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HYPOTHETIC ROBOT DESIGN USED BY SECURITY FORCES

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ABSTRACT
This article is analyzing usage of robots in security service departments, for example during conflagration localization, natural disasters and eliminating of terrorist threats.

KEYWORDS
robot, person and property protection, security forces

INTRODUCTION

Modern robotics is a science department that explore robots, it's construction, manufacturing, and it's application. Modern robotics is connected to mechanics, electronics, and software. The name "robotics" is for the first time used by writer Isaac Asimov in his novel Liar (1941). He described the set of rules which restricted and determined the behavior of robots. He also predicted further evolution in robotics. Nowadays, in the era of computers, automatization and different technological advancements, human activity is replaced by machines called robots. The robot is an automaton, capable of adaptation and reaction to outer impulses.

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ROBOT CONCEPTION FOR SECURITY FORCES

Hypothetic robot design for security forces is an update of current robotic machines, which would be extended of paralyser, water cannon, automatic targeting system, termovision etc. These upgrades have to be removable according to the situation.

The main goal is to propose such conception, which could fulfil mentioned parameters and also could be friendly to ratio rate price – properties. It is very important to choose wisely selected upgrades. The most important thing is the size of a mobile monitoring device. Small device would have problems with terrain and also a problem with cargo capacity. It is necessary to find a compromise between capability of terrain crossing, compactness, and manufacture price. The device is meant to protect persons and properties and for monitoring dangerous or unavailable areas. The main reason is to substitute humans during bomb crisis, human protection in dangerous areas, hostage negotiations, transport of hazardous packages etc. The main properties are mobility, operability, compactness and reliability. This device should be able to transfer pieces of information (audio + video) by cameras and also be able to eradicate IED (improvised explosives device). This device has to be able to move in buildings (object with obstacles, door frame sill, door steps, cables, restricted areas, slip plane).

ROBOT FUEL SYSTEM

We have to analyze some aspects of the matter before we approach to final proposition. We have to define where the robot would be used and for what purpose. We have to find out the appropriate type of chassis, fuel system, fuel, control unit, sensors, and further upgrades. This paper is focused on chassis and upgrades. Other systems would not be part of the hypothetic solution.

Controls:
- automatic;
- remote (teleoperated).

Information transfer:
- cable;
- radio.

Energy source:
- accumulators;
- cable.

Sensors:
– inner sensors;
– outer sensors.
Engine:
– one way engine;
– step engine;
– servomotors.
Chassis:
– wheel;
– belt;
– walking.

CHASSIS SELECTION

It is necessary to choose the chassis for the robot. Chassis would be selected according to environment, activity, and obstacles the robot should cross. We require good obstacle crossing and small size chassis. It does not require a big platform for replaceable upgrades, only a good price. We could find different types of chassis on the market. It is a better option to buy one than to design the new one. The platform could be obtained with motors and other subsystems. The environment is crucial in the selection of chassis.

We present the current chassis:

– wheel chassis: high-speed velocity and better effectivity, but less capable of crossing the doorsteps. An appropriate number of wheels is 4 or 6;

– belt chassis: good speed, control by slip, lower effectivity, but good ability to cross obstacles;

– walking chassis: control demanding, slower movement, energy--demanding;

– other types: flying robots, helicopter principles etc. It cannot be used in small areas. Good speed, no problems with ground obstacles.

We choose the belt chassis for its speed and its obstacle crossing. There is a good offer on the robots market.

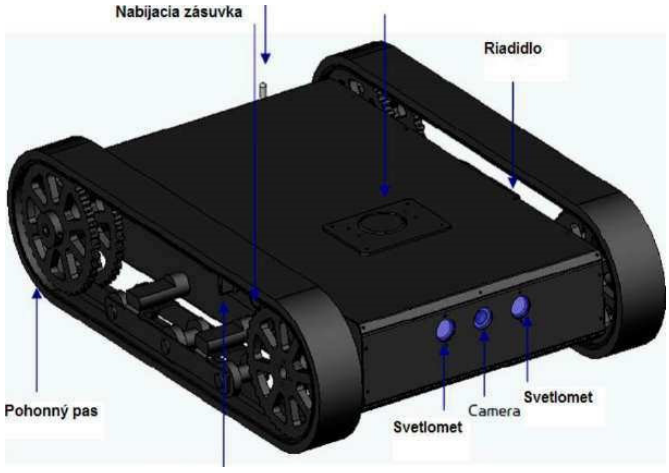
We picked up this kind of chassis:

1. Dr. Robot Jaguar Lite Tracked Mobile Platform (EU) (Figure 2.).
2. SuperDroid LT-F Complete Surveillance Robot w / Pelican Remote (EU) (Figure 1.).
3. Ares (EU) (Figure 3.).

Figure 1. SuperDroid LT-F. Win Antenna. GPS and 9 DOF IMU (Gyro/Accelerofneter/Compass)

Source: M. Ficery, *Analysis of the use of robotic devices in security forces*, Kosice 2014 (thesis).

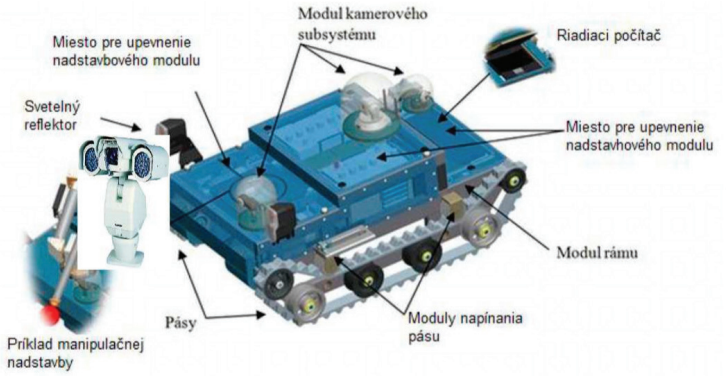
Figure 2. Vypínač. Dr. Robot Jaguar



Source: M. Ficery, *Analysis of the use of robotic devices in security forces*, Kosice 2014 (thesis).

We compared the mentioned attributes and we chose the robot Ares. It has ideal size, weight, and obstacles crossing (doorsteps, door frame) and good stand-by mode. It is equipped with main tools in communication and control. The great advantage of SuperDroid LT-F is the better construction and upgrade platform. We also need further investment to upgrades and robot enhancement.

Figure 3. Ares



Source: M. Ficery, *Analysis of the use of robotic devices in security forces*, Kosice 2014 (thesis).

ROBOT UPGRADES

Paralyser

The robot could be used during a suspect arrest when suspect does not cooperate. The robot could use an upgrade from TASER company (Figure 4.). The striking distance is 6 meters and its main purpose is to paralyse the human target. This weapon has two big disadvantages: main control cannot be positioned as 20m from the taser, reload time is 15 sec., and it is questionable if the suspect would be willing to wait so long. Company TASER and iRobot joint their efforts to eradicate these limitations.

Figure 4. Paralyser company TASER Water canon

Source: M. Ficery, *Analysis of the use of robotic devices in security forces*, Kosice 2014 (thesis).

Another upgrade of mobile chassis is connected to a water canon (Figure 5.). Robot with this upgrade is mentioned to eliminate dangerous objects, like IED, old ammunition etc. Mostly, they are pyrotechnic actions. Distance from the target is 6–12m (IED, old ammunition). The robot is controlled by the operator.

Figure 5. Water canon

Source: M. Ficery, *Analysis of the use of robotic devices in security forces*, Kosice 2014 (thesis).

Robot remote control enhancement

Our current experience with robot control revealed disadvantages with communication between human – machine. Operator, working in virtual reality, has to control several movement configurations (for example, one for control, another for camera or setting weapons systems), and the target surveillance is diminished.

For this purpose, the robot has a function „motion detection", with online picture information analysis. It includes three elements:

– movement control;
– camera layout control;
– weapon layout control;
– waterline layout control.

It was developed software called „POLOHA" for mentioned elements.

Automatic acquiring the target and it's surveillance

The camera targeting system (Figure 6.) is supported by panoramic infrared vision. Zoom system (PTZ – pan-tilt zoom) with high resolution enhances the targeting. Jamming influences (stillness of the object) are integrated by protocol PTZ to two-level searching. It means that system is scanning a wide area. Then comes objects zooming by PTZ camera, acquiring the target, and identifying the target by the expert system, which can differentiate several numbers of objects and specify vulnerable spots. Human identification is connected to non-lethal weapon activation for paralysing purposes.

Figure 6. Camera PTZ – pan-tilt-zoom Audio-video record with lower visibility

Source: M. Ficery, *Analysis of the use of robotic devices in security forces*, Kosice 2014 (thesis).

Person and property protection cannot be often provided in ideal environmental conditions, so it is necessary to use a termovision camera. Termovision camera is used during the night, in heavy weather, or during fog. Termovision camera does not need illumination.

Figure 7. Combine camera FLIR

Source: M. Ficery, *Analysis of the use of robotic devices in security forces*, Kosice 2014 (thesis).

Combine camera by company FLIR (Figure 7.) sees the scene in visible spectrum and in infrared. It enables recording from both mods.

The selection of the camera mod is determined by place parameters and it cannot be generally determined. It was created a camera control system with cooperation Technical University in Košice. It is complicated software called KAMERA.

Upgrades Subsystems

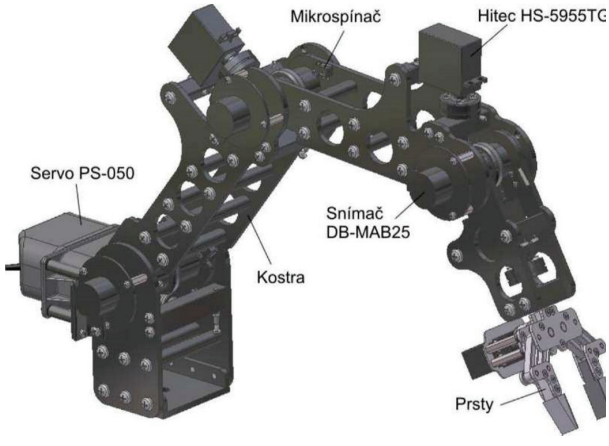
Space movement of working effector (with mission setting) can be solved by several approaches. According to the mission (technological, manipulative, auxiliary), action mechanism MSR can be solved by an artificial arm (analogy with PR) including the wrist with a mechanical interface for effector application.

a/ as robotic arm of static SR (for example for handicapped persons) **b/** as the robotic arm for manipulation with hazardous material **c/** as the robotic arm for agent models (for example door opening, food delivering) **d/** as the robotic arm for further use.

Robotic arm for hazardous material manipulation

The important upgrade would be a robotic arm (Figure 8.), which could manipulate hazardous material. Arm has six levels of freedom. Three levels include solo arm and another three include wrist. The final effector is the tentacle. The arm is connected to the base, which has a trapezoid shape. This base implemented the first level of freedom. The second, third and fourth level of freedom is created by the skeleton of the dual sheet 4mm. The fourth level of flexibility is part of the arm as part of the wrist. The fifth level of flexibility is maneuverability – catching ability. The tentacle includes two symmetric fingers, which move toward each other. It is sixth level of flexibility. Each joint includes s servo, movement sensor, final outputs and convolute cession. The second level of flexibility is used of motor with higher circle movement because the arm at this point is the biggest. Arm control is maintained by software RORA 14.

Figure 8. Robotic arm



Source: M. Ficery, *Analysis of the use of robotic devices in security forces*, Kosice 2014 (thesis).

CONCLUSION

This paper is focused on robots used by security forces for the person and property protection. The practical part includes the own proposition of a hypothetic robot. The mentioned design could be constructed. The main problem is a software of individual platforms and upgrades. The robot is created by several parts. The robot with changeable parts and upgrades could vital part of crime investigation and military actions. The robot could be a good devices to provide personal and property protection.

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