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ANALYSIS OF RESCUE ROBOTS

Urgency of the research. *The analysis shows that besides keeping pace in "classic" applications of robots (industrial robots) for manufacturing (engineering) industrial processes, at the same time the applications tend to concentrate mainly in the so-called non-engineering industrial and non-manufacturing (service) industries.*

Target setting. *Trends bring functional and constructional new requirements for robots and their applications, especially those related to the efficient usability of robots in new segments of the non-manufacturing and service sector.*

Actual scientific researches and issues analysis. *Actual research is nowadays focused at such problematics, because return of investments based on robotic devices seems to be reliable and people at workplace can realize and focus to another type of tasks.*

Uninvestigated parts of general matters defining. *Within this sector, it is primarily the area of rescue, where service robots have to overcome various obstacles in the performance of their activities, get into hard-to-reach and dangerous places, etc. depend mainly on its conceptual solution.*

The research objective. *Given that the company's priority is to continually improve its products, this group of robots is also looking for new innovative approaches that would improve the conceptual solutions of service robots and their operation in the application space. On this basis, it can be assumed that this aspect of continuous innovation opens up a large number of possibilities for new improvements to this group of robots.*

The statement of basic materials. *The emergence of this group of robots was conditioned by the requirements of practice, which required the concept of robots to be incorporated into non-industrial and non-production areas where robots would only perform activities that would be useful to humans or to technical and operational systems. For these reasons, the first designs of these robots began to emerge, which have been continuously improved over time and adapted to the needs of practice to such an extent that today they are an integral part of the service industry.*

Conclusions. *Mobile robotic systems are currently under intensive development. Variety brings service activities in service robotics need to use different principles for dealing with their mobility. The most prevalent application of the principle of a wheeled chassis. In terms of theory as well as technical solutions are the most sophisticated wheeled chassis and most widely used in service robotics. This work is developed in the direction of the current service robotics and the essential characteristics and problems associated with the solution that we applied in the educational process.*

Keywords: *Service robot; mobility subsystem; undercarriage; rescue robots.*

Fig.: 4. References: 12.

Introduction. Until recently the use of service robots for protection and human health (police and emergency services, fire departments, protecting against terrorism ...) were seen as cost-consuming experiment. The current global security situation in the world, as well as the reality of geographical and operational disasters (terrorist attacks, trade in hazardous materials, natural disasters, natural disasters, traffic accidents, ...) and in particular their adverse developments radically changed their minds and activities to use the service robots in the execution of the corresponding safety and rescue actions, as well as the performance of preventive and responsive exploration activities. Despite their wide use, rescue service robots are considered a costly experiment. Nevertheless, they have found their application mainly in hazardous environments and situations such as fires, floods, earthquakes, rescue, ie in various types of geographical and operational disasters. The rescue work in these disasters is considered to be a race against the clock, where the rescuer - robot must move fast enough to save as many living people as possible, but on the other hand, move without causing further damage or threats to human life.

Analysis of current IED and EOD service robots. Conceptual evaluation of solutions of individual modules was done by references leading manufacturers and service robots with their custom applications. The basic objective of the SR application in this area is to save human lives as well as to investigate life-threatening environments. Another reason is the ability of the Slovak Republic to get into spaces and places where one could not get and would be dangerous for him. The deployment of the Slovak Republic at the level of rescue services can be explained mainly by the nature of the risks related to the performance of the corresponding activity and the relation to human beings. These risks are:

- Risk from poor knowledge of the terrain and space of the event;
- Risk of not recognizing the rescue facility;
- The risk of an unknown state of danger of the intervention environment;
- As well as the risk of an unrecognized actual rescue situation and conditions for carrying out rescue activities.

In addition to the advantages of using these robots in this area, their application also brings disadvantages and unpleasant consequences, which can be characterized from two points of view:

• Failures to perform tasks that result from a person being excluded from decision making;

• In terms of the morality of the performance associated with the risks of above-average autonomy of the MSR in its performance and performance of the desired task.

The application possibilities of these robots can be explained on the model, which gives space for the classification of SR, which are suitable for application in the safety sector, but also for the compilation of the type series of robots for service tasks.

The robots can be deployed in the rescue area by deploying robots in locations that require direct performance of activities. These places respectively areas are:

Inspection and monitoring of the area and objects - the application is similar to that of the same segment of the security sector, but the difference is in the effects and technologies of the performance of monitoring and control as well as in the area and object of control. These applications are characterized by streamlining control performance as well as eliminating the mentally and physically strenuous control activities performed by man.

Rescue actions - the application is characterized by a high degree of operational risk and a high degree of readiness, with the aim of reducing the risks of performing rescue activities, eliminating demanding procedures of human intervention as well as trying to increase the independence and safety of performing intervention procedures.

Handling of hazardous material - the application is oriented to the performance of handling activities with designated hazardous material such as explosives, chemicals, unknown objects, etc., but it is also possible to monitor the degree of material risk or disposal of this material. The main objective of the application is to increase the safety of the implementation of procedures for handling and disposal of hazardous materials. Performance of given tasks is bound to confined space, inaccessible and dangerous space.

The conducted survey shows:

1. The basic principle of generating movement is where the movement of non-standard indoor and outdoor environments are the most commonly used tracked undercarriages, a 2, 4 and 6 band versions. Wheeled trucks are used rather to move on urbanized terrain. What is interesting is the combination of wheel and belt (f. REMOTEC) and can take advantage of the belt and the wheel to the terrain in the area of deployment, fig. 1 [3].

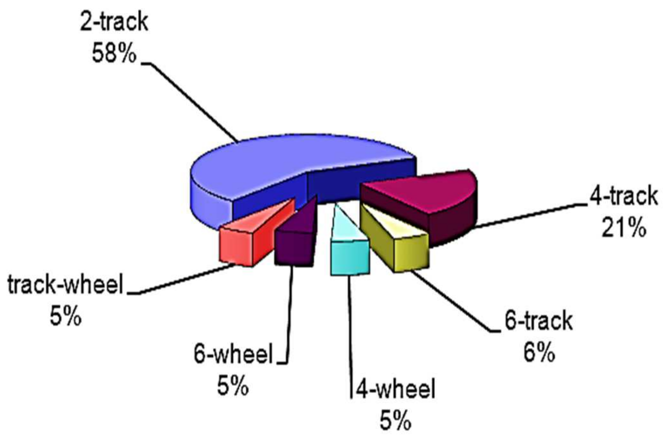

Fig. 1. Representation of service robots according to the principle of movement

For the design of the SR for deployment in the security services are the most typical of the following: As a source of energy Fig. 2, the most commonly used batteries, but mostly with robots for firefighting often use an external power source. To improve battery performance using the hybrid system, where the combustion engine recharges the batterycells.

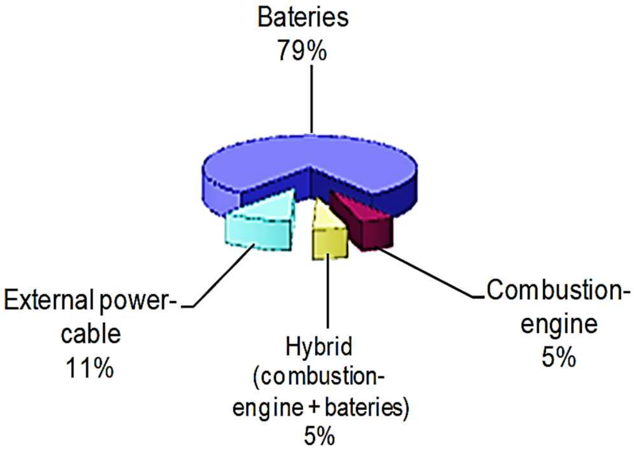

Fig. 2. Representation of service robots according to the source of energy

In Figure 3 the evaluation of climbing ability, we found that the greatest percentage of hill-starting ability of robots to 45 degrees and 47%. Robots from the hill-starting ability 40 ° up 24%, the rest are hill-starting ability of robots to 30 °.

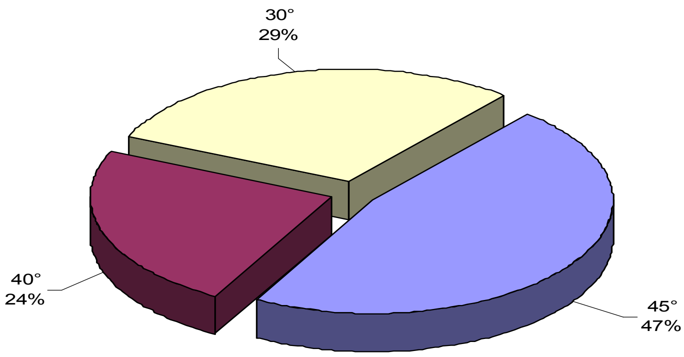

Fig. 3. Maximum gradeability of service robots

In the evaluation of velocities, we found that the largest share of the robots at 5 to 10 km / h. The type used are represented in virtually all known concepts of 1 ° to 6 ° of freedom. Prevail arms with 2 ° and 4 ° degrees of freedom. In terms of the kinematic pairs, the most common rotation axis.

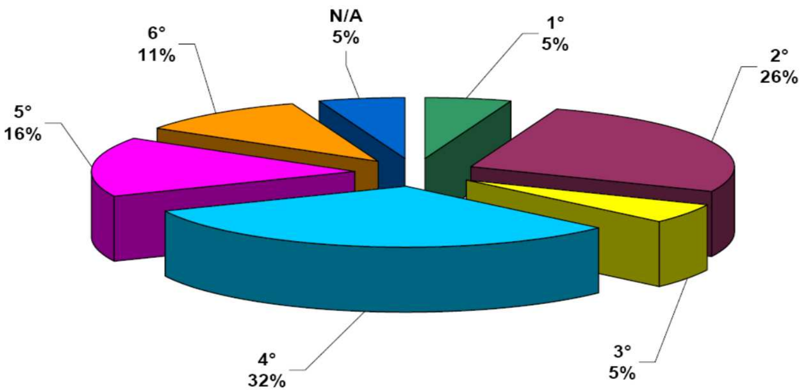

Fig. 4. Number of degrees of freedom of action of the superstructure

The abundance of arms to the base of the overriding concept of action with one arm (79% rated agents), especially in the category Fire and prieskumníckych robots. Contrast, double-arm approach prevails in the category of heavy vyslobodzovacích robots.

Note: The arm was treated for fire-fighting robot machine with a nozzle for extinguishing medium with at least 1 degrees of freedom.

Evaluation of the presence of effector and technical execution points to the fact that the effector is used most gripping in the 2-finger concept. Even if the equipment arm device for the automatic exchange of effector in most cases were listed as primary footed tentacles.

3. The vast majority of SR is controlled by the operator if necessary. teleoperator, which controls the movement and application hit the robot from a safe distance.

4. The development and production of service robots is required close cooperation with manufacturers of robots - mostly producers of service robots in the field of terrorism. Thus many companies unifies its new mobile chassis for use in different applications. The process of unification is often initiated by manufacturers and service robots. The most comprehensive approach in this area, attesting to the company QinetiQ.

By researching the conceptual solutions of the Slovak Republic in this area, where we focused mainly on the mobility subsystem, we obtained conclusions that can be written into the following points:

- Service robots are approximately equally represented in all rescue applications (inspection and monitoring, rescue operations, hazardous materials handling).
- The most used concepts are built on a crawler chassis in 2, 4 and 6 crawler versions.
- Applications on wheeled chassis in 4 and 6 wheel versions are also used, as well as applications based on a 6-foot walking chassis.
- Possibility to use a conceptual solution based on a hybrid system, such as a walking-wheel system.
- The most commonly used power source is a battery or battery. external power source - cable (fire extinguishing).
- Some applications are also based on a hybrid system (improving battery life).
- The maximum speed of the SR is in most cases from 5 - 10 km / h
- Service robots with the 45% climb rate are the most represented in the rescue sector.
- Arms with 4 ° - 6 ° freedom are predominantly used.
- Single arm concepts are applied in inspection and reconnaissance and firefighting
- Two-arm concepts are mainly applied in the field of rescue and hazardous materials handling.
- Service robots control is based on operator or teleoperator control.
- The most common way of communication is based on WiFi technology.

Recommendations for designing EOD and IED robots. Analysis of the current implementation of SR in this field allows formulating the framework conditions for SR, but also specifically bound by the requirements to perform specific tasks. Requirements can be summarized for each sub-SR as follows:

- mobility subsystem solved by belt-type locomotion system because the benefits provided by this solution (specific surface pressure, permeability, maneuverability, Wading depth ...). Motion control is recommended to solve the differential form of governance that meets the desired range of speed of movement (3, respectively. 5 ms^{-1}) and the minimum turning radius. The proposed solution is recommended to structurally solve a manner that the degree of resistance (degree of protection, resistance to environmental factors ...).
- action extension (as is clear from the submission) as a single-deal - the kinematics of the action mechanism is recommended to deal with 6 degrees of freedom with angular workspace. Since our body is assumed as a modular solution, are permitted other kinematic arrangement pairs. It is recommended to resolve system stability of the subsystem mobility in relation to the maximum reach and capacity of each of the planned arms. The end effector is recommended to deal with the needs of a particular application of determining the arm. Consider the possibility of a need for an automatic exchange of the end effector, respectively tools.
- intelligent control subsystem teleoperator deal with the possibility of autonomous management tasks. Communication with the robot operator dealt with in accordance with the

compatibility interface bus systems with open architecture. Sensor Used to guarantee the required communication with the working and operating environment.

• sensor subsystem in relation to a report by the internal sensors to solve application usage on the monitored parameters and mechanism function (accuracy, range of measured values, for the principle of scanning parameters, performance measurement, performance monitoring, ...); in relation to the compatibility of the control-control system according to the interface (mechanical, electrical, programming, data transfer); prepare outputs from the sensors for management purposes;

• set of external sensors addressed by technology and the role of controlling environmental factors, respectively. Role of service performance parameters (sensitivity, sensing principle for variables, functions, monitoring, alarm function, night vision, thermography, virtual 3D gloves, 3D cameras, etc.).

• in relation to the performance features to address the operating range for diluted version of the cable operators across a range max. 150 m, a wireless version with a max. deal range to 1000 meters (outdoors). For wireless version to consider the duration of the mission about 3 hours possible forms of sleep waiting for the mission until 24 hours. Operational readiness and resolve to intervene when necessary could be implemented immediately. The same condition applies for transportability (own transfer activity, transfer to another means of stability for transport and so on.).

The current development of service robots is associated with two approaches to their design and their construction.

• classical concept design by the chosen system structure, based on its own (original) design, in which the use of appropriate components,

• modular design and modular structure according to the chosen system, and the best use of available modular units and components.

Sets of modular units (translational and rotational) with staggered parameters, strokes, and performance sections, to create more complex system, allow considering the compatibility Interface compilation of different robot configurations as required by the shape and size dimensions, useful load, throughput, and the like.

Conclusions. Mobile robotic systems are currently under intensive development. Variety brings service activities in service robotics need to use different principles for dealing with their mobility. The most prevalent application of the principle of a wheeled chassis. In terms of theory as well as technical solutions are the most sophisticated wheeled chassis and most widely used in service robotics. This work is developed in the direction of the current service robotics and the essential characteristics and problems associated with the solution that we applied in the educational process.

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Рудольф Янош

АНАЛІЗ РОБОТІВ-РЯТУВАЛЬНИКІВ

Актуальність теми дослідження. *Аналіз показує, що, окрім збереження «класичних» застосувань роботів (промислових роботів) для виробничих (інженерних) промислових процесів, останнім часом їх застосування переважно, сконцентровано в так званих неінженерних промислових і невиробничих (сервісних) галузях.*

Постановка проблеми. *Тенденції висувають нові функціональні та конструктивні вимоги до роботів та їх застосування, особливо тих, що стосуються ефективного використання роботів у нових сегментах невиробничого та сервісного секторів.*

Аналіз останніх досліджень і публікацій. *Актуальні на сьогодні дослідження орієнтовані на сформульовану проблему повернення інвестицій у роботизовані пристрої, що є гарантованим завдяки тому, що люди на робочому місці можуть розвиватись та зосередитись на інших видах завдань.*

Виділення недосліджених частин загальної проблеми *у цьому секторі, а це передусім сфера порятунку, де роботам доводиться долати різні перешкоди при здійсненні своєї діяльності, потрапляти у важкодоступні та небезпечні місця тощо, залежить головним чином від концептуального рішення робота.*

Постановка завдання. *Враховуючи, що пріоритетом компанії є постійне вдосконалення своєї продукції, ця група роботів також шукає нові інноваційні підходи, які б покращили концептуальні рішення сервісних роботів та їх використання в прикладних галузях. Зважаючи на це, можна припустити, що цей аспект постійних інновацій відкриває велику кількість можливостей для нових удосконалень цієї групи роботів.*

Виклад основного матеріалу. *Поява цієї групи роботів була зумовлена вимогами практики, яка вимагала включення концепції роботів у непромисловій та невиробничій сферах, де роботи виконували б лише дії, які були б корисні людині або технічно-експлуатаційним системам. З цієї причини почали з'являтися перші конструкції таких роботів, які з часом постійно удосконалювалися та адаптувались до практичних потреб настільки, що сьогодні вони є невід'ємною частиною сфери послуг.*

Висновки відповідно до статті. *Мобільні роботизовані системи сьогодні перебувають в стадії інтенсивного розвитку. Різноманітність сервісної діяльності у сфері обслуговування вимагає залучення робототехніки з різними концептуальними рішеннями щодо їх мобільності. Найбільш поширене застосування принципу колісного шасі. З погляду теорії, а також технічних рішень найскладнішим є колісне шасі і саме воно найбільш широко застосовується в сфері робототехніки. Ця стаття виконана в напрямку сучасного обслуговування робототехніки та основних характеристик і проблем, пов'язаних із рішенням, яке ми застосовували у навчальному процесі.*

Ключові слова: *сервісний робот; підсистема мобільності; ходова частина; рятувальні роботи.*

Рис.: 4. Бібл.: 12.

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