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THE FUTURE OF THE PROFESSION OF INDUSTRIAL ROBOTICS IN THE SUSTAINABLE DEVELOPMENT OF THE ECONOMY OF THE REPUBLIC OF KAZAKHSTAN

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In the context of modern globalization and digital transformation, the sustainable development of national economies is inextricably linked with increasing production efficiency and the systematic introduction of innovative technologies. The use of modern technologies, especially in the industrial sector, is becoming one of the main drivers of economic growth. In this sense, industrial robotics is of particular importance as one of the most important tools for automating, optimizing and digitizing production processes.

Industrial robotics allows you to increase labor productivity, reduce production costs and improve product quality. In addition, these technologies contribute to increasing the level of safety of production, reducing errors arising from the human factor. World experience shows that in countries with a high level of robotization, the competitiveness of industry will be quite high.

The Republic of Kazakhstan also implements a number of state programs aimed at digitalization and automation of industry. In particular, within the framework of the Digital Kazakhstan program, priority is given to the modernization of the manufacturing sector and the introduction of high technologies. However, despite the pace of development of the industrial robotics industry, a number of problems remain in this direction, such as personnel support, technological infrastructure and insufficient research base[1].

In this regard, the analysis of the current state of the profession of industrial robotics and the determination of prospects for its future development is an urgent scientific problem from the point of view of ensuring the sustainable development of the economy of Kazakhstan.

Today, industrial robotics is rapidly developing at the global level and has a direct impact on the economic, technological and educational policies of each country. To compare the level of development of this industry in the countries of the world, the level of robotization (robot density), the personnel training system and technological infrastructure are considered as the main indicators. here and directly depends on the education system[2-7].

Table 1. Comparison of Universities by Robotics Specializations

University	Country	Specialties	Features	Advantages
Massachusetts Institute of Technology	USA	Robotics, AI, Mechanical Engineering	World Group university	Strong laboratory, communication with large IT companies
Stanford University	USA	Robotics, Computer Science	Silicon Valley Center	Startup, innovation, high salary opportunity
Technical University of Munich	Germany	Mechatronics, Robotics	Industry 4.0 Center	Practice, production connection, learning is Cheaper
University of Tokyo	Japan	Advanced Robotics	Robotics leader	Experience with Toyota, Honda
KAIST	South Korea	Robotics, Smart Manufacturing	High robotization	Practical research, state support

Satbayev University	Kazakhstan	Automation, Robotics	National Technical University	Affordable, production direction
Almaty Technological University	Kazakhstan	Automation, Smart Tech	Close to production	Practicality, adaptability to the local market

The presented table relatively reflects the features of the training of the specialty industrial robotics in higher educational institutions of the world and national level. The table contains the country of location of the University, the specialties offered, the features and main advantages of the education system.

US universities, such as the Massachusetts Institute of Technology and Stanford University, which belong to the first group, are world leaders in the field of robotics, artificial intelligence and computer science. The main feature of these educational institutions is the high level of development of scientific research, the formation of an innovative ecosystem and close cooperation with large technological companies. As a result, graduates will be in high demand in the international labor market.

As a representative of the European education system, the Technical University of Munich occupies a special place. Education at this university is carried out on the basis of a dual system, that is, students master industrial practice in parallel with theoretical knowledge. The widespread introduction of the Industry 4.0 concept will allow graduates to quickly adapt to the production environment.

Asian countries, in particular the University of Tokyo and KAIST, are distinguished by the priority of the practical direction in the field of robotics. In these universities, students take part in real production projects and gain experience in the development and implementation of modern robotic systems. The high-end Robotic Industries of Japan and South Korea have a direct impact on the quality of Education[2-7].

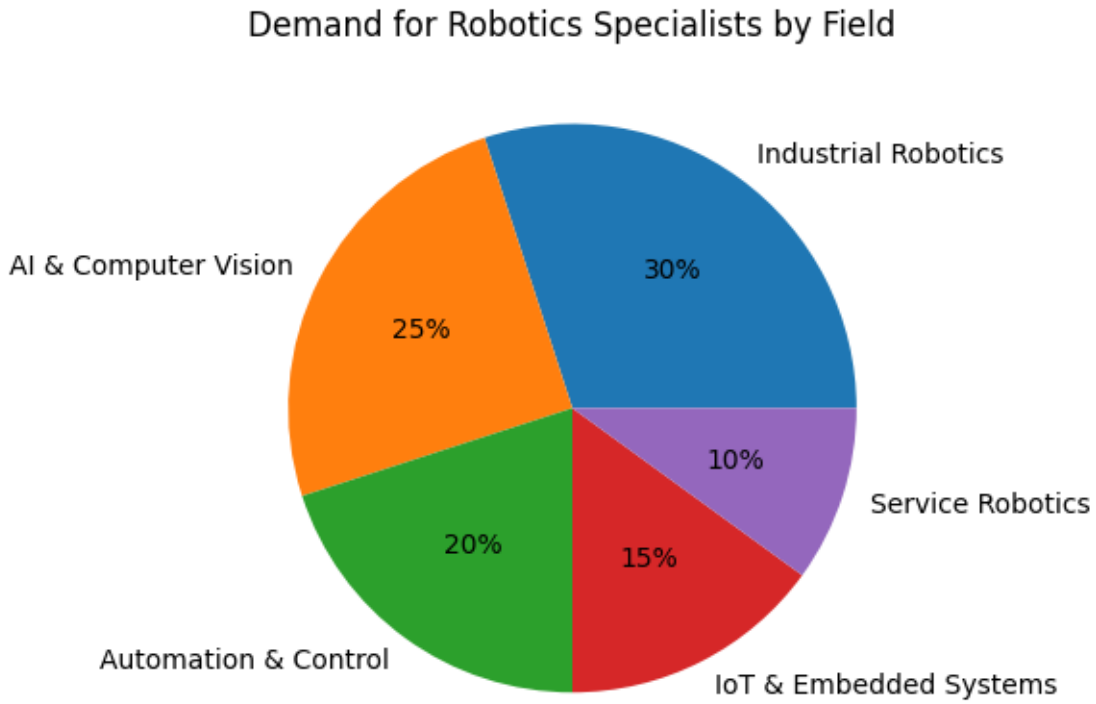

Fig 1 - Demand for Robotics Specialists by Field

The results of the analysis of the structure of the demand for specialists in the field of robotics show that the highest demand falls on the industrial robotics industry (about 30%). This is due to the rapid development of automation and robotization of production processes.

The demand for specialists in the direction of artificial intelligence and computer vision is about 25%. This direction plays an important role in the development of intelligent control systems, autonomous robots and data analysis systems.

The field of automation and control systems covers a share of about 20%, which is explained by the need for effective management of industrial processes.

The demand for specialists in IoT and embedded systems (embedded systems) is about 15%. This direction is important in the development of smart devices and industrial internet systems.

Service robotics (service robotics) occupies a share of about 10%, which includes medical household and logistics robots.

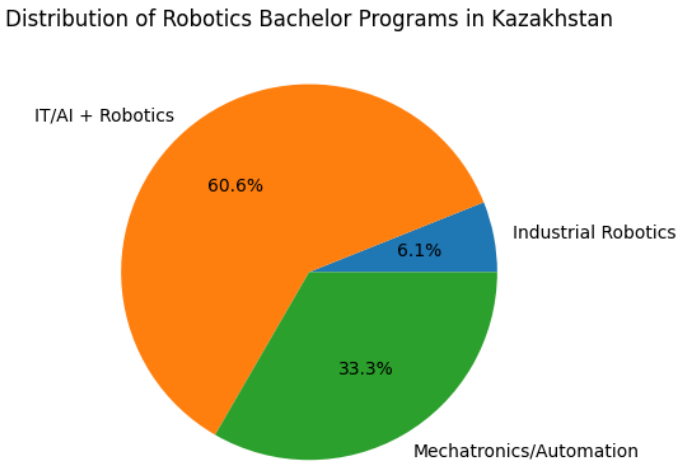

Fig - Distribution of Robotics Bachelor Programs in Kazakhstan

Kazakhstan universities-Satbayev University and Almaty Technological University – are now rapidly developing training in the field of industrial robotics. The advantage of these universities is the availability of knowledge and adaptation to the needs of local production. However, the material and technical base and the level of research still require improvement in comparison with developed countries.

In general, the results of the table show that the quality of the specialty industrial robotics directly depends on the scientific potential of the University, production links and the level of technological development of the country. While in developed countries this industry is highly developed, in Kazakhstan it is at the stage of formation and development.

In the Republic of Kazakhstan, more than 30 educational programs (EP) are implemented at the undergraduate level in the direction of robotics. The results of the analysis showed that the structure and orientation of these programs is uneven.

Most of the programs are integrated with information technology and artificial intelligence. In particular, about 60% of educational programs in the field of robotics are focused on IT and AI. These programs mainly cover the areas of programming, data processing, computer vision, and Intelligent Systems Development.

Kazakhstan's universities-Satbayev University and Almaty Technological University – are currently intensively developing training in the field of industrial robotics. The advantage of these universities is the availability of knowledge and adaptation to the needs of local production. However, the material and technical base and the level of research still require improvement in comparison with developed countries[2-7].

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In addition, about 30-35% of educational programs belong to the field of Mechatronics and automation. In these areas, students master the basics of electromechanical systems, control theory, sensor systems and industrial automation.for real industrial applications, engineering training remains at an insufficient level.

In this regard, there is a need to develop new educational programs and improve existing ones in the direction of Industrial Robotics, Digital Production, Industry 4.0 and smart factories. This, in turn, makes it possible to train qualified engineering personnel in accordance with the requirements of the labor market[8].

Currently, the direction of industrial robotics in the Republic of Kazakhstan is one of the most promising and demanded areas of engineering education. In this context, the educational program "industrial robotics" offered by Almaty Technological University is distinguished as an innovative direction that fully meets the requirements of modern production.

The main feature of the program is its clear orientation towards the direction of production. The educational process includes engineering tasks such as the design, modeling and operation of robotic systems. Students master industrial robots, Control Systems (PLC, HMI), as well as automation and digitalization technologies . This ensures that they are ready to work in a real production environment.

Another important advantage of the program is interdisciplinary integration. It combines elements of Mechatronics, electronics, instrument making, programming and artificial intelligence. Such comprehensive training forms the ability of future specialists to design and manage complex engineering systems .In addition, the educational program is distinguished by practice-oriented training. Students work with real robots and participate in engineering projects,

which allows them to build their professional skills from an early age.

Fig 3 - KUKA robot at ATU University

In conclusion, with the advent of digitalization and automation of the craft in Kazakhstan, quilting is becoming more and more relevant, especially through the implementation of the Digital Kazakhstan initiative. Introducing advanced technologies to the manufacturing sector has accelerated the economy's pivot to the basins and improved labor productivity. Furthermore, there remain several system problems that hinder the fully-fledged development of the sector of craft robotics. These are, first of all, the lack of access to qualified cadres, the inadequate readiness of modern technological infrastructures, and the weak dynamics of scientific research. Therefore, updating the education system, developing a scientific and innovative environment, and improving the interaction between manufacturing and science ultimately become a priority. Only in this direction does the Republic of Kazakhstan have the opportunity to achieve sustainable development of the field of craft robotics accomplished.

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