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MOBILITY OF SELF RECONFIGURING SYSTEMS OF ROBOTS PLATFORM

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МОБІЛЬНІСТЬ САМОРЕКОНФІГУРОВАНИХ СИСТЕМ РОБОТ-ПЛАТФОРМИ

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This paper aims to remove barriers to mobility inherent. The current proposals robot locomotion, adaptability and extending the range of the robot with mixed / multiple modes of mobility. Designing identical elements for a modular system has several advantages over large and complex robotic systems is assumed that the robot will navigate to a known and controlled environment, or provided with a smart structure to allow free movement of the robot.

Key words: *modular robots, mobility, robot platform, self-reconfiguring*

Fig. 3. Bibl.: 3.

Розглянуто заходи усунення бар'єрів для невід'ємної мобільності. Запропоновано пересування, адаптивність і розширення діапазону робота зі змішаними або декількома режимами мобільності. Проектування ідентичних елементів для модульної системи має кілька переваг у порівнянні з великими і складними роботизованими системами. Передбачено, що робот буде переміщатися у відомому та контрольованому середовищі, або за допомогою спеціального пристрою, який дозволить вільний рух робота.

Ключові слова: *модульні роботи, мобільність, робот платформи, самореконфігурування.*

Рис.: 3. Бібл.: 3.

Рассмотрены меры устранения барьеров для неотъемлемой мобильности. Предложено передвижение, адаптивность и расширение диапазона робота со смешанными или несколькими режимами мобильности. Проектирование идентичных элементов для модульной системы имеет несколько преимуществ по сравнению с крупными и сложными роботизированными системами. Предполагается, что робот будет перемещаться к известной и контролируемой среде, или при условии, с помощью специального устройства, которое позволить свободное движение робота.

Ключевые слова: *модульные роботы, мобильность, робот платформы, самореконфигурирование.*

Рис.: 3. Библ.: 3.

Introduction. The purpose of this research is to introduce a new autonomous reconfigurable robotic system designed to be capable of performing urban survey, inspection, surveillance, reconnaissance and/or other similar applications. The research focuses on eliminating mobility constraints inherent in current designs, thus extending the robot's adaptability and range. Presently the locomotion of most robotic systems can be divided into three main categories: rolling, walking, and reconfigurable approach. While really effective, a rolling robot is restricted to flat horizontal and low-grade surfaces. A walking robot is able to climb and access elevated areas, but is often characterized as being slow, having complex motion and balancing issues on flat horizontal surfaces.

Reconfigurable robots display a wide range of locomotion and ability to adept to new tasks by altering their configuration. On the downside, they require many actuators, plenty of power and provide very little room for payloads. Thus there is a need to introduce a robotic system that can be efficient on flat horizontal surfaces in mobility, speed, and simplicity as well as possessing climbing ability.

Defining the basic concepts. Recent progress in technology forced the research thrusts in autonomous mobile robots to consider locomotion in non-ideal environments, mainly on unstructured terrain. Statically stable gaits that are currently available for mobile robots include wheels, treads and similar methods that limit the locomotion capabilities of a particular robot. For example, a robot using a wheeled locomotion system is probably incapable of climbing a set of stairs, or move over relatively large obstacles. Although there are many examples of robots with climbing capabilities, a robot that can move with relative ease on flat terrain with an ability to climb over large obstacles is yet to be designed. On the other hand, new technologies such as micro electromechanical systems (MEMS) opened the pathway to small-scale mobile robots. MEMS technology enables multiactuator, multi-sensor systems that can be implemented in millimeter scale, if not smaller. Applications to use small inexpensive robots to accomplish tasks in unstructured environments and narrow spaces are slowly emerging. Drawing from the recent research on modular robots (e.g., Chen and Paredis' works1,2) and on small mobile robots with limited capabilities (e.g., Millibots3), we envision a modular self-reconfigurable group of robots that consists of two modules with different characteristics. A sufficient number of modules combined as a single entity will be capable of selfreconfiguring themselves into defined shapes, which in turn will provide a new type of locomotion gait that may be combined with other capabilities. A large group of modules that can change its shape according to the locomotion, manipulation or sensing task at hand will then be capable of transforming into a snake-like robot to travel inside a air duct or tunnel, a legged robot to move on unstructured terrain, a climbing robot that can climb walls or move over large obstacles, a flexible manipulator for space applications, or an extending structure to form a bridge.

Designing identical elements for a modular system has several advantages over large and complex robotic systems. The units can be mass-produced, and their homogeneity can provide faster production at a lower cost. A large system consisting of many elements is less prone to mechanical and electrical failures, since it would capable of replacing nonfunctioning elements by removing them from the group and reconfiguring its elements. Homogeneous groups of modules that are capable of self-reconfiguring into different shapes also provide a manufacturing solution at the design phase where identical elements are considered, while providing a modular system that can be re-arranged for different tasks.

To obtain the advantages listed above, a modular system must have several essential properties, such as geometric, physical and mechanical compatibility among individual modules. Furthermore, several design issues need to be considered for a modular self-reconfiguring system to become autonomous. Essential properties of our particular system as well as design issues relating to the implementation are given in Section 2.

Previous work on modular robotics include serial link manipulators that can be designed based on task pecifications4, design of kinematic structures that can be modularly synthesized5, and cellular systems as self-organizing manipulators6. These and similar ideas on modularity has been applied to modular structures that are capable of self-reconfiguring into desired shapes. Previous 2-D examples include Inchworm7 and self-organizing robots8 moving in vertical plane, self-repairing Modula machine9 and metamorphing robots10 moving in horizontal plane. Recent 3-D systems include Polypod that can combine different gaits11, and the self-reconfiguring molecule12 and another self-reconfigurable structure13 that are both capable of moving in any direction using neighboring elements as pivot points.

The system described here is a self-reconfiguring bipartite system that separates the components that provide computation, sensing and power from the components that provide actuation in order to combine different gaits and task-oriented modules with self-reconfiguration capabilities. In the next section, we introduce our approach to modular self-reconfiguring robotíce system, defining its characteristics and advantages. Section 3 illustrates simple examples of reconfiguration and motion in three-dimensional space. Section 4 describes the hardware implementation while Section 5 discusses the experiments on recent prototypes. Section 6 concludes the paper with a discussion on current implementation and future additions.

A integrated self-reconfiguring system solution specifics. Effort about complexity activity in the range integrated kinematical chain (interaction, manipulation, locomotion) prevents to the development and the application of new structures for robotic technology and at the same time evokes need of new conceptions element and knot in she application. In the robotic technology this handicap maybe in part eliminates with solutions susceptible transformation and extension functions [2] following:

- multifunction realization modular,
- adaptability, exploitation optimal principle generation energy and her transformation,
- reconfigurable accomplishments, exploitation integrated kinematics building chain,
- effective adaptive way control for immediate and reversible operations.

A result of solution is smaller number of autonomous subsystem and adaptability to the various production tasks and optional form surroundings, par example about reconfigurable bucking - locomotion subsystems. The bucking - locomotion subsystem provide effective movement of robotical technical on the working scene- drown integration near the change her position (place, position, orientation) and the management working element for immediate respectively transposed execution of production operations (technological, bucking) after determination trajectory.

Conception model simple. A particularity of integrated cinematic X,Z- manipulation and locomotion on fig. 1.a.- simple is visualization of relative relation of terminative members (basic, working) kinematical chain to the reference base. Create her two shoulders, which are fall one termini joint coupled, and on the second, relatively free end measure multifunction joint- sliding and fixed (arm 1) and sliding, fixed and effectors (arm 2).

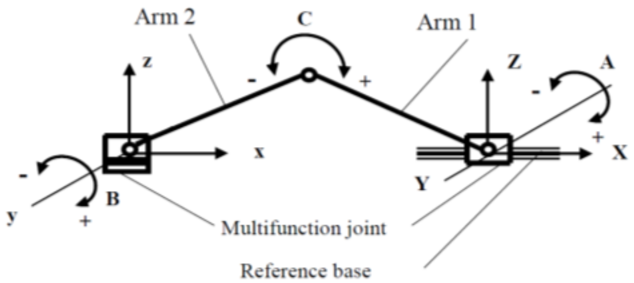

Fig. 1. Simple conception model of integrated kinematics of robotic technical

Integrated kinematics allows a plane motion of terminative elements (advance motion in the axis x a z, rotational motion around axis y), derivative from the integrated building chain with three degrees of freedom. The answer construction with of three control motion (turning around dot A a B, crank around dot C).

Conception model pair. A modeller conception of integrated cinematic robotic technical (fig. 2) is founded on the couple in parallel arrangement couple shoulders from Fig. 1.

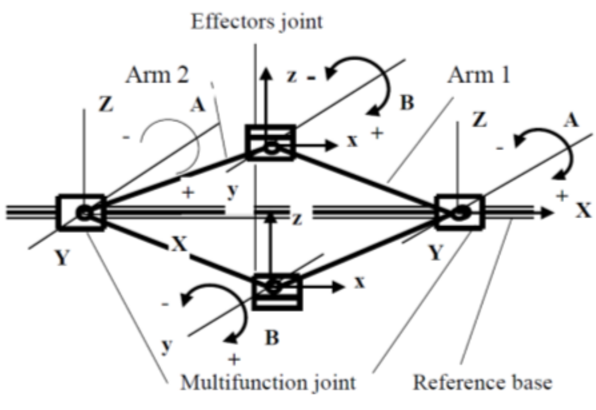

Fig. 2. Pair conception model of integrated kinematics of robotic technical

Output for aplication. Used solutions (fig. 1 and fig. 2) utilize system of traversing linear, generally symmetrical arrangement drives (fig. 3).

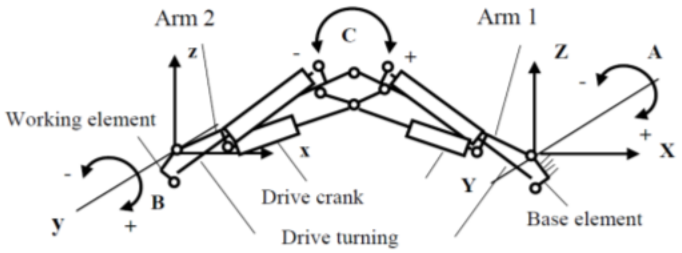

Fig. 3. Construction model of reconfigurable service robots

The regime of locomotion (changes position of robotical technical) is realized by interchange of carrying bases, i.e. carrying base (frame) gradually he'll ride (in the conclusion bucking cycles) of joint of shoulder 1 on joint of shoulder 2 until then, as far as oneself unhitched movement in a necessary scope. In this manner way maybe to reach a change of position at upright respectively horizontally plain (perpendicular wall, ceiling), namely by either directly (climbing to wall), or indirectly (utilizing cable and systems of poles).

Volts regime manipulation (technology) oneself performs sequence bucking/technological activities on working area. This is realized during renovation and constitution robotically technical in asking spoil (carrying base lives ever joint shoulders 1) in opening bucking cycles per second.

Sector of development and application

Connect her above all with the development of this characteristic:

– relative advantage, priority of new technique to existent technology,
– compactness, degree of suitability characteristics for new modifications technology,
– compatibility, degree of suitability characteristics for new purposes,
– integration, suitability switch-over with others elements,
– complexity, celestnost and systems approach.

To plan new solutions robotical technique near acceptance this characteristics and concrete realization condition maybe following by:

– new progressive materials (light alloys, composite constructional materials with carbonaceous and glass fibre eventually polymer),
– new constructions(material replacement, kinematical replacement) connected with hike stiffness and cut-down weighted a cost machine system,
– integrated constructions (integration and replacement of functions) connected with cut-down membership kinematical chain and extension function,
– harmonization grades universality of mechanisms transfer and transmission with a question of precision positional and her repeatability,
– cut-down of unproductive time darling machine system, cut-down continuous bucking time and maximization of working parameters for away bucking of the process,
– standardized modules for standard and non-standard applications.

Another of way to increase technical economic level is development of robotical technique following multilaunching integration of reconfigurable modules. The result is reduction of machine module and simplification technological realization, e.g. in form instrument- part modular system [2].

Conclusion. This research presents an innovative robotic system, which can be used for a wide variety of applications. The models of integrated kinematics of robotical technique are assigned to realization demanding working task (line and operate mode near manipulation and profiled object) on working surface upright (wall) lotuses. horizontally (ceiling) arrangement. By program they introduce cartage- bucking respectively multiprofessional production module logistic chain amounting to far wide variability effects, than what a could oneself reach near individual used single-function modulated.

Contribution has arose with advancement of project: Výskum a vývoj inteligentných mobilných robotických platforiem a polohovacích systémov s vysokou presnosťou pre využitie vo výskume, vývoji a v priemysle*, (2015-10961/33306:2-15F0).*

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