RECENT DEVELOPMENT OF ROBOTICS AND THE NEEDS FOR DEVELOPMENT OF RELEVANT AREAS

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Abstract
The analysis of recent development as well as recent trends of development of automation of production and non-production processes proves that robotization of those processes has, in the general concept of their automation, still its unique and irreplacible position. These trends place higher demands on the complexity of innovation of all means entering automated production and service systems. Recent trends formed new needs on the development and construction of new categories and generations of robots as well as new approach to the appplication of robots. View of the trends of further development of robotics and relevant areas presented in the paper indicate only a part of these relations and following selected technical problems.

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

Introduction

The analysis of recent development as well as recent trends of development of automation of production and non-production processes proves that robotization of those processes has, in the general concept of their automation, still its unique and irreplacible position. The advance of robots can be documented by its history, see Fig. 1, s well as by data about their production, see Fig. 2, or data about their application, see Fig. 3, which IFR (International Federation of Robotics) presents.

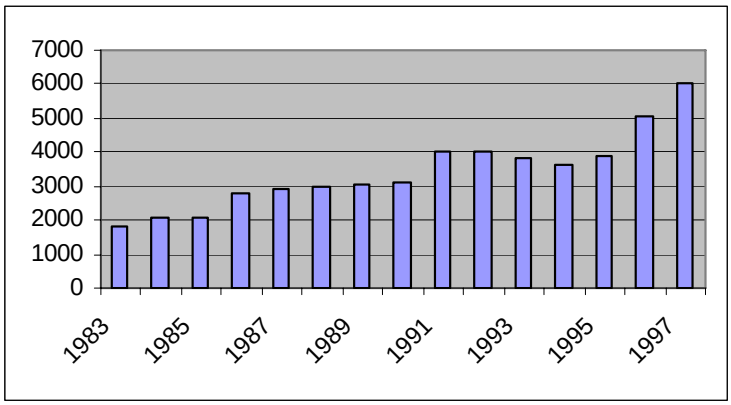

Fig. 2

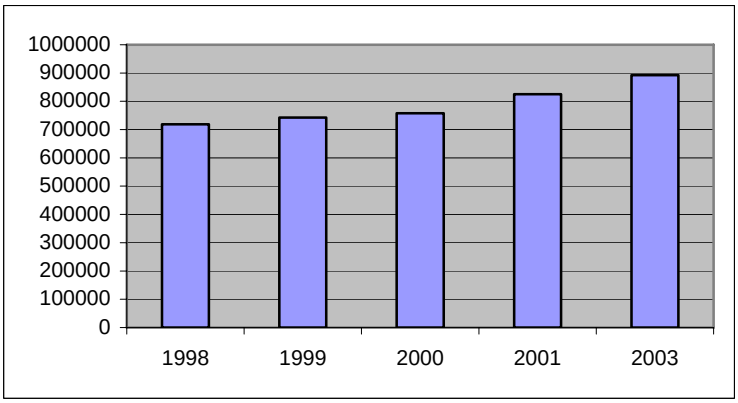

Fig. 3

The areas where robotic systems are implemented have been spreading dynamically, besides „classical“ applications in industrial/production fields and technologies, mainly into the areas and technologies with non-industrial/non-engineering applications, but also into new areas of services, see Fig. 4.

These trends place higher demands on the complexity of innovation of all means entering automated production and service systems. Recent trends formed new needs on the development and construction of new categories and generations of robots as well as new approach to the appplication of robots based on higher sophistication of automated/robotic systems conditioned by highly distinct implementation of non-traditional mechanical principles of control/computer technology, information technology and artificial intelligence.
It is possible to say that recent trends of development in robotics together with trends of relevant areas and subject-matter products have brought about so striking differences that it is necessary to restructure not only the profile and content of the

area of robotics but it is also needed to specify the profile of relevant enetering areas too.

View of current state of art and its characteristics

Current state of art in robotics and its development trends can be characterised and described by the following characteristics:

- Development of knowledge and creativity in the area of robotics on the base of interest and stimulation of practice has been formed into the following: robotics (field covering theoretical interdisciplinary basis), robotic technique (field covering theory of structure and construction of robotic technological devices, and indirectly also their completing base), robotic technology (field covering the application of robots, idirectly also development of new technology applications), robotic operation (field covering management of operating robotic systems in whole cycle of their lifespan)
- Development of applications and production of robots has, generally speaking, characteristics of permanently dynamic growth
- Application of robots in „classical“ industrial/production areas keeps its „own pace“ of growth
- Development in application of robots documents general dynamic advance of robots in new „non-traditional“ areas (practically into all areas of human activities including non-production and service activities)
- Trends and directions of development of robotic concept in time expression can be characterised by succession of new categories and generation of robots implementation (industrial robots, service robots, personal robots) in practice

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

- In „classical“ robots 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)
- Development of small and medium size businesses will „bring and revive“ the conception of automated/robotic workplaces of the model JOP SHOP (models of development of „small-size“ businesses in Japan, Germany and Sweden) based mainly on multiprofessional automated/robotic production centers
- It will make the automation of production/non-production processes on the principles of BMC (Bioneci Manufacturing Systems), IMS (Intelligent Manufacturing Systems), CIM (Computer Integrated Manufacturing), CHIM (Computer Human Integrated Manufacturing), ICIM (Intelligent Computer Integrated Manufacturing), AI – Agents – Holons – Fractals more intensive, however, with a new system approach to their description and application

- 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)
- 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 appliations has recently been compared to the importance of automobile industry (number of applications and different solutions/designs will be considerably higher than with automobiles)
- Application of robots into dangerous and health-damaging environments on the base of dynamisation of recent social demand will be much higher (nuclear plants, military, security services, chemical industry, pharmaceutic industry, forestry and agriculture, medical services, social services, etc).

View of recent development of relevant areas

Given development in the field of robotics evokes the need to make the profile of development also in relevant areas more specific. This quotation can be supported by the fact that robotics is an interdisciplinary area defined by integration of mechanics/drive technology/sensorics/operating and computer technology/information technology/artificial intelligence. Described integration documents mutual interaction of demands and needs among the areas of robotics and relevant areas entering it.

Analysis of given development of robotics, but mainly the analysis of trends and the realization of the development in details of their technical interpretation forms the view and opinion of specifying profile of development of relevant areas mainly in the following areas:

- In the area of approaches to robot design: concept of industrial robots is stabilized, 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 application of robots) and parallel structures (beginning of development, great perspective); concept of service robots (typical mechatronic systems), which evolves from the confrontation of the needs of application (tasks, demands), non-structure of working/operating environment (exceptionally great variety of environments, practically unlimited) and technologies of realized tasks; concept of motion systems is to be solved as action members transforming incoming energetic signal into mechanical output given by position, speed, moment or power; high requirements on potency, efficiency and working parameters, minimization of size design and working reliability is to be solved by the concept of high functional integration (valid also for the concept of component basis); to improve the methods and means of designing robots, using CA technology, on the base of “automated design lines”;

- In the area of mechanics: use the possibility to design kinematic structure of robot and their modifications for pre-set (technological, manipulation) task; use wide spectrum of possibilities of applications of parallel mechanisms and suitable features of parallel kinematic structures (higher rigidity, higher precision, suitable rate of loading capacity, higher values of acceleration of final part, possibility of simple modular construction, etc.); use the principles of modular concepts in the robot design or in the design of its autonomous modular units (translation, rotary); use features and possibilities of new materials for designing new mechanical parts (composite materials, materials with hybrid structure, etc);
- In the area of driving technique: design driving aggregates as intelligent servosystems working as online expert systems in real time assembled in the structure of hierarchically structured and control system (open speed servosystem, adaptive system with referential model, etc.); design driving aggregates to use motors running on liquids with maximum possible rate of functional integration (regulated generator, built-in elements for circuit for operation and regulation of movement direction, of movement speed, measuring the position of piston-rod, recording immediate load);
- In the area of sensorics: use sensoric systems for specified sensoric functions (information base is the classifying element corresponding basic senses of human), in the relation to operation and level of given intelligence so that "behavior" of a robot (modeled biological system) would be either feasible algorithm or a group of algorithms operating whole robotic complex; use principles of physical phenomena of animate and inanimate nature to design intelligent sensor systems with ability and features of artificial seeing, hearing, feeling, keeping and operating the position, etc.; design the application of intelligent technical sensor systems in lower (sufficient) quantity of technical sensors, lower quantity of concentrators, solve collection and processing of information in system on the base of serial principle;
- In the area of control: use methods of massive control so that feedback operation solving watching the given trajectory of state would be solved and model of closed system of control would be guaranteed; use methods of adaptive control with connection to intelligent components of robot mechanics or connection to information from working and technological environment of application; design control program for navigation of service robots on the need of parallel processing of tasks in classes: recording and evaluating of data from inner and outer sensors, transfer of data into inner representation of environment, planning of final motion activity, operating working tasks and drives; set structure of control of intelligent robotic system as a multilevel system with hierarchy securing mutual integrity of different levels and their subsystems with sequencing their functional activities: activity/thinking/stimulus;
- In the area of application of technologies of artificial intelligence: implement methods and techniques of artificial intelligence for the needs

of simulation of robot activities, for the needs of interaction of robot with environment (automatic recognition of shapes, orientation, obstacles; computer seeing, hearing, feeling; communication with environment) for the needs of robot navigation in space (service robots, global and local navigation), for the needs of control robot (processing information and communication with operation center, understanding natural language);

- In the area of running: implement methods and means of modeling and simulation in design, operation and securing robotic systems working; increase sophistication of operation and securing robotic systems working; use methods defining and describing robotic system operation through the operator of functional relations as operation of multi-element complicated technical system created from technical, biological (human, service) and organization elements where operating is set by relations and links of those elements from the point of view of their functional influence and selection in system structure; use methods of describing of operating conditions n-random quantities (characteristics) enabling to get scholastic model of operating conditions of real robot operation and quantify hypothetic unit of its technical life (relation between operating conditions and operation reliability); construct models of diagnostics of technical state of art on the base of robot equipment and service means for the needs of prognosis and operating the system; design models of robot maintenance on the base of modern approaches (TPM).

Presentation of recent state of art of technology

Recent state of the art of robotic technology (robot – automatic or computer control integrated system able of autonomous task oriented reaction with natural environment according to human instructions) can be documented by a presentation of selected (from the base of accessible information) types of robots and a choice of their possible applications which can be arranged according to recent classification of this technique, Fig. 5.

Robots technique		
Industrial robots	Service robots	Personal robots

Fig. 5

Industrial robots (IR) – automatic equipment with pre-programmable operating system to perform motion and control functions in production process which replace analogical functions of human in manipulation and technological operations, Fig. 6. IR is conceptually designed from mechanical system (manipulator mechanics / robot mechanics, positioning, orientation in working zone) and control system (control, programming); the task following its application is technically solved by working head (manipulation, technological).

Fig. 6

Service robots (SR) – uniform and generally approved definition is not accepted yet; interpretation has been accepted that they are freely programmable mobile devices that partly or fully perform service operations, Fig. 7. Service operation is understood to be an operation, which does not serve directly for production of goods (material products) but serves in favor of people, technical systems or other objects. The decisive and constructionally most important feature of SR is locomotion parts (wheeled, walking, floating, special), which secure their mobility. Superstructure of locomotion parts is always solved according to the type of task (transport, manipulation, technological), which is supposed to be performed by SR and at the same time whole SR is designed in concept and details according to the kind and character of environment (dangerous, harmful, communal, domestic), in which it operates.

Fig. 7

Personal robots (PR) – uniform and generally approved definition has not been accepted yet, there is an interpretation in the process of formulating that it is a freely programmable device, which partly or fully automatically performs service operations, Fig. 8.


Fig. 8

Conclusion

The sense of automation as an activity without direct presence of human has been changing in the course of development of human activity. Recently there has been a

stabilization of the spectrum of motifs of automation, mainly of production processes in the following order: rapid reaction to the change of market (tempo of products innovation), decreasing the dispersal of quality, increasing the effectivity, flexibility (quick and effective functional adjustment in relation to required change of product). Those motifs considerably influence recent state of art of robotics as well as the trends of further development.
View of the trends of further development of robotics and relevant areas presented in the paper indicate only a part of these relations and following selected technical problems. Working out and solving of 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.

Acknowledgements

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Fig. 1

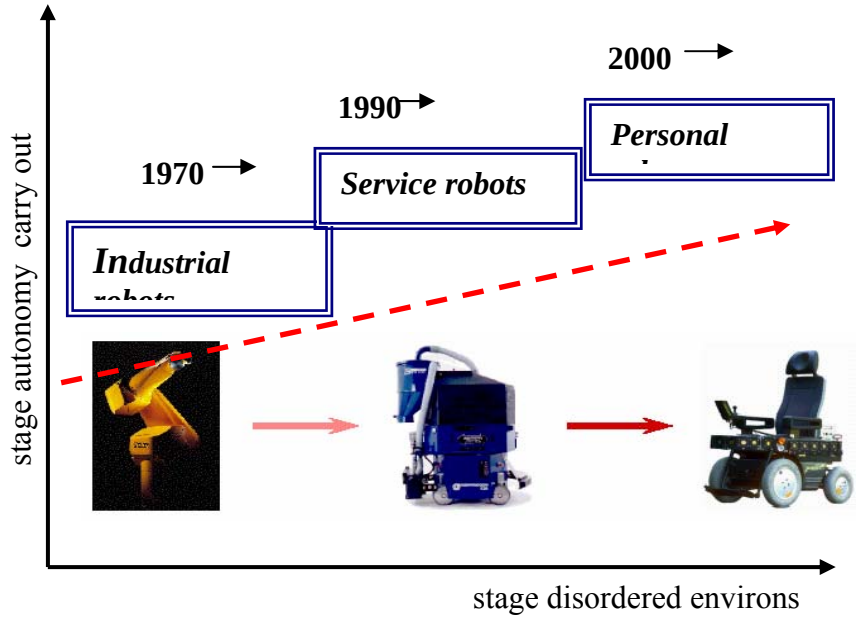

Fig. 2