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APPLICATION OF THE PROTOTYPE OF BELT MOBILE ROBOT IN URBAN ENVIRONMENT

APLIKACE PROTOTYPU PÁSOVÉHO MOBILNÍHO ROBOTU V MĚSTSKÉM PROSTŘEDÍ

Abstract

The article presents applications of produced prototype of a belt mobile robot in urban environment. After checking the functionality of all subsystems of produced prototype of the belt robot there will be a layout service tasks for urban environment realized. Chosen service tasks, for which the robot was designed, have technological and no-technological execution. In most of applications there will be used a manipulation extension carried by robot. Then there will be service tasks of rescue type executed. The robot can carry for example water holing hole etc. The paper also presents another version of the belt mobile robot intended for service tasks of similar character.

Abstrakt

Článek prezentuje aplikace vyrobeného prototypu pásového mobilního robotu v městském prostředí. Po ověření funkčnosti všech subsystémů vyrobeného prototypu pásového robotu budou realizovány vytypované servisní úlohy pro městské prostředí. Vybrané servisní úlohy, pro které byl robot navržen, jsou technologického i netechnologického výkonu. V převážné většině aplikací se bude jednat o využití manipulačních nástaveb, které robot ponese. Dále to budou servisní úlohy zásahového typu. Robot může nést např. vodní rozstřelovač apod. Článek prezentuje také další variantu pásového mobilního robotu určeného pro servisní úlohy podobného charakteru.

1 INTRODUCTION

From point of view of application of the mobile robots, urban environment is characteristic, because there can be robots with all type of possible locomotive mechanism used. From point of view of a number of applications, the most frequent types nowadays are mobile robots with wheel or belt locomotive mechanism. In many cases there are used also hybrid locomotive mechanism robots (wheel – belt, leg – wheel etc.). The mobile wheel or belt locomotive mechanism robots are suitable for wide spectrum of service tasks realized just in urban environment. During the realization of these tasks the robots must be able to move in indoor and also in outdoor environment. It is possible to divide service tasks realized in urban environment according to various points of view. It is possible to divide service tasks according to character of execution of transaction to these types:

- Technological achievement (diagnostics, monitoring, destruction, servicing, cleaning, hygiene etc.)
- No-technological achievement (transport, handling, identification, searching, guided, gripping etc.)
- Character helping achievement (helping operation, collecting information, hold etc.)

Character of technological and no technological achievement during the service tasks realized by mobile robots prevails in urban environment. Relatively big group of mobile robots is formed by robots targeted to monitoring and identification. It is not only about monitoring of indoor or outdoor environment with the aid of one or more cameras. Range of service tasks is specialized also to monitoring of presence of various matters in atmosphere, of taking and analyzing liquid or solid samples

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etc. In such case we can consider for example application of emergency robots in urban environment during accidents, natural disasters etc.

The next big group of the robots is presented by mobile robots intended for servicing, cleaning and hygiene. In this area there is a wide spectrum of service tasks. There can assert the mobile robots from small size to robust, for using in indoor and also outdoor environment. Except ordinary cleaning activity there are also realized tasks like cleaning and servicing sewerage system, servicing outdoor green etc. Many robotic devices with this specialization are used especially in areas of health service and building industries.

The mobile robots intended to application for transport and manipulations represent the third big group. The robots intended to exercising the service tasks of this type have one or more manipulation extensions, or eventually they are adapted for transport smaller or bigger subjects. There is also substantial variability of service tasks. In this field we can consider also application of the mobile robots to the areas of dangerous or unnatural environment. In this field there are also registered emergency robots carrying out manipulation with dangerous matters, explosive substance etc.

The mobile robots intended to application for searching, navigation, collecting information, holding etc. constitute a group that is not so good-sized compared to the mentioned groups above. Nevertheless for example in health service areas there are some service tasks, which have to be realized. We can mention as an example mobile robots for helping handicapped people, surgical robots etc. Mobile robots with belt or wheel locomotive mechanism are suitable for assertion in mentioned short choice of specified service tasks realized in the urban environment area. Except that there is also a range of other specific requirements for construction of the robots. All the requirements depend on concrete type of service tasks and on factors affecting existent environment [1, 4].

2 APPLICATION OF THE PROTOTYPE MODULAR BELT MOBILE ROBOT

On the Department of Robotics there are questions regarding the design of robots for area urban environment still actual and they are answered in terms of solving various projects. In terms of solving the science and research project there was in cooperation with students a design of mobile robot with the belt locomotive mechanism solved. This was the robot we can use with advantage for application in urban environment. The robot is able to carry a heavier loading and it is possible to fasten it by a range of various extension of modulus to the upper platform of locomotive mechanism. 3D model of the robot in connection with manipulation extension is shown on Fig. 1 [2].

According to a conception of the belt robot and according to purpose of its usage (area of urban environment) there were some requirements for its ground plan size and other parameters given. All parameters of produced prototype of the belt robot are mentioned in paper describing its construction. There was given a requirement for possibility to get through a door of 800 mm width and to drive up and down on the stairs. On the locomotive mechanism there is a rubber belt suitable for movement in indoor and outdoor environment used. Frame design of locomotive mechanism of the robot shows the possibility to fasten extension modulus to the upper carrying area with total mass 80 kg at maximum. The robot is able to safely take the obstacles of 220 mm height. On Fig. 2 there is shown one phase of drive of the robot during crossing the indoor stairs of normalized size 170 x 290 mm.

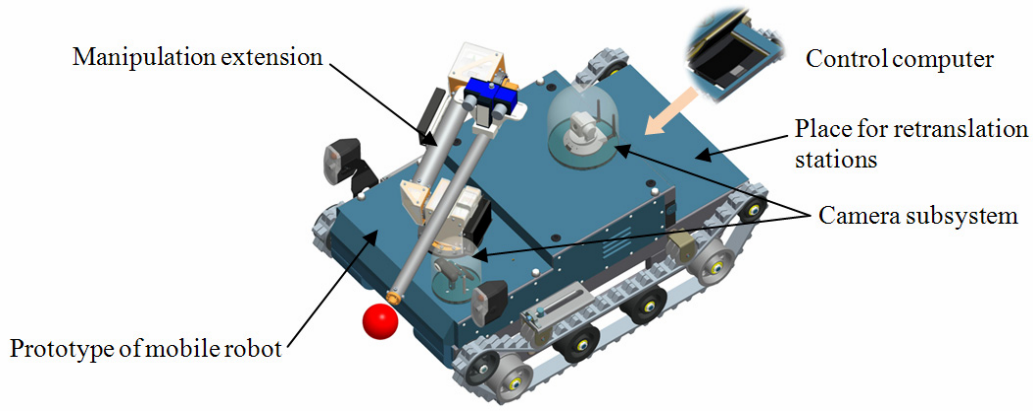

Fig. 1 3D model of the robot with manipulation extension

The belt robot is designed as a modular construction. It is possible to modify a range of modulus (modulus power supply, control module, modulus belt tensioning etc.). In connection with extension modulus we can use the mobile robot for a wide spectrum of the service tasks in urban environment. In this case we can consider the manipulation extension, chambers for obtained samples, grippers for taking samples of different state phase, camera subsystems for monitoring and camera subsystem for 3D metric data capturing, shoots for liquidation of demolition bombs etc. Further we can equip the robot with a detection apparatus for qualitative determination of dangerous substances and an apparatus for reconnaissance stricken space with long-distance data transmission to operator station.

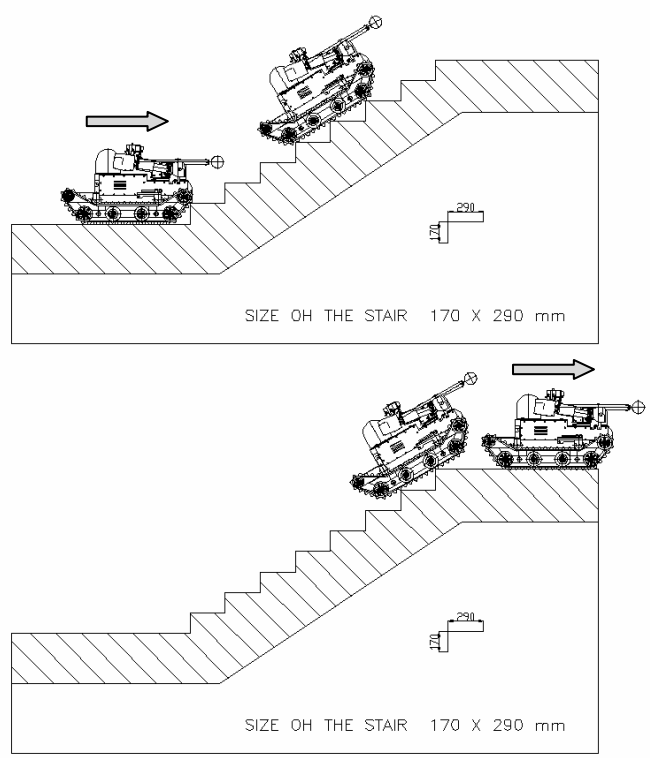

Fig. 2 Phase drive belt robot up and down on the stairs

Very interesting application is using the prototype of belt robot for 3D metrical data capturing. In this case we can use camera subsystem designated for these purposes. 3D data capturing system has been taken and further modified from a previous grant partially solved, which was funded by Grant Agency of Czech Republic. Lens shutters of the cameras during making stereo pair images of the measured object are controlled from the operator station. Images are transmitted wireless to monitor to operator. Processing of the images is made directly in the computer placed at the robot. Accuracy of the captured 3D data depends on measured object distance. With the photogrammetric base and camera types we use, best results are achieved at 10 m distance – in this case it is lower then 15 mm. Connection the belt robot with camera subsystem for 3D data capturing is shown on Fig. 3 [3].

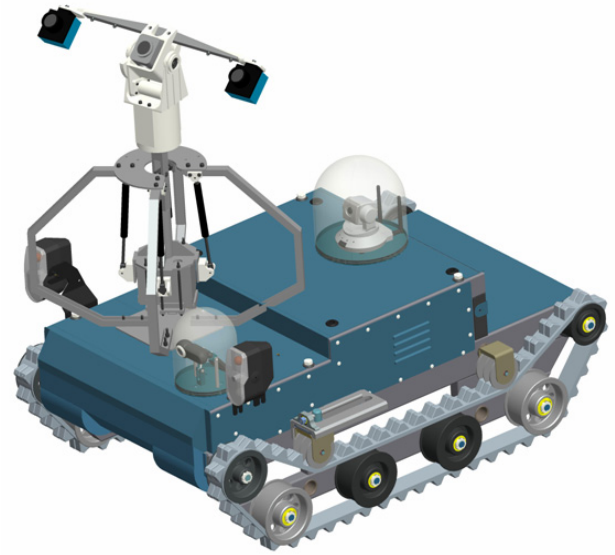

Fig. 3 The belt mobile robot with camera subsystem for 3D data capturing

From the point of view of practical application we can apply the robot with 3D capturing device for the following service tasks in urban environment:

- Gathering 3D metric data during survey in unknown terrain.
- Gathering 3D metric data during survey of human inaccessible areas.
- In chemically or in other way contaminated environments suitable completion.
- Various security related tasks.
- Size determination in indoor and outdoor environments.
- In the area of civilian use this robot may help with labor intensive tasks measurements of shape complex objects.
- Specific tasks in other fields for 3D metrical data capturing.

As a next concrete example it is possible to show a placing of the manipulation extension to the upper platform of locomotive mechanism. In this case there is a service robot used for example for taking samples in the place of extraordinary matters and their following translation to the mobile laboratories. Fastening one of possible types of manipulation extension to the belt locomotive mechanism is shown on Fig. 1.

The designed belt locomotive mechanism with manipulation extension can be used for intervention in environment, where some dangerous substances have occurred. Except that it is possible to carry out a range of other service tasks. It is possible to consider next situation:

- Accident in chemical industry or in energetic.
- Accident after natural disaster.
- Accident on product lead.
- Accident during transportation of dangerous substance by the road, railway etc.
- Security hits (terrorism etc.).
- Service of green vegetation in city parks.
- Production of color marking on outside objects etc.

The robot can take place in the areas inaccessible or dangerous for human presence. We plan to modify the robot for several different tasks in the future. Extension camera module can be applied to various types of locomotion mechanisms. Last but not least these robots can be very helpful during rescue operations. In such case the condition of using the robot in special environments, including explosion risk areas can be considered.

2.1 The next version of modular belt mobile robot

Nowadays there are other versions of mobile belt robots prepared. One of those versions is a belt robot with flexible kinematics of the belt. The robot of such design has better manoeuvrability during the movement on broken terrain. Construction of the locomotive mechanism has a beaded frame and allows applying more loading to upper platform of the robot. Upper platform has a bigger ground plan surface. During the movement of the robot past the inclined plane, the upper platform is able to set up to the horizontal position. Such a design of the robot allows adding for example a chamber on obtained sample, an automatic exchanges gripper subsystem etc. to the fastened manipulation extension. The robot has more powerful motors and achieves during the movement higher speed c. 6 km/hour too. 3D model of new version of the belt robot is shown on Fig. 4 in connection with same manipulation extension as on Fig. 1 and chamber on obtained samples.

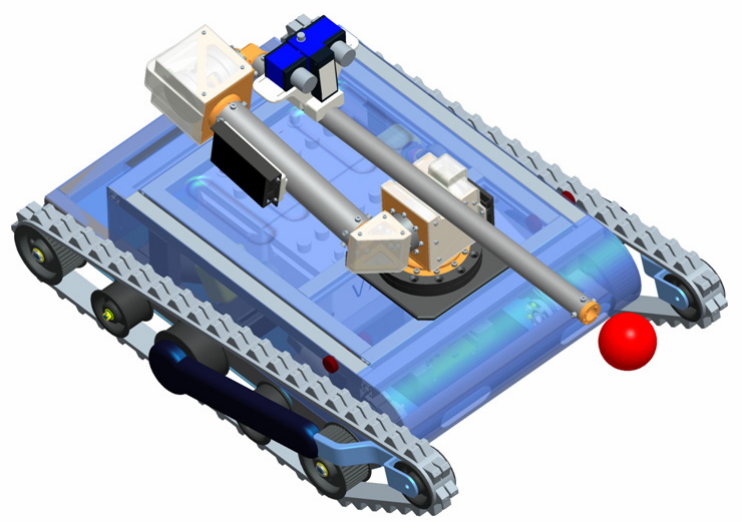

Fig. 4 The next variant of belt mobile robot

At the rear of new version of belt robot there is a space for fastening the manipulation modulus prepared, as well as in existing variants on Fig. 1. The manipulation modulus is prepared in these days and will allow unloading and loading of retranslation stations. Control of the robot with usage of retranslation stations will make the communication with robot in spaces, where is a problem with wireless communication better. Firstly we can consider two retranslation stations.

3 CONCLUSIONS

For produced prototype of the modular belt mobile robot there are nowadays prepared selected service tasks from versions mentioned above. There is also prepared the manipulation extension which will be used on the robot. Among others we will test the influence of various environments on behavior of the robots, control subsystems and video signal transmission. During the testing of produced prototype there will be gained knowledge acquired in to the anew prepared versions of the belt robots. This article presents knowledge gained during solution of grant project no. BI 3549011.

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