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RESEARCH AND DEVELOPMENT OF A MOBILE RECONNAISSANCE ROBOT

Tokbayev S.[1], Zhumahan N.[2]

"Almaty Technological University" JSC, Almaty

Introduction. In recent decades, technology has made a giant leap forward, and robotics has become one of the leading areas defining our future. One of the most promising developments in this field is mobile reconnaissance robots. Such devices are designed to perform tasks in extreme conditions where it is dangerous or impossible for a person to get to. They are used in the military, rescue operations and even in research expeditions.

An example of the successful use of such devices is the PackBot robot, which was used by the US military to clear mines in Iraq and Afghanistan. Such robots demonstrate how effective their assistance can be in high-risk tasks.

Goals and objectives. The purpose of the intelligence robot development is to create a device that can perform complex tasks in an autonomous or semi-autonomous mode, collecting data and ensuring their safe transmission to the operator.

Example: During the earthquake in Turkey in 2023, robots equipped with cameras and thermal imagers were used to search for survivors in the rubble. This allowed rescuers to focus on spot operations without risking their lives.

The main tasks facing such robots include:

Intelligence gathering. For example, monitoring the terrain before performing military operations.

Work in dangerous conditions. An example is the use of a robot to inspect a chemically contaminated area.

Quick response. In case of emergency situations, such as a gas leak or an accident at a power plant, the robot is able to quickly assess the situation.

Stages of development.

Choice of construction and mechanics .

At the first stage, it is necessary to determine the type of movement of the robot. For example, tracked robots such as Dragon Runner show high cross-country performance. At the same time, wheeled robots such as RoboScout provide greater speed and maneuverability on flat surfaces.

Equipment with sensors and communication modules.

To perform reconnaissance tasks, the robot is equipped with special equipment:

Cameras. They include night vision or a thermal imager, as in the FLIR SUGV robot.

Lidars. They are used to map the area, as the Boston Dynamics Spot robot does.

Gas sensors. Such systems are used in robots to assess the level of toxic substances, for example, in industry.

Software.

Modern robots are equipped with artificial intelligence systems, which allows them to find their own way in unfamiliar terrain.

Example: The Robot Operating System (ROS) software used in the development of the Husky A200 robot allowed the integration of machine learning algorithms, which made it useful for complex cartography tasks.

Pic 1. FLIR SUGV robot

Pic 2. Boston Dynamics Spot Robot

Real-world testing.

At the final stage, the robot is tested in conditions as close as possible to real ones. For example, robots designed to work in minefields are being tested in training areas with simulated real threats.

Areas of application. Military tasks. Mobile reconnaissance robots are actively used for reconnaissance and disposal of explosive devices. For example, the iRobot PackBot robot was successfully used to inspect buildings for threats during operations in Afghanistan.

Rescue operations. After the Fukushima nuclear power plant accident in 2011, robots such as Quince were used to survey radioactive areas. This made it possible to minimize the effects of radiation on people and quickly collect damage data.

Civil Research. In the scientific field, robots are used to explore dangerous areas. For example, the Remus 6000 underwater robot studied the remains of the sunken ship Titanic at a depth of more than 3 km.

Problems and solutions.

Problems:

– Limited battery life. Modern batteries do not always provide sufficient duration of missions.

– High cost. The development of robots requires large financial investments.

– Interference and communication failures. In conditions of strong electromagnetic influence, for example, on the battlefield, communication with the robot may be disrupted.

Possible solutions:

– The use of more capacious batteries and solar charging technologies.

– Development of modular structures that make it possible to reduce the cost of production.

– The use of secure communication protocols, such as those used in military drones.

Ethical Considerations. The deployment of mobile reconnaissance robots raises several ethical questions that need careful evaluation. While these machines are designed to minimize human risk, their use in military or surveillance contexts can potentially lead to unintended consequences.

For example, reliance on autonomous robots in military operations might lead to decisions being made by artificial intelligence without sufficient human oversight. This could result in ethical dilemmas, especially in situations where civilian safety is at risk. Additionally, the use of robots for surveillance purposes may infringe on privacy rights, necessitating clear regulations and transparency about their usage.

Ensuring that these technologies align with ethical standards requires international cooperation, guidelines, and the development of fail-safe systems that allow humans to override critical decisions made by AI.

Future Trends and Innovations. The future of mobile reconnaissance robots is poised to bring groundbreaking innovations, driven by advances in artificial intelligence, energy storage, and material science.

Swarm Robotics:

Research is underway to create networks of small, interconnected robots that can operate collaboratively. Inspired by the behavior of insect swarms, these robots

could perform tasks such as area mapping or search-and-rescue missions more efficiently than a single robot.

Biomimetic Design:

Future robots may take inspiration from nature, adopting characteristics like the flexibility of snakes for navigating narrow spaces or the agility of animals for climbing and jumping over obstacles. For instance, the Boston Dynamics Cheetah prototype demonstrates high-speed mobility resembling a real cheetah.

Integration with IoT:

By connecting robots to the Internet of Things (IoT), they can gather and process data from a wide range of external devices. This capability could enable seamless integration with smart cities, where robots monitor infrastructure, detect hazards, or even deliver critical supplies.

Advanced Power Solutions:

Scientists are exploring new power sources, including hydrogen fuel cells and piezoelectric materials, to increase robots' operational time and reduce dependence on traditional batteries.

Conclusion. Reconnaissance mobile robots play a key role in carrying out tasks that were previously associated with a risk to human life. Using the example of robots such as PackBot and Quince, it is clear that such technologies not only increase work efficiency, but also save lives.

The future of robotics is linked to the development of autonomous systems, artificial intelligence and improved energy efficiency. Each new stage of development brings us closer to making robots an integral part of our lives, performing complex and dangerous tasks.

References

1. Beketayev, K., & Abdrakhmanov, M. (2020). Introduction to Robotics: Theory and Applications. Almaty: Kazakh Technical Press.

2.Yessenov, A. (2018). Sensors and Actuators in Robotics. Nur-Sultan: Eurasian National University Publishing.

3.Kairat, S., & Zhussupov, R. (2021). Artificial Intelligence in Modern Robotics. Al-Farabi Kazakh National University.

4.Kazakhstan Robotics Research Institute (2022). Applications of Robotics in Resource Exploration. Almaty: KRRI.

5.Nurpeisov, D. (2019). Autonomous Systems: A Practical Approach. Astana: Future Technologies Press.

Information about the authors

Tokbayev Sultan[1], student, Automation and Robotics Department, telephone number: +7 776 967 8575, sultantokbaev.sch22@gmail.com

Zhumahan Nurzhan[2], lecturer, Automation and Robotics Department, telephone number: +7 747 647 3295, nurzhan_14_95@mail.ru

"Almaty Technological University" JSC, 100, Tole bi str., Almaty, 050012, Kazakhstan