

## MODERN TRENDS IN THE DEVELOPMENT OF AUTOMATION AND ROBOTICS IN CIVIL ENGINEERING

**Yukhnovets O.M.**, *student of gr. CCE-202*

*Scientific adviser – Vashpanov Yu., Dr. of Sciences, PhD, professor, Brain Korea 21 professor, academician of the Academy of Metrology of Ukraine (Department of Physics, Odesa State Academy of Civil Engineering and Architecture)*

**Abstract.** The article is devoted to the study of the peculiarities of automation development in construction. Based on the available scientific research, mainly by foreign scholars, a comprehensive analysis of the history of automation, including industrial robots, in construction was carried out. The essence of automation and its role in construction is defined. The cases of the first use of industrial robots in construction are identified. The modern examples of the use of robots in construction and the main areas of their use in this industry are considered. The main modern trends in the introduction of automation in various forms in the construction industry are analyzed. The study proves the importance of automation for modern construction, which also contributes to the development of this industry.

**Introduction.** Today, we can observe an increasingly large-scale spread of modern technologies in various areas of human economic activity. Modern industry is closely connected with the use of various technical devices, digital devices, the Internet of Things, digital applications and programs (for example, AutoCAD, Mathcad and etc.) as well as artificial intelligence, which simplify human activity and increase the efficiency of various production processes. With this in mind, it should be emphasized that today we can also observe the active use of automation in construction industry. Construction is a sphere of human economic activity in which physical labour is an integral component, which, if safety rules are not followed and accidents occur, can lead to physical injury and death of employees. Nowadays, construction is a dangerous and tiring industry where workers face strenuous physical demands on a daily basis to complete their work and ensure that the plan is completed. With this in mind, robotics in modern construction is becoming the basis for increasing construction efficiency and reducing the danger to workers. Today, the introduction of robotics in construction is becoming more widespread, however, there is currently a small number of scientific studies devoted to this topic, so there is a need to fill the existing gaps and provide a scientific review of current trends in robotics in this area.

**Analysis of recent research and publications.** The issue of automation in construction is not sufficiently studied among Ukrainian scientists today. Among the available scientific works, it is worth mentioning the article by O. A. Kyslun and I. O. Skrynnik on the use of IT in construction, which partially mentions the issue of automation [1]. There are more modern works by foreign scientists. Researchers led by C. Ituralde studied the use of robots in facade work [2]. M. Casini studied current trends in robotics in the context of general innovations in construction [3]. Researchers led by K. Saldi studied the use of different types of robots in construction [4]. However, despite the relevance and widespread use of robots in construction, the issue under study is still not sufficiently understood.

**The purpose of the study** is to provide a detailed overview of current trends in automation and robotics in the construction industry by examining examples of foreign companies.

**Research methodology.** The study is based on an analysis of modern scientific research papers on automation and robotics in civil engineering.

**Summary of the main material.** First of all, it should be noted that modern construction is associated with such phenomena as automation. Automation is manifested in the use of special machines and equipment that increase company productivity during construction processes, reduce the time required to complete tasks, and improve the quality of construction products. Examples of this include the use of excavators, cranes, concrete mixers, etc., which ensure the performance of

work that a builder cannot always perform on his own due to lack of physical capabilities. In addition, special portable units are used to automate the construction of monolithic buildings, cooling towers, etc. [5].

However, automation do not allow for the majority of human work to be replaced, as about 50% of construction processes continue to be performed by builders. This does not allow for an increase in construction speed, can lead to delays in the completion of construction tasks, and can also lead to negative consequences for the safety of workers. With this in mind, the role of robotics in construction is increasing.

Industrial robots were first used in the United States, in particular, Versatran and Unimation robots. Ten years later, Japanese companies began to create industrial robots, followed by others. This became the driving force behind the introduction of robotics in construction. Given this, we emphasise that the use of robots has become particularly relevant in recent decades [1].

One of the simplest, yet most convenient and useful robots used in construction work is a robot designed to perform painting work. Painting walls is a labour-intensive process that is also hazardous to human health. The researchers propose the use of special robots that can eliminate the risks of painting for workers, increase the efficiency of the process and reduce time. The concept of such a robot is outlined in the study by A. Jayaraj and H. N. Divakar, who propose to create a special robot paint sprayer [6].



Fig. 1. Examples of modern 3D construction printers and KUKA robots in construction [11]

There are also currently trends in the use of robotics in the manufacture of materials, modules and prefabricated building structures at construction sites. Accordingly, special robots are used to help automate the process of creating building materials and structures, thereby making it possible to increase the efficiency of these processes and make them less time-consuming. Unfortunately, there is no detailed information on the design and operation of such robots, but it is known that they are already used in different countries [7].

In addition, another area where robotics can be used in construction is the construction of high-rise buildings. Researchers led by S. Tsai note that such technologies are used in different countries, including China. They are used for various processes: transporting building materials, monitoring safety during construction work (in this case, robotics is integrated with sensors and cameras to alert builders to possible dangers), bricklaying and welding parts, etc. The advantages of such robots include avoiding human error and mistakes, reducing construction time, and improving the quality of processes [8].

Robots are also used in the context of heavy construction equipment. Self-driving bulldozers, trenching machines, autonomous track loaders, excavators, construction cranes, etc. are being developed. They operate on the basis of artificial intelligence, depend on GPS, and are equipped with special sensors. An example is the Heap robotic excavator, which allows for precise work in the case of embankments with unique shapes. Like the previous ones, they also have a number of advantages that make construction processes more efficient [9-11].

Another current trend is the creation of special drones [12]. They are used to monitor the construction site, analyze areas that may need to be improved, and also make it possible to explore places that are difficult to access for builders. This makes it possible to obtain timely information about certain shortcomings, improve the safety of construction processes, etc.

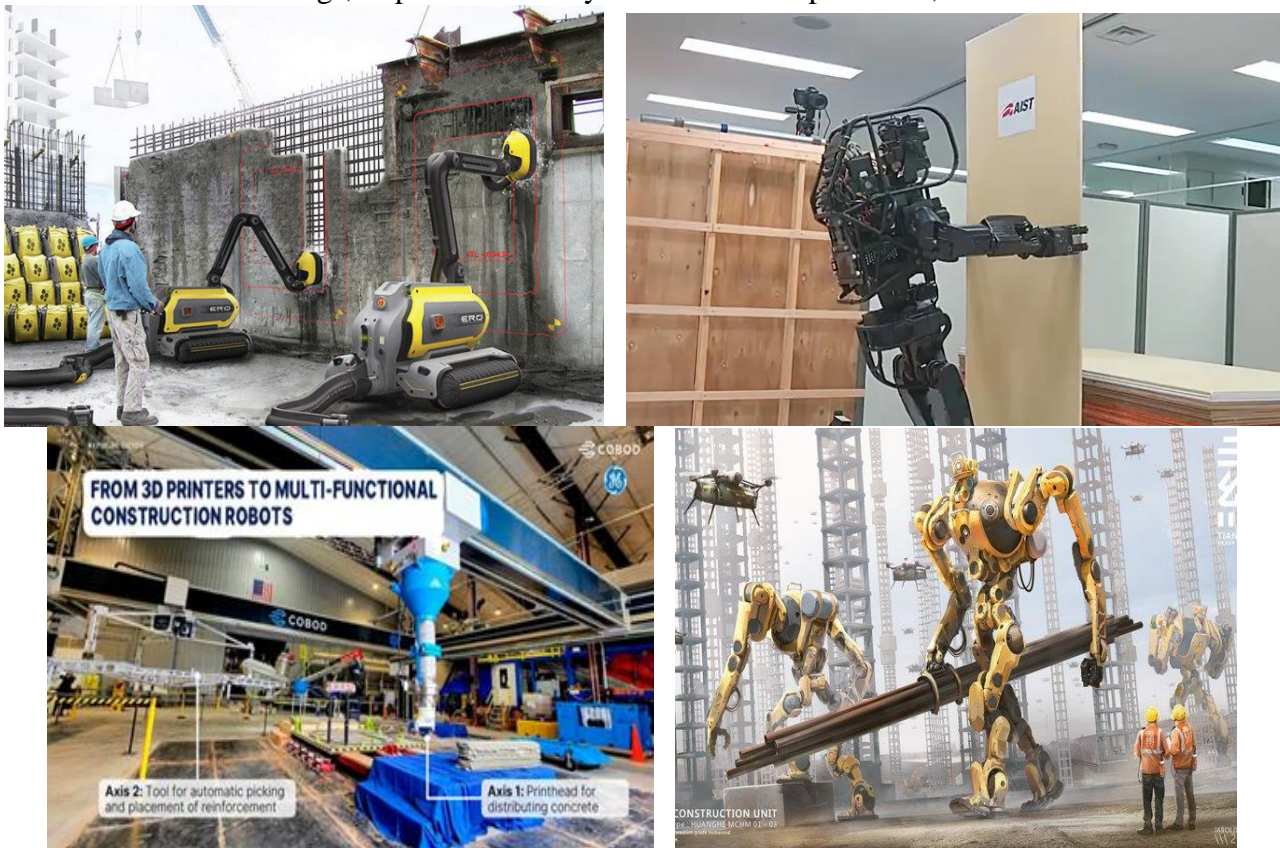


Fig. 2. The present and future of automation and robotics in civil engineering

**Conclusions.** Thus, the range and scope of tasks performed by robots in the area of civil engineering has recently expanded significantly. Robots are gradually performing more and more tasks that were previously performed by humans. Accordingly, their use increases the efficiency of construction processes, improves the quality of structures, makes it possible to erect buildings quickly and efficiently, and reduces the number of potential hazards for builders. According to the data of the American company COBOD, future trends in the development of additive technologies in the construction industry will take place from construction 3D printers to multifunctional construction robots. This means that the role of mechatronics in the modern construction industry will only grow, and therefore the training of modern engineers with experience in mechatronics is essential.

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## PROBLEMS OF CREATING SMALL ARCHITECTURAL FORMS IN ODESA

**Zhakot A., Sultanova M.**, students of gr. A-176

Scientific supervisor – **Kalinin O.O.**, PhD, Associate Professor (Department of Descriptive Geometry and Engineering Graphics, Odesa State Academy of Civil Engineering and Architecture)

**Annotation.** The relevance of the problem of equipping waiting areas (stops) for public transport is formulated. The systematic principle of the approach to solving such problems that occur not only in the city of Odessa, but also in other cities of Ukraine, as well as abroad, is substantiated.

Small architectural forms, in addition to their immediate purpose, in one form or another must fit into the overall ensemble of urban landscapes.

These include kiosks for periodicals, small stalls intended for selling ice cream, soft drinks and other small piece goods, small pavilions for sports entertainment. For example, for shooting at targets from pneumatic or laser weapons, Chess and checkers pavilions, small playgrounds.

Small architectural forms occupy a special place when equipping park areas and squares with gazebos of various configurations, fountains, flower beds, sculptural compositions, openwork bridges thrown over various small obstacles, for example, through streams and ravines, and so on.