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Concept of Mobile Robots for Movement in an Unknown Environment

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Abstract The paper deals with the design of the s models of a wheel and belt chassis with improved ability to cross a rugged terrain. This concept of mechatronic systems will have a good ability to overcome obstacles encountered in urban and non-urban environments. With its properties and characteristic features it should be able to adapt to diverse terrain, overcome obstacles such as stairs, slopes, rocks, but also muddy, sandy or slippery surface. The requirements and criteria imposed on this robot will depend on the mentioned properties.

Keywords: *mobile robot, wheeled chassis, belt chassis*

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1. Introduction

The current global security situation in the world as much as the reality of geographic and operational disasters and especially their adverse development radically changed activities of utilizing service robots for use in the corresponding security and rescue actions.

Mobile robots can be utilized in many places of human life. They can be designed for various environments [1]. Research, development and education in the mobile robotics requires verification of properties of different systems [2].

The design of the robot for a certain purpose always implies several steps. Before thinking about the design of the robot, it is necessary to establish an environment in which it should work. For example, we consider a kind of bedrock or obstacles that may occur during the motion. The rugged environment can be defined as non-urban environment, i.e. exterior, its terrain and obstacles. Nowadays, there are many types of chassis that are designed for such environment. Individual types differ from each in concept and type platforms.

This mainly concerns the difficult operating environment, special tasks such as security, nuclear industry, building industry, agriculture and forestry. A model is also required for examining behavior of chassis on diverse terrain, for examining the influence of dimensions on chassis behavior during crossing over roughness of terrain. What is well adapted to the mentioned tasks are the tracked and wheeled chassis, which have the desired properties for overcoming obstacles, and have very good balance between weight and load capacity.

The main reason for the application of service robots for these services is to limit the risks and potential losses. Another reason is the ability and technical readiness of service robots to get to places inaccessible and dangerous to humans, or which a person would not be able to control.

2. Mobile Robot with Divided Chassis

Robot GTR 2010 represents a solution of wheel chassis with autonomous 4x4 wheel drive designed for diverse terrain.

It can be used for a variety of special tasks such as inspection of automobile chassis and explosives disposal, pipelines, cavities and difficult to reach locations inspection, manipulation with dangerous materials, telecommunication and cable network installation, tactical tasks in fight against terrorists and so on. The base of the device is chassis frame composed of two parts connected by a passive joint.

The robot chassis has a four-wheel drive that does not lose traction even on diverse terrain surface due to the passive joint. It enables both parts of the frame to tilt freely depending on terrain difficulty. This achieves that every wheel at any given moment keeps contact with the terrain.

Figure 1. Mobile robot GTR 2010

The functional model contains a single-chip microcomputer with electronic modules to control the operation of motors and is also equipped with adjustable camera system with wireless image transmission.

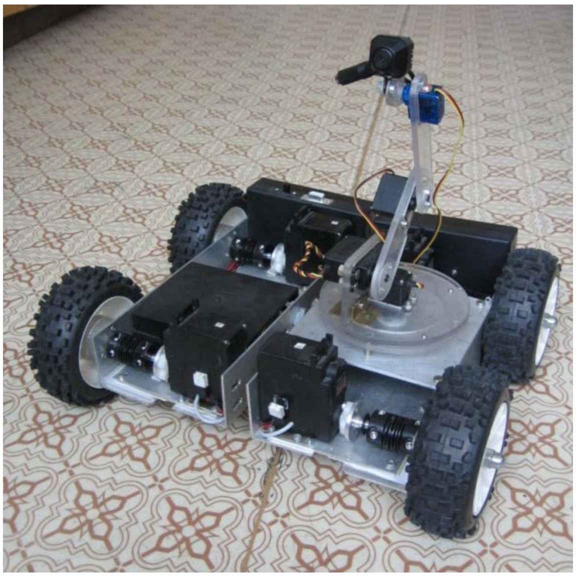

Figure 2. Chassis frame of mobile robot

Technical parameters of functional chassis GTR 2010 model:

- wheel base: 190 mm
- gauge: 370 mm
- inner diameter: 30 mm
- total mass: 3 kg
- maximal loading capacity: 10 kg
- average motion velocity: 0,3 m/s.

For its motion the designed chassis uses differential method of wheel control. The wheels rotation is independently controlled which allows the device to turn on the spot with a zero turning radius (similar to a military tank) [3]. Changing the direction of travel is carried out using different rpm of left and right wheels. This is called differential wheel control, which is also used in the control of tracked vehicles [4].

3. Mobile Robot of the Six-wheel Chassis

The proposed concept of the six-wheel chassis with all-wheel drive, in comparison to other existing concepts, improves the crossing of the chassis through rugged terrain and other difficult obstacles.

The designed chassis uses for its motion differential method of wheel control. Chassis motion should be stable and fluent to avoid slipping between wheels and terrain and to avoid mechanical shock resulting from rapid changes in chassis motion.However during chassis motion unavoidable trajectory deviations between current position and requested trajectory do occur because of path tracking control imperfection using wheels velocity and fault variables from environment (terrain roughness, friction forces changes between wheels and terrain and so forth).

The chassis consists of five modules, which are interconnected. Their rotation against each other is limited by the upper connecting frame. Two modules placed between the wheels fulfil the role of storage space. They act as a spur formed by spacing columns for already mentioned connecting frame, where the control equipment and possible action superstructure are placed [5].

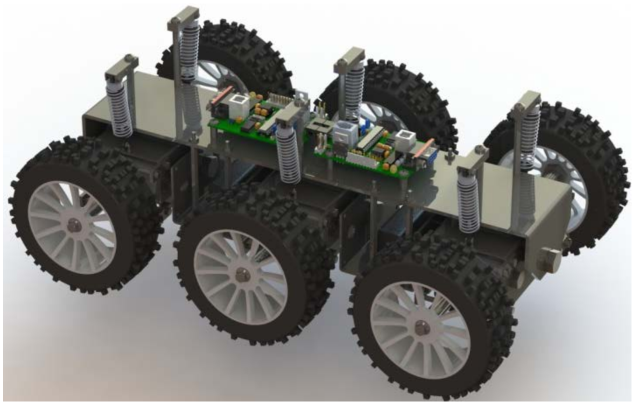

Figure 3. Mobile robot of the six-wheel chassis

The individual modules with wheels do not differ from each other.

Dimensions and weight of the robot:

Length /width /height: 410 /240 /150 mm

Weight of the entire variant is: 6000 g

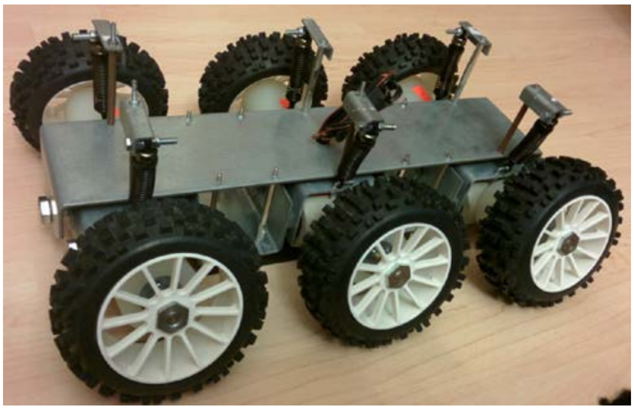

Figure 4. Real model

As it can be seen in Figure 4, we approached to the design of the individual modules suspension. Using damping devices, the cases with the engines and wheels are mounted on these modules. They are placed on the top bearing part of the robot. Damping devices reduce fluctuation of individual modules and absorb bumps arising when the wheels are passing through rugged terrain.

4. Mobile Robot of the belt Chassis

The concept of the tracked mobile robot is based on the structure of the system mobile model. The subsystem of mobility of the tracked mobile robot is built on the principle of the belt drive mechanism.

Methodology of mobile robot design is based on a rational approach to ensuring and implementation, from the layout to the description of the new mobile robot.

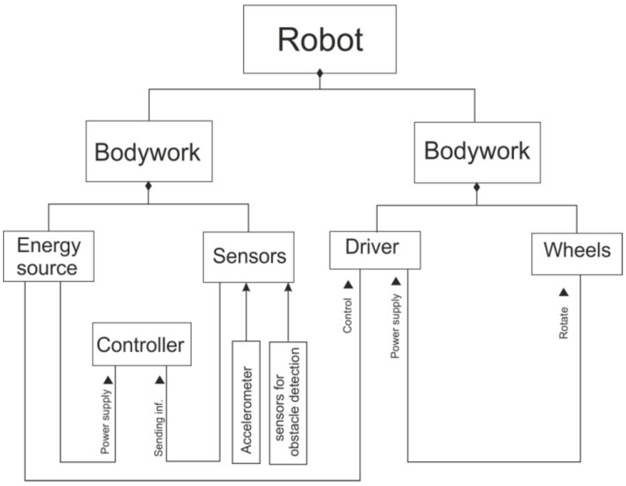

Figure 5. UML diagram of concept robot

The system model of the tracked chassis (Figure 5) is based on functional groups: platform, chassis frame, drive unit, power source, belt module, internal sensor system, external sensor system, car body.

The designed tracked robot is composed of frames around which the belt revolves. This structure is sufficiently rigid and less vulnerable to damage.

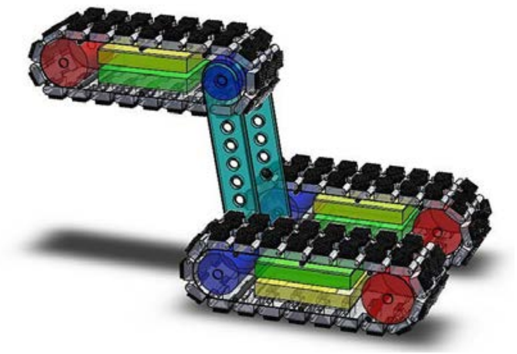

Figure 6. Model of mobile robot

The arms can turn out the central belt upward and to a greater distance. This allows easy passage through the complex and high obstacles.

The frame is filled with all of the important components. The individual parts of the robot are connected by means of output shafts of the actuators. Each frame must have its own propulsion, power supply, control unit, electronics, and also ditch crossing.

Dimensions and weight of the tracked robot:

Length /width /height: 230/230/85.5 mm, the weight of the entire variant is: 3190 g.

The Figure 7 shows a realistic constructed model and the three-dimensional model in Solid Works.

5. Conclusion

The paper deals with the proposal to the concept of mechatronic system for overcoming obstacles.

Robotic systems should in the future replace man at work in a hazardous environment. This would limit the unnecessary loss of human lives at work in guarding services, protection of soldiers in the army, terrorist attacks and removing of minefields. In real life experience, it is very often needed to perform manipulation with materials dangerous to humans. With the increasing number of nuclear power plants and workplaces with hazardous operations also increases the demand for manipulators and devices that would eliminate direct contact of personnel with hazardous materials.

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Figure 7. The real model of belt robot and a model in SolidWorks

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