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Analysis of Ground Search and Rescue Robots

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Annotation: In this article, the characteristics and parameters of existing ground search and rescue mobile robots were analyzed. During the analysis, the authors set the task to consider the advantages and disadvantages of their use for solving the problems of monitoring the place of the incident and the efficiency of work..

***Keywords*:** search and rescue robots, mobile robots.

I. INTRODUCTION

At the moment we live in the world of natural, man-made, social and many others. All these situations are a threat to human life and health. Almost every hour from different parts of the world we receive news about various catastrophes, accidents or natural disasters that harm a person.

In case of emergencies, people carry out emergency rescue and other urgent work aimed at saving lives and preserving people's health, as well as reducing environmental damage. Along with the nature of emergencies, the method of their elimination and rescue operations has also changed. So the idea arose to use robots for search and rescue operations, since human capabilities are limited. Now such robots are in great demand, and development in this area seems to be very promising. [1]

Technological advances in the field of rescue operations are robotic technologies that can independently or with the help of an operator conduct search and rescue operations in case of accidents of a man-made, natural, ecological, biological and social nature. They are unique robots because they can be in conditions dangerous to the health and life of people. Such robots must perform a complex of different tasks depending on the nature of the incident. [2]

II. ANALYSIS OF GROUND SEARCH AND RESCUE ROBOTS

Consideration of various models of ground search and rescue robots requires action and analyze the tasks performed.

Snakebot is an infinitely expandable robotic platform that uses a moving wave locomotion method similar to the serpentine walk of biological snakes.

The assembled Snakebot contains 10 two-segment blocks, a total of 20 powered segments, as well as a head that has its own servo, allowing you to wag it independently if desired. The Arduino Micros used for control can intelligently control four servos each (the other ports are used for various signaling and communication functions). Thus, the blocks alternately carry the microcontroller and the battery. With this in mind, the basic repeating unit consists of four servo elements, one controller and one battery.

The serpentine mode of locomotion ensures that wherever the head goes, the rest of the snake follows it, moving in the same direction. Thus, as long as the head successfully navigates the environment, an indefinitely long body can follow it without modifying the navigation or locomotion algorithms.[3] An example of a snake robot design is shown in Figure 1.

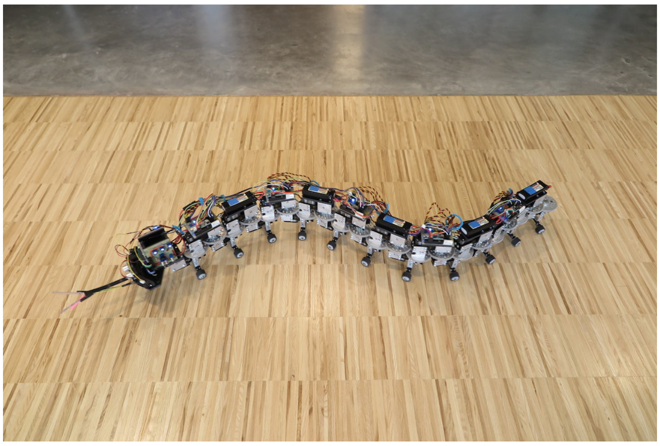

Figure 1. – Snakebot [3]

This design of the robot is very costly and difficult to program. But Snakebots that are being developed will be able to independently dig in loose extraterrestrial soil, are smart enough to slither into cracks in a planet's surface, and are capable of planning routes over or around obstacles. This model is good for analyzing the scene of a disaster, but it cannot carry out rescue operations or help the victim. An example of such a robot can be seen in Figure 2.

Figure 2. – The Snakebot as it maneuvers through the rocks. [4]

Rescue services of Japan received at their disposal a new universal mobile robot Quince, developed jointly by experts from Tohoku University, Chiba Institute Of Technology and Japan International Rescue System Institute. This eight-wheeled robot is designed to be used in the most challenging chemical, biological, radiation and nuclear emergency environments. The model has a fairly small size, but quite heavy. The design of the Quince robot allows it to withstand falls from a height of 1.5-2 meters without damage. To analyze the environment and measure environmental parameters, the robot is equipped with various sensors, a laser scanner that acts as a range finder, and an infrared thermal imaging system. To communicate with the control center, Wi-Fi wireless equipment is used, in case of detection of victims, this will help inform them about yourself. To penetrate the premises, the robot can be equipped with a primitive manipulator that allows it to open doors and move small objects. Thanks to the propulsion system, the robot can move up stairs and on inclined surfaces. [5]

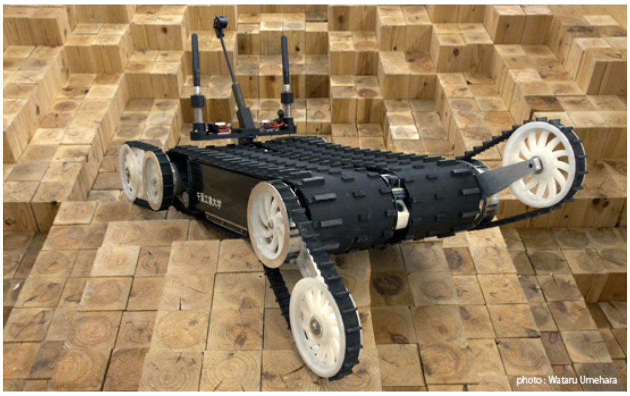

Figure 3. – Moving the mobile robot Quince. [5]

Also, after one of the emergencies (building collapse), various caterpillar-type mobile robots began to gain popularity. They are one of the first rescue robots known to the general public. Figure 2 shows the initial group of robots. Only three models were actually used on the rubble pile from 11–21 September. These models were the micro-Tracs, the Inuktun micro-VGTV, and the Solem, and are circled in the photograph. [6]

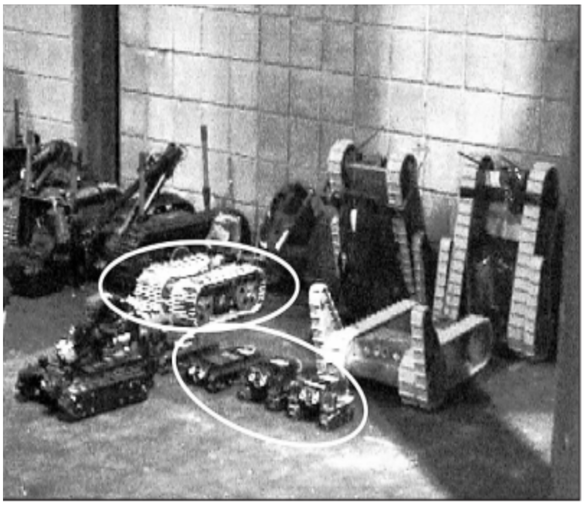

Figure 4. – Robots on static display at the Javits Convention Center where rescue teams were housed from 11–21 September 2001. Robots that were used on the rubble pile are circled. [6]

Subsequently, these rotobo models were improved and are commonly used in rescue operations at the present time. An example of a newer model of such a robot equipped with more sensors and a camera can be seen in Figure 5.

Figure 5. – Track robot rescuer analyzes the terrain[7]

Such a robot has a less fragile wheel design and can also roll over on its own. However, due to the massiveness of the caterpillar tracks, such a model is more overall and massive.

The use of ground-based search and rescue robots is not so in demand, but such robots, in turn, are more effective than drones, since they can analyze the surface of the accident site not only from a height, but also allow you to look inside and explore the surface, thanks to sensors. For example, to study the level of seismic activity or the level of radiation. [8]

III. CONCLUSIONS

After analyzing and considering various models of ground-based search and rescue robots released in different years, one can summarize their shortcomings and advantages. Search and rescue robots are designed not only to analyze the area and simplify the work of rescuers, but also to help the victims in an emergency (deliver water, provisions or contact the rescue service).

Ground robots are typically used to go into places that searchers can't fit into and go farther than search cameras can. Search cams typically max out at 18 feet, whereas ground robots have been able to go over 60 feet into rubble. They are also used to go into unsafe voids that a rescuer could fit in but that would be unsafe and thus would require teams to work for hours to shore up before anyone could enter it safely.

The main problem of any rescue robots is the permeability of the environment, since, for example, in the debris of a building, in addition to concrete, there may be fragments of furniture, ceramics, fabrics, carpets, etc. Therefore, the maximum grip of the wheels on any type of surface is important, caterpillar tracks made of single plates, as presented above, are not the best solution for this. Also, the robot must have minimal dimensions for maximum cross-country efficiency and simple movement mechanics.

Based on the analysis above, the robot snake has more advantages in terms of size, movement mechanics, and tortuosity. However, such a robot does not have good enough balance and also does not have wheels or limbs to push off from an obstacle. Track rescue robots have a sufficiently strong body, which is important in hazardous areas of collapse. The disadvantages of such robots are their rather massive caterpillar wheels, and their movement mechanics. Such robots are balanced enough to roll over on their own.

Human error is also an important factor. Not every rescuer is able to control the robot and analyze the data coming from the sensors of this robot. Such robots should have an intuitive control interface. Also, despite the professionalism, rescuers are not without anxiety, excitement and their own emotions during rescue operations.

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