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Trends in industrial robotics development

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Abstract. The article describes the development and defines the change of approach in the development of today's industrial robotics, provides an overview of the latest trends in the field of industrial robotics. Until now, the industrial robots have been deployed to less demanding work environments to perform "only" handling operations and to synchronize the operations of individual facilities. Now they are undergoing a major innovation process, the bulk of which is focused on increasing their intelligence and multi-functionality.

Introduction

Industrial robots are expanding from automotive to food, pharmaceutical and chemical industries, also in logistics and recycling processes. They can be installed as a replacement for "disposable" tool, as well as at workplaces where greater flexibility is required, so that these robots fill in the gaps of hand actions in automated lines and using the 3D visual systems they provide great opportunities for application in palletization of irregularly incoming objects such as from the line or the press, and in sorting activities.

Wide application possibilities of robots require managing their design based on a modular principle allowing the construction of a variety of kinematic configurations of robots, as well as of effectors and flexible and intelligent control. The times when a robot was only suitable for repetitive handling operations are gone. Today's range of robots includes nanorobots which are capable of handling molecules, large robots with capacity of more than 1 000 kg and robots for virtually every manufacturing and non-manufacturing sector, but also in radioactive environments, sea and space, and there are less and less areas without the use of robots. So far we have been looking for new areas to use robots but we have reached the point of asking a question: "Is there an area where the use of robot has not been possible yet?"

Robotics development in the world

At the forefront of the global development of robotics are Japan, The USA, Europe and South Korea (Fig. 1). The USA dominates in service robotics for military use deploying mobile robots type off-road. They are unique in the field of space robots and in the development of interplanetary robots. Interestingly, the USA does not dominate in industrial robotics, even though robots were first manufactured in the U.S. (General Motors, Cincinnati Milacron, Westinghouse and General Electric). Well-known manufacturers of industrial robots in the U.S. today are only Adept and San Jose-based Company.

In Japan and South Korea research activities and production of service robotics are widely developed, humanoid robots includes. These robots are primarily focused for household jobs, entertainment or rescue work. It turns out to be one of the most traded goods in the next 10 years. Japan and South Korea see great potential in the development of robots for elderly care. Japan has traditionally been strong in industrial robotics.

Industrial robots and service robotics dominate in Europe. These are focused on mobile robotics, transport and logistics, and especially in the external environment (in urban environment). The second area is represented by robots to work with humans. Europe is the leader in manufacturing and deploying industrial robots (with 33% representation). There are about 15 major companies producing industrial robots in Europe (KUKA, ABB, Reis, SCHUNK, STAUBLI, PROMOT, COMAU, CLOOS, FATRONIC).

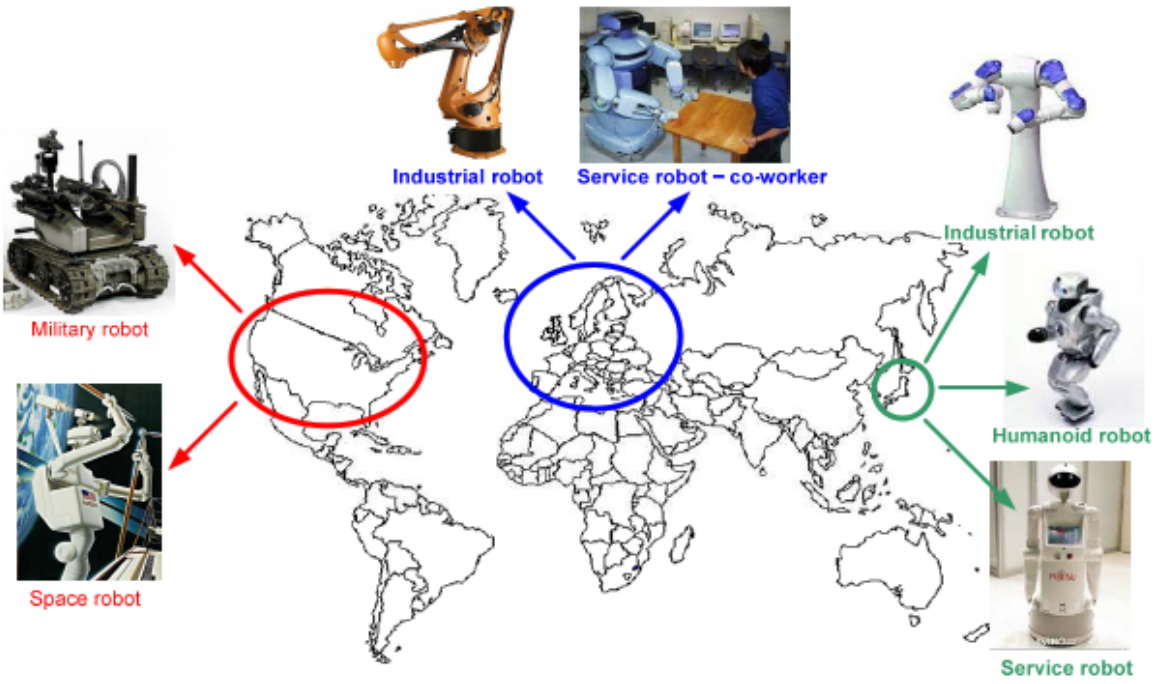

Fig. 1 The distribution of the global development of robotics

There are a few dominant national and international programs for robotics research in these areas. The USA adopted the document Robotics and Automation Research Priorites for U.S. Manufacturing in 2009, which emphasizes that robotics is the key to the transformation of production to achieve high competitiveness. In Japan, large companies have their own programs to develop new solutions and applications of robots. Also in Europe there are more and more research programs focused on robotics.

The year 2010 is known as a strong comeback towards industrial robotics. This stems from the fact that in 2009 the annual installation of robots fell to 60,000, in 2010 it was already 118,000 in 2011 about the 130000. The upward trend is expected in the next five years and in the 2017, the annual number of installed robots should exceed the value of 200000. This trend is based mainly on dynamic growth of markets and deploying robots, especially in China, South Korea and ASEAN countries.

New areas of development and application of industrial robots

Development of industrial robotics abandons the individual and "isolated" deployment of robots and moves to a group building and deployment of workstation of type robot - human. Changes in the approach to the development of today's industrial robotics are shown in tab. 1.

Up to now	Now
stabile industrial robot	mobile reallocation
periodic or repeated cycles with little changes	frequently changed tasks, rarely repeated cycles
individual activity of robots	robots' cooperation
on-line/off-line programming	on-line task assigning
no human-robot cooperation in the robot zone	mutual human-robot cooperation on tasks
efficiency at middle and higher series	higher efficiency a lower series

It has been shown that the preferred way of deploying the robots of type one robot - one action has been inefficient. However, at the workplace there are much more activities identified as auxiliary such as the exact position of the object, withdrawal and many others, for which they were designed as a single-purpose device. At the current time of innovation, these workplaces do not meet the requirements. The solution is represented by the robots with automatically replaceable effectors, respectively technology heads or reconfigurable grippers as well as the use of multiple robots as a group with a common purpose and robots with multiple arms and increasing the autonomy of robots in more and more unstructured environment. Typical applications of multirobotic cells include welding systems in which one or more robots carry out welding and positioning and handling of weldments is executed by the other robot, fig. 2. The benefit is obvious. The advantage of such sites is that they can perform more of various activities.

Fig 2 Welding – typical application of multirobotic systems

From duo robots (Fig. 3) can be expected in the near future to go beyond the human ability, even in sensitivity, not only in strength, speed and accuracy. The basic idea of duo robotic development are human activities carried out with both hands for everyday handling and in collaboration with several workers.

Fig 3 Dual – arm robot

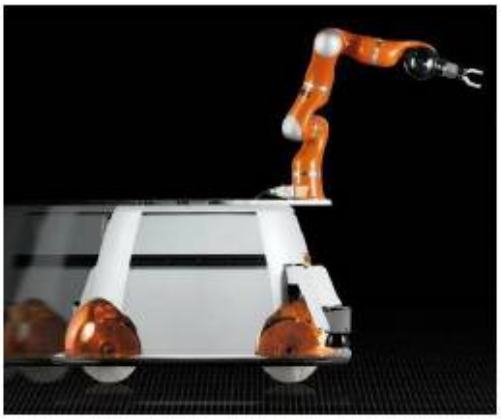

Fig 4 IMR - Industrial Mobile Robot)

In multirobotic systems and duo robots the establishment of activities, handling paths and synchronization of their movements and speed are new challenges. Key aspects of multirobotic systems are parallel control and synchronization and cooperation of their activities.

Industrial mobile robots

Industrial robots on a mobile platform (Fig. 4), also known as Industrial mobile robots (IMR - Industrial Mobile Robot) is presented as a new category of robots.

Integration of industrial robot and mobile platform/gear as a fundamental part of the service robot is a logical consequence of their development (Fig. 5).

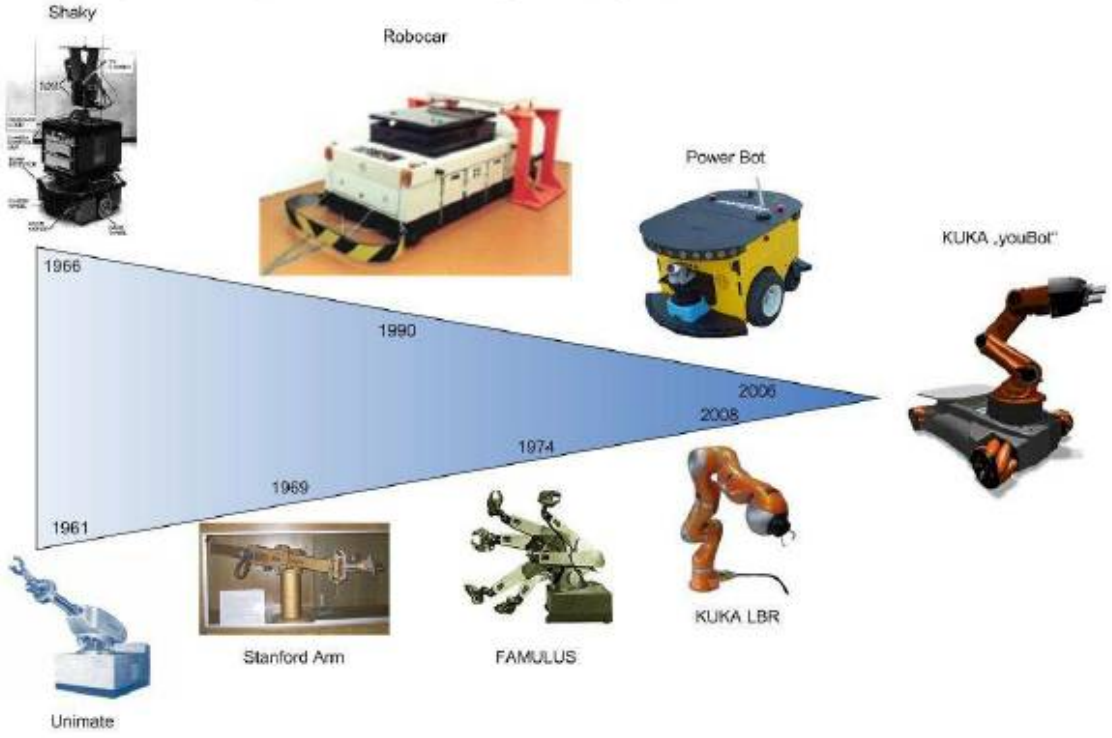

Fig 5 Integration of industrial robot and mobile platform

Classical industrial robot is taking on a new technical characteristic which is mobility. Presence of synergies from such integration enables further increase in the degree of automation of production. IMR application is mainly in the logistics chain in manufacturing, but also in non-manufacturing operations. IMR with the equipment for installation and service robot effectors and tools include in the category of service robots. Integration of industrial robots and mobile platform/chassis provides further extension of the use of industrial robots.

Robot Co-worker

Logical result of further development and of application of industrial robots will be robot co-worker-human worker systems- based on high symbiosis (Fig. 6). Since these robot systems are expected to be able not only to help a person in many different applications, but to be able to communicate in natural language. Highly level of autonomy and intelligence and of course safety is expected too.

Fig 6 Robot Co-worker

Designers and engineers had a dominant role in the design of industrial robots up to now, and their job was to make the best robot integrated into the manufacturing process, the task of design now passes to raise intelligence "human" behavior of the robots. Psychologists take particularly important role here. The existing approach was based on the conditions of appropriate integration with other machinery. In terms of the position of man, it is important to design the appropriate interface for programming the robot and ergonomic aspects of its maintenance.

Robot Co-worker is equipped with 3D systems for sensing the environment, even outside its work area, especially taking into account the movements of humans and safety identification. One area of research of robot -human common workplace is one method of finding the optimal allocation of tasks between robots and humans.

Robot arm and human hands manipulate a single object together or both are involved in the same technology operation. Such robotic arms are very sensitive and robot can respond to human commands. It is believed that this type of robots will be of a great use, not only in industrial applications, but it will become our assistant, helper in many activities. Furthermore, it is expected to have wide use in medical rehabilitation, healthcare and support to immobile people.

Conclusion

The basic requirement for the development of industrial robots is to improve their design in order to achieve greater mobility and maneuverability and to increase their level of intelligence so that their autonomy is increased. The main trend in the design of industrial robots is an intelligent mechanotronic drive solution module with direct integration in the robot joint. The key technologies of industrial robots are the use of new material components, which are stronger and lighter, and which achieves design improvements, better dynamic properties at a higher capacity and improved actuators and arms equipped with different sensors with sensitivity and visual homing to desired positions.

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