Abstract. The atomic mechanism of wear of hard alloys based on the formation of metal bonds by the valence electrons of the processed and tool materials is described. Neural network models for cutting tool wear and selection of wear resistant coatings have been developed.

References

1. Loladze T.N. Durability and wear resistance of the cutting tool. M.: Mechanical Engineering, 1982. 320 p.
2. Bobrov V.F. Fundamentals of the theory of cutting metals. M.: Mechanical Engineering, 1975. 344 p.
3. Grigorovich V.K. Metal bond and metal structure. M.: Science, 1988. 296p.
4. Vereshchaka A.S. Efficiency of coated cutting tools. M.: Mechanical Engineering, 1993. 336 p.
5. Kabaldin Yu.G., Kretinin OV, Shatagin DA, Vlasov E.E. The choice of composition and structure of wear-resistant nanostructured coatings for carbide cutting tools based on quantum mechanical modeling. M.: Innovative engineering, 2017. 216 p.
6. Artificial intelligence and cyber - physical machining systems in digital production: monograph / Yu.G. Kabaldin et al. Nizhny Novgorod: Nizhegorod. state tech. un-t named R.E. Alekseev, 2018. 271 p.
7. Andrievsky A.R., Spivak I.I. The strength of refractory compounds and materials on their basis. Directory. Chelyabinsk: Metallurgy. Chelyabinsk branch. 1989. 368 p.

UDC 629.365 https://doi.org/10.26160/2618-6810-2019-2-122-124

AUTONOMOUS MOBILE ROBOT FOR EMERGENCY SITUATIONS

Rachkov M.Yu., Emelyanov A.M., Kolot V.Yu.
Moscow Polytech, Moscow

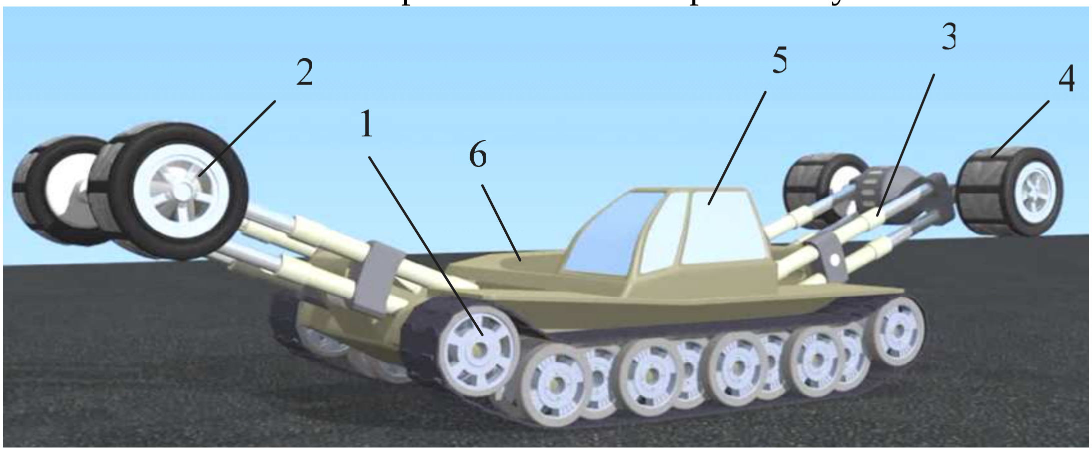
Keywords: autonomous robot, reconfigurable design, off-road locomotion, emergency work, simulation.

Abstract. The article describes research results of a new transport robot type with enhanced functionality due to the possibilities of overcoming various obstacles as well as high-speed motion along even surfaces by reconfiguring its structure to a kind of the motion surface. The robot allows automating various types of work in zones of increased danger to humans and in hard-to-reach areas. The robot has wide opportunities to move over a rough terrain as well as to overcome obstacles of various shapes, including obstacles with a height greater than the height of the tracked groups. The experimental model with remote control based on standard components has been implemented. Efficiency of the experimental model was tested with remote manual control over the radio channel.

In emergency situations, for example, in case of fires or during hazardous operations, such as demining, it is necessary to deliver appropriate technological, inspection or rescue equipment to the working area in automatic mode. A convenient solution to the problem is the use of autonomous robots that have specified equipment on board.

The proposed design of the robot contains a combined drive system consisting of transformable tracked and wheel groups (Fig. 1).

The robot has two tracked drives located on technological platform sides, and two wheel drives mounted to the front and back parts of the platform between the tracked groups [1]. A peculiarity is that the axles of the wheel drives are connected with the platform by means of levers. The lever drives are placed on the platform with the possibility of moving the wheel drives vertically relative to the platform. A lever length can vary that allows transforming the robot to overcome various obstacles. There are extending parts on the wheels that have a form of spikes. This solution increases a diameter of the wheels and its passability. A kinematic model of the robot in the SolidWorks environment has been developed for the study of various modes of robot movement. The motion on a flat surface is carried out only by the wheel groups with retracted spikes and raised tracked groups. That provides increased speed in this mode. The motion along an uneven surface is carried out only by the track groups. The wheel drives are raised in this mode that provides increased passability.



1 – tracked group, 2 – wheel group, 3 – telescopic levers, 4 – extending parts (spikes), 5 – onboard control system, 6 – technological platform

Fig. 1. Design of the robot

Flights of stairs and obstacles of complex geometric shape can be overcome by simultaneous use of the wheel and tracked groups. Positions of the wheel groups are changed relative to the tracked groups. The length of the levers and the height of the wheel spikes are determined by sizes and shapes of stairs and obstacles.

The results of kinematic simulation showed the possibility of the robot to overcome all these types of obstacles. The robot control system allows automatic mutual position reconfiguring the tracks and the wheels that depends on road and obstacle features. The obstacle features are measured by means of obstacle height sensors, obstacle width sensors, sensors of the platform angle, obstacle distance sensors, and sensors of presence of the next upper and lower step on stairs flights.

The experimental model of the robot is its reduced copy made on the basis of standard components, namely, the wheel group and the tracked group with built-in drives. It is controlled from a remote control unit. General view of the experimental model is shown in Fig. 2. The overall dimensions of the model in the position shown in Fig. 2 are: 500 mm length, 250 mm width and 170 mm height. The wheel group can change the length and the height of the model accordingly while moving.

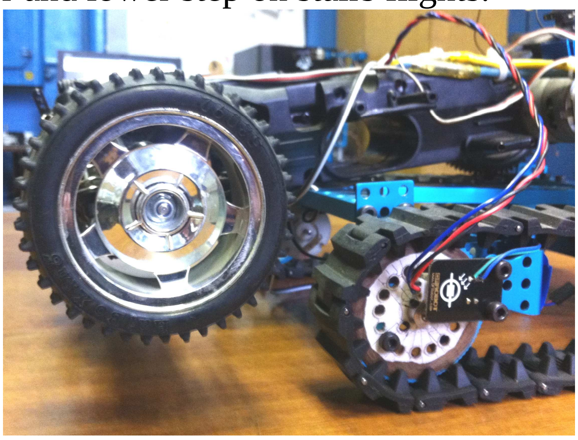


Fig. 2. General view of the experimental model

The drive control unit of the each track includes an asynchronous motor controlled by a frequency converter. Speed feedback is based on a tachogenerator located on a motor shaft.

The signal from the tachogenerator is fed to the inputs of an ADC. Then it goes to the speed control unit of the tracked group in a digital form. The speed control unit is built on the basis of a comparator and a digital controller. Usage of the regulator in the system allows compensating speed change that is correlated with the torque change of the motor shaft. As the torque increases, the rotation speed decreases. The controller adjusts the control signal so as to maintain the speed at a constant level while monitoring the maximum possible frequency of the alternating current supplied to the drive. DC motors with protection against an overload and a short circuit are used in the drive lever.

System stability was evaluated by program methods. The Matlab Simulink results confirmed stability of the system with different given parameters.

References

1. Patent №53370 RU. Wheel-tracked vehicle / Rachkov M.Yu. – Publ. 10.05.2006, Bull. №13.

Сведения об авторах:

Рачков Михаил Юрьевич – д.т.н., профессор, профессор, Московский политех, г.Москва;

Емельянов Алексей Михайлович – студент Московского политеха, г.Москва;

Колот Виталий Юрьевич – студент. Московского политеха, г.Москва.

АВТОНОМНЫЙ МОБИЛЬНЫЙ РОБОТ ДЛЯ ЧРЕЗВЫЧАЙНЫХ СИТУАЦИЙ

Рачков М.Ю., Емельянов А.М., Колот В.Ю.

Московский политехнический университет, г.Москва

Ключевые слова: автономный робот, реконфигурируемая структура, внедорожное движение, чрезвычайная ситуация, моделирование.

Аннотация. В статье рассматриваются результаты исследования новой конструкции мобильного робота, обладающего повышенными функциональными свойствами за счет возможности преодоления различных преград, а также скоростного перемещения по ровным поверхностям путем реконфигурации своей структуры под тип поверхности перемещения. Робот позволяет автоматизировать различные виды работ в местах повышенной опасности для человека, а также в труднодоступных зонах при чрезвычайных ситуациях. Разработана кинематическая модель робота в среде SolidWorks для исследования различных режимов движения робота. Создан экспериментальный образец робота с дистанционным управлением на основе стандартных комплектующих узлов. Его лабораторные испытания подтвердили справедливость полученных результатов моделирования. Приводятся конструктивные особенности робота, результаты моделирования и эксперимента.

Список литературы

1. Патент №53370 РФ. Гусенично-колесное транспортное средство / Рачков М.Ю. – Опубл. 10.05.2006, Бюл. №13.