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Editor
Komarytskyy M.L.
Ph.D. in Economics, Associate Professor

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SAFE COBOTS IN DEVELOPMENT OF INDUSTRIAL ROBOTICS

Sotnik Svitlana Viktorivna,
PhD, associate professor of CITAR department
Usenko Yevhenii Sergeevich,
Shakhov Pavlo Volodimirovich
students
Kharkiv National University of Radio Electronics
Kharkiv, Ukraine

Introductions.

Artificial intelligence is integral part of modern society [1-3]. Cobots (collaborative robots) are robots designed to cooperate with humans, most often in limited workspace, which is key feature of their versatile application and growing demand [4, 5]. Cobots are flexible, safe and convenient enough to be customized through software, which makes them valuable tools in variety of fields, such as: medicine, logistics and warehousing, education and science, construction, manufacturing, assembly, and this is not whole list of cobot applications.

Unlike industrial robots, cobots are known to be safe, and they can work in synchronization with humans without need for fencing.

The first cobots appeared in late 1990s and were known as force-controlled robots. The first stage of cobot development focused on exploring ability to respond to forces and resistances that occurred during interaction with environment or humans to work together with people and other objects without endangering others.

The second stage of cobot development, also known as "Second Wave of Cobotics", began around 2010 and continues until today. This period is characterized by increased use of force control, safety sensors, and more sophisticated algorithms for interaction between cobots and humans.

The second stage of development focuses on improving flexibility, safety, and integration of cobots into real-world manufacturing environments where they can collaborate with operators and perform variety of tasks.

Aim.

The purpose of this paper is to explore possibilities of cobots in development of industrial robotics, as this field covers many areas and technologies, without which it is currently impossible to provide high degree of automation, improve production efficiency and ensure safety of workers.

Analyzing capabilities of cobots in industrial robotics will reveal best ways to integrate these robots into manufacturing processes, their potential to automate routine and hazardous tasks, and their ability to cooperate with humans in collaborative work environments. Such analysis contributes to more efficient design and development of robotic systems.

Materials and methods.

Let's start by highlighting the main benefits of safe cobots:

- collaborative work with humans in all environments. Cobots are designed to work safely with operators even in challenging environments (unfavorable for humans, e.g. high or low temperatures, aggressive chemical environments, etc.);

- easy to reconfigure for other scenarios and new production tasks;

- the same cobot can perform several different operations or functions within same production line or even in different work areas;

- relatively low price and, consequently, short payback period;

- increased productivity, high degree of consistency in execution of operations, and therefore, maintenance of high product quality.

The ways in which cobots can be integrated into manufacturing processes, are summarized in Figure 1.

The integration of cobots into industrial robotics production processes can be accomplished in variety of ways depending on specific needs and objectives of company.

Collaboration with operators – cobots can perform certain tasks that complement work of humans. This collaboration can be interaction at same workstation or even on same production line.

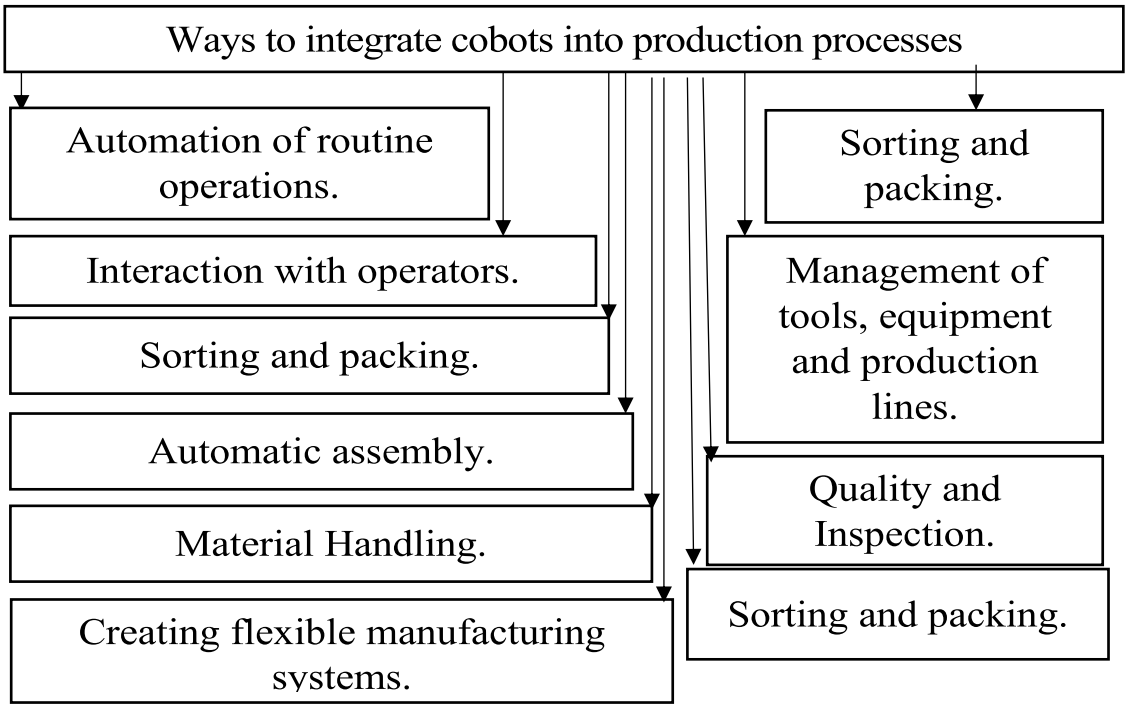

Fig. 1. Ways to integrate cobots into production processes

Automating routine operations – cobots can automate tasks that are routine and repetitive, thereby freeing operators from monotonous work and allowing them to focus on more complex tasks.

Sorting and packing – cobots can perform sorting, packing and palletizing operations to optimize logistics and warehouse processes.

Controlling tools, equipment and production lines – cobots can be used to control tools, manipulate parts and perform precision operations such as drilling, milling and cutting. In addition, cobots can control and coordinate production lines, optimizing product flow.

Quality and Inspection. Cobots equipped with sensors and cameras to detect defects are able to perform product quality control.

Automatic assembly. With high precision, cobots are able to assemble parts and assemble products.

Material Processing. Cobots can perform material processing operations such as grinding, welding, painting, etc.

Creating flexible manufacturing systems. Cobots allow production lines to be quickly reconfigured and reprogrammed to adapt to changes in demand or product

configuration.

Cobots can be created by manufacturer, but there are times when integrator uses traditional industrial robot and makes it collaborative. For example, APAS robot created by Bosch is based on FANUC robot.

Examples of cobots that are used in industrial robotics include: Fanuc CR Series (line of cobots that can integrate into variety of manufacturing processes), ABB YuMi (two-armed cobot with high degree of precision and flexibility); KUKA LBR iiwa (has sensitivity and transparency in motion, allowing it to work closely with humans in variety of tasks including assembly, testing, and more).

Results and discussion.

The development of safe cobots is of great importance to industry and they play key role in future development of robotics. The development of safe cobots requires innovations in sensors, collision avoidance algorithms, machine learning and other technologies. The specific use of cobots in industrial robotics is driven by their unique characteristics and advantages that make them particularly suitable for certain tasks in manufacturing environment. In general, characteristic of using cobots in field of industrial robotics is manifested in their ability to interact with humans, flexibility in performing variety of tasks, high accuracy, and ability to adapt to changing production conditions.

Conclusions.

The study summarized evolution of cobots in industrial robotics.

The paper identified significance and specifics of cobots in industrial robotics. The main advantages of safe cobots have been identified. A scheme of ways to integrate cobots into industrial processes is proposed and essence of each is described. These ways provide opportunities to use cobots to optimize logistics, improve product quality, and increase productivity. This research contributes to optimization of design and development of robotic systems, by studying: potential of cobots; diversity of applications; and optimal ways of integration depending on needs and objectives of company, which ultimately reduces time and resource costs of implementing robotic systems.

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