in robotics, spurred by events like the DARPA Grand Challenge, which pushed for autonomous vehicle navigation. Military engagements in Iraq and Afghanistan further underscored the need for UGVs, leading to increased research and deployment. These earlier endeavors laid the groundwork for today's UGV systems, integrating AI, sensor tech, and rugged design [7]. Rakshak is a compact effective and reliable system to overcome maximum problems which is being faced by soldiers. It helps soldiers by providing them ability to perform difficult tasks remotely keeping themselves safe from all kind of possible circumstances [8-11].

1. The system is designed in such a way that it

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can reduce maximum threats on soldiers.

2. The system uses a belt drive (Caterpillar track) and also it has good ground clearance to be successfully operated in rough terrains.
3. The machine can be controlled by smart phone, transmitter and it also have self-drive feature to drive autonomously.
4. The system is so compact and has a heavy payload lifting capacity.
5. It can be used various situations. Independent mounting system makes the system more flexible to perform various tasks in less time.
6. It can perform tasks like bomb disposal, enemy termination, rescue operations, landmine detection and much more.

2. The RAKSHAK System

Rakshak is an innovative UGV designed to minimize the risks faced by soldiers during missions. Key features of the Rakshak system include [12].

2.1.Robust Design

Equipped with a belt drive (caterpillar track) and substantial ground clearance [13], Rakshak can navigate rough terrains effectively.

2.2.Remote and Autonomous Operation

The UGV can be controlled via smart phones, transmitter, autonomously all owing for flexible development.

2.3.Heavy Payload Capacity

Compact size, Rakshak has a significant payload capacity, making it versatile for various tasks [14].

2.4.Modular Mounting System

The independent mounting system enables quick adaptation to different missions, such as bomb disposal, enemy engagement, and rescue operations.

3. System Design and Features

Rakshak robots are built on a modular and customizable platform, ensuring adaptability to various tasks and environments. Key features include:

3.1.Off-Road 4WD Caterpillar Track Chassis

Provides the maneuverability on rough terrains.

3.2.Control Modes

Can be operated wirelessly using a 2.4GHz transmitter or autonomously via GPS

3.3.Modularity

The chassis can be reconfigured for different roles, such as a tank or ambulance [15].

3.4.Accessories

Remote Controlled Weapon Station, Bomb Disposal Arm Carriage, System Landmine Detection Module.

4. Methodology

- Rakshak robots are multipurpose unmanned ground vehicles (UGVs) developed to address critical challenges in military and agricultural operations (Figure 1).
- In military contexts, they offer solutions for tasks such as bomb disposal, landmine detection, and battlefield surveillance [16].
- In agriculture, they assist with crop maintenance tasks such as harvesting, pesticide application, and weeding. This methodology section details the deployment process, from system design to operational implementation.

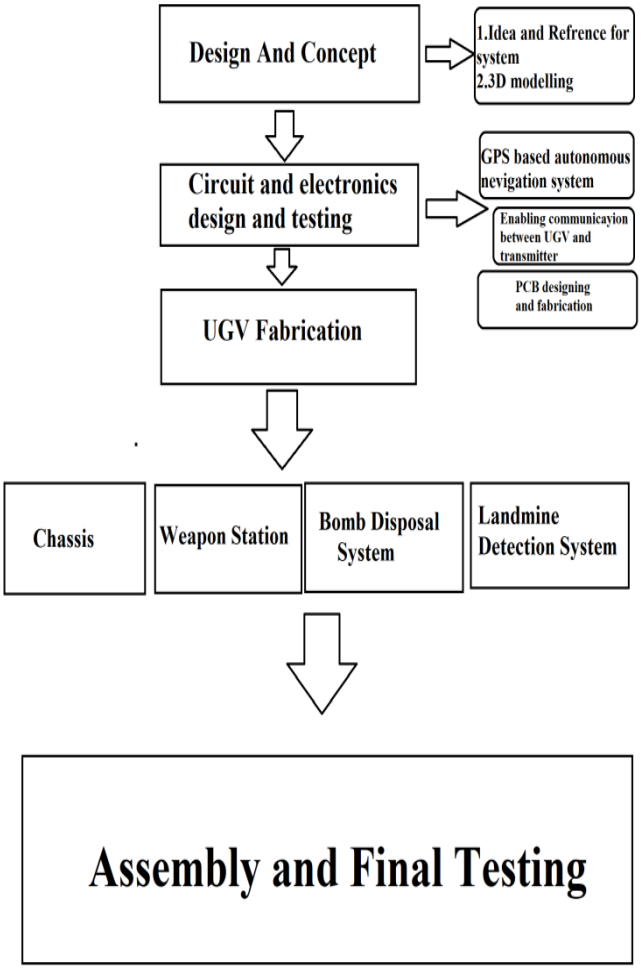

Figure 1 Flow Chart

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Our system has all the required features which make it advance and easy to use. The features of the robot are following: -

1. It has a 4 DOF robotic arm for safe disposal of IED's.
2. It have an advance Remote Controlled Weapon System which can be equipped with any long calibred rifle which can be used to terminate enemies hidden in buildings by using an camera based scope.
3. It has a landmine detection module which can detect landmines and sent threat alarms to the operator so that they will be aware of them.
4. It have both autonomous and manual mode.
5. It is designed in a way to carry over payload.
6. The autonomous mode can be used to send injured soldier back to the base where operator can easy set waypoints using GPS and robot will start following that waypoint.
7. It has 360 surveillance cameras to give visuals of the surroundings.
8. Our system has a manual controlling range of up to 1.5km.
9. It has a good ground clearance and advance vision system to overcome any obstacle.
10. We are also adding LIDAR to give flexibility of generating maps.

5. Results and Discussion

Unmanned Ground Vehicle Systems, or UGVS, are robots designed to move on land without needing a human inside. They can be controlled remotely or work autonomously. These systems are used for various tasks like surveillance, transportation, and even in dangerous environments like mines or battlefields. UGVS help keep people safe by doing risky jobs instead. They are equipped with sensors and cameras to navigate and gather information. With advancements in technology, UGVS are becoming more capable and are expected to play a bigger role in many fields in the future.

5.1.Chassis and Mobility

The chassis excels in maneuvering over various types of rough terrain and can successfully climb inclines up to 30 degrees. The modular and customizable design allows for quick conversion from a tank to an ambulance within a minute, enhancing operational flexibility.

5.2.Weapon System

The weapon system and its trigger control mechanism perform well with good response time and balance. It includes a Remote Controlled Weapon Station capable of engaging enemies from a safe distance.

5.3.Surveillance and GPS Navigation

The surveillance system is effective, with reliable operation via smart phones and receiver control. However, there are issues with GPS navigation related to power consumption and connectivity.

5.4.Bomb Disposal Arm

The bomb disposal arm functions as intended, but there are challenges with its movement due to unbalanced weight and rough design. It may help to diffuse the IEDs also.

5.5.Accessory Integration

Accessories can be easily attached and detached, providing flexibility to perform various tasks quickly. Available interchangeable accessories include a bomb disposal arm, landmine detection system, and carriage.

5.6.Power Consumption

High power consumption is a significant issue, and efforts are underway to minimize it by integrating all systems into a single PCB. The RAKSHAK – Consumption image is shown in Figure 2 (a,b).

(a)

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(b)

Figure 2 (a, b) RAKSHAK - Consumption

Conclusion

1. The system has many applications like: -
   - Agriculture
   - Defense
   - Industrial
   - Disaster management
2. It will reduce maximum threats from soldiers.
3. Person can operate the system wirelessly and autonomously.
4. It is safe, fast, accurate, stable and affordable.

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