UDC 007.52:004.896:658.51-52

NEKI ASPEKTI U RAZVOJU ROBOTA
SOME ASPECTS IN THE DEVELOPMENT OF ROBOTS

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Sažetak: *Analiza nedavnih razvoja, kao i najnovijih trendova razvoja automatizacije proizvodnje i ne-proizvodnih procesa dokazuje da je robotizacija tih procesa u općem konceptu njihove automatizacije i dalje u jedinstvenom i nezamjenjivom položaju. Ovi trendovi postavljaju više zahtjeve o složenosti inovaciji svih načina unosa automatiziranih proizvodnih i uslužnih sustava. Najnoviji trendovi stvaraju nove potrebe za razvoj i izgradnju novih kategorija i generacija robota, kao i novi pristup primjene robota.*

Ključne riječi: – nedavni trendovi
– automatizacija proizvodnje
– neproizvodni procesi
– industrijski roboti, uslužni roboti, osobni roboti

Summary: *The analysis of recent developments as well as recent trends of development in the automation of production and non-production processes proves that the robotization of those processes retains, in the general concept of their automation, its unique and irreplaceable position. These trends place higher demands on the complexity of innovation in the introduction of automated production and service systems. Recent trends create new needs in the development and construction of new categories and generations of robots as well as a new approach to the application of robots.*

Keywords: – recent trends
– automation of production
– non-production processes
– industrial robots, service robots, personal robots

1. INTRODUCTION

The analysis of recent developments as well as recent trends of development in production automation and non-production processes proves that robotization of those processes retains, in the general concept of their automation, its unique and irreplaceable position. The advance of robots can be documented by data about their production and application, see Figure 1, which the IFR (International Federation of Robotics) presents.

The areas in which robotic systems are implemented have been spreading dynamically, in addition to the "classical" applications of industrial/production fields and technologies, mainly in the areas and technologies with non-industrial/non-engineering applications, and in new areas of services [1, 7].

These trends place higher demands on the complexity of innovation of all means entering automated production and service systems. Recent trends have created new needs in the development and construction of new categories and generations of robots as well as new approaches to the application of robots based on higher sophistication of automated/robotic systems conditioned by highly distinct implementation of non-traditional mechanical principles

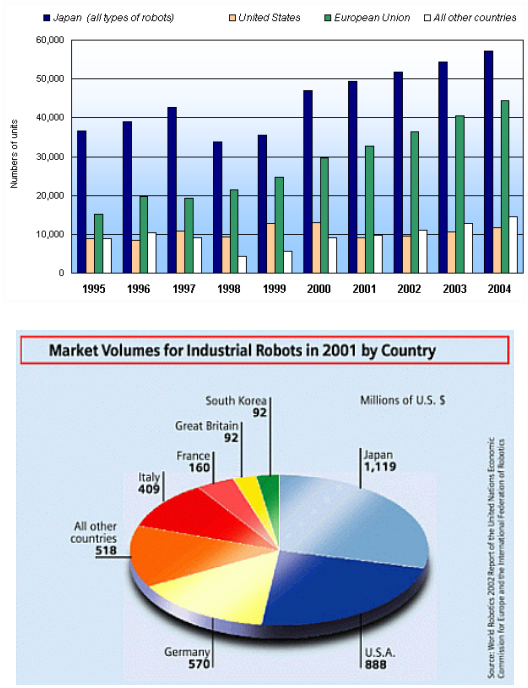

Figure 1. Robots production and application

of control/computer technology, information technology and artificial intelligence [11, 12].

2. VIEW OF CURRENT STATE OF THE ART AND ITS CHARACTERISTICS

The current state of the art in robotics and its trends in development can be characterised and described by:

- Development of knowledge and creativity in the area of robotics on the basis of interest and stimulation of practical application has been categorized in the following manner: robotics (a field covering the theoretical interdisciplinary basis of robotization); robotic technique (theory of structure and design of robotic technological devices and indirectly also their complete basis); robotic technology (the application of robots, indirectly also the development of new technology applications); and robotic operation (operating robotic systems throughout their lifecycle).
- Development of applications and production of robots has, generally speaking, characteristics of permanently dynamic growth. Application of robots in "classical" industrial/production areas maintains its "own pace" of growth.
- Development in the application of robots documents general dynamic advance of robots in new "non-traditional" areas (all areas of human activities including non-production and service activities).

From what has been shown above, it is possible to claim that under real conditions in practical application the development of robotics will be marked mainly by the following features:

- In "classical" robot applications, the recent "pace" will be kept; dispersion in quantity will be a reflection of recently demanded efficiency of production in object areas (automobile industry, food processing industry, chemical industry and so on).
- It will substantiate the automation of production/non-production processes on the principles of BMC (Bionic Manufacturing Systems), IMS (Intelligent Manufacturing Systems), CIM (Computer Integrated Manufacturing), CHIM (Computer Human Integrated Manufacturing), ICIM (Intelligent Computer Integrated Manufacturing), AI-Agents-Holons-Fractals will be more intensive, however, with a new systematic approach to their description and application.
- The concept of robots, as machines and devices, will be influenced by the advance of new generations of components for their construction (mechatronic approach, biomechanical principles, integrated intelligent components and parts). The new concept of robots will be based on a modular self-reconfigurable system, with a high level of flexibility [8].
- Emerging new categories of robots which will be designated mainly for the areas of non-traditional applications and new areas of usage (service robots, personal robots), while the development of service robots and their applications has recently been compared to the importance of the automobile industry (the number of applications and different solutions/designs will be considerably higher than with automobiles).

3. VIEW OF RECENT DEVELOPMENT OF RELEVANT AREAS

Analysis of current developments in robotics, mainly the analysis of trends and the realization of the development of details in their technical interpretation lead to the view and opinion of a specific profile of development in relevant areas, mainly in the following areas:

- In the area of approaches to robot design: the concept of industrial robots is stabilized, the development of robot families is being solved in comparable types and sizes (innovation of completing bases is used), new concepts of serial structures are being solved (meant primarily for new applications of robots) and parallel structures; the concept of service robots, which evolves from confrontation with application requirements, non-structured working/operating environment and the technologies of realized tasks;
- One of the current theoretical and engineering roles of robotics is the innovation of approaches to robot and robotic systems constructions for industrial applications invoked by the need to extend their functional possibilities not only by extending the scope of the kinematical structure of their action mechanism but also by controlling the change of its function. A theory of mechanisms with self-reconfigurable (variable) structure has begun to be elaborated as a realistic direction toward a solution. This direction gives new quality to a robot that is based on the controlled reconfigurability of its kinematical and functional structure.
  Reconfigurability is a new direction in the construction of robotic technology, which began to be intensively pursued in the construction of industrial as well as services robots. Whereas the area of service robots is on a relatively high level and the first applications have been tested in practice, in industrial robotics this direction represents only an initial phase in research efforts.
- In the area of mechanics: to use the possibility of designing the kinematic structure of robots and their modifications for pre-determined tasks; to use a wide spectrum of possible applications of parallel mechanisms and the suitable features of parallel kinematic structures; the use of principles of modular concepts in the robot design or in the design of its autonomous modular units; the use of features and possibilities of new materials for designing new mechanical parts (composite materials, materials with a hybrid structure, etc);
- In the area of driving technique: design driving aggregates as intelligent servosystems working as

online expert systems in realtime assembled in the structure of the hierarchically structured and control system; design driving aggregates to use motors running on liquids with a maximum possible rate of functional integration;

- In the area of sensorics: to use sensoric systems for specified sensoric functions, in relation to operation and level of given intelligence so that the "behaviour" of a robot would be either a feasible algorithm or a group of algorithms operating the whole robotic complex; to use principles of the physical phenomena of an animate and inanimate nature to design intelligent sensor systems with the ability and features of artificial sight, hearing, sensing, maintaining and operating of position, etc.; design of the application of intelligent technical sensor systems with fewer technical sensors, fewer concentrators, to solve collection and processing of information in a system based on the serial principle;
- In the area of control: to use methods of massive control so that feedback operation solving the monitoring of the given trajectory of state would be resolved; to use methods of adaptive control in connection with intelligent components of robot mechanics or in connection with information from the working and technological environment of the application; design control program for navigation of service robots addressing the need for parallel processing of tasks in classes: recording and evaluating of data from inner and outer sensors; to set the structure of the control of the intelligent robotic system as a multilevel system;
- In the area of application of technologies of artificial intelligence: to implement methods and techniques of artificial intelligence for the needs of simulation of robot activities, for the needs of robot navigation in space, and for the needs of robot control;
- In the area of running: to the implement new methods and means of modelling and simulation in design, operation and securing robotic systems operation; to use methods defining and describing robotic system operation through the operator of functional relations as an operation of a complex multi-element technical system; to use methods of describing operating conditions of n-random quantities enabling the determination of a scholastic model for operating conditions; to construct models for diagnostics of a technical nature; to design models of robot maintenance on the basis of modern approaches.

4. PRESENTATION OF RECENT STATE OF THE ART OF TECHNOLOGY

The Recent state of the art of robotic technology can be documented by a presentation of selected types of robots [2] and the designation of their possible applications that can be arranged according to the current classification of this technique, Table 1.

Table 1. Classification of robots technique

Robots Technique		
Industrial Robots	Service Robots	Personal Robots

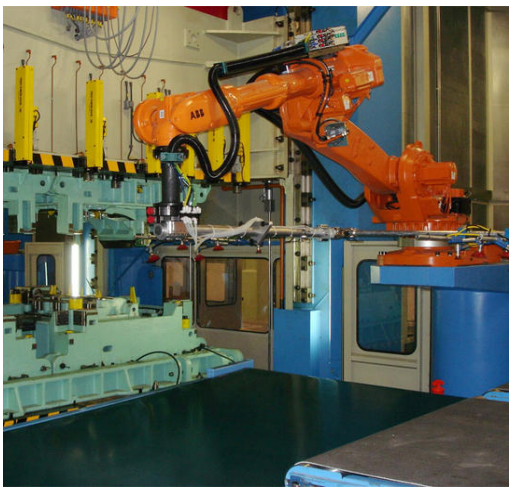

Figure 2. Example of industrial robot application

Industrial robots (IR) – IR is conceptually designed from a mechanical system (manipulator mechanics/robot mechanics, positioning, orientation in working zone) and control system (control, programming) [4]; the task following its application is technically solved by working head (manipulation, technological), Figure 2.
Service robots (SR) – The decisive and constructionally most important feature of SR is the locomotion parts (wheeled, walking, floating, special), which secure their mobility, Figure 3. The superstructure of locomotion parts is always solved according to the type of task, which is supposed to be performed by SR and at the same time the whole SR is designed in concept and detail according to the kind and character of the environment in which it operates [6, 10].

Figure 3. Mobile service robot

Personal robots (PR) – uniform and generally approved definition has not been accepted although there is an interpretation that is in the process of formulation that it is a freely programmable device [5, 9], which partially or fully automatically performs service operations, Figure 4.

Figure 4. Personal robot for home application

5. CONCLUSION

The view of the trends for further development of robotics and relevant areas presented in the paper indicate only a part of these relations to the selected technical problems that are associated with them. Working out and solving the given technical problems will affect different specialized fields and areas, new areas of tasks for specialists from different fields will emerge and they will require creative dynamic work.

AKNOWLEDGMENTS

The Slovak Ministry of Education has supported this work, contract KEGA No. 3/5172/07, and by contract of applied research No. AV4/0003/07.

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Primljeno / Recived: 27.2.2009.

Prihvaćeno / Accepted: 18.4.2009.

Pregledni članak

Subject review

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