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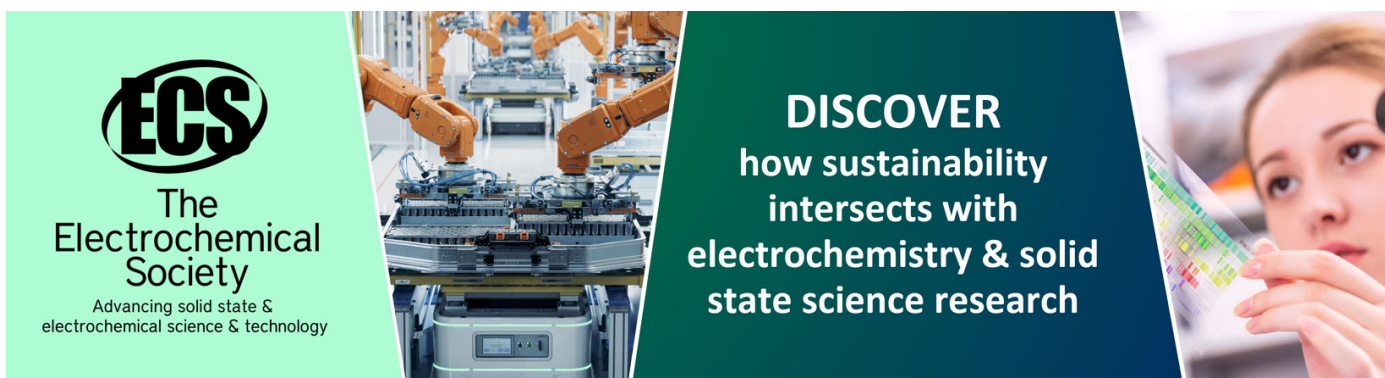
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Automation of Russian industry as an indispensable condition for sustainable economic development in the digital environment

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Abstract. Today, robots are actively being introduced in all sectors of the economy from the production of industrial goods to the service sector. The leader in this area is China, it is ahead of the United States and Europe. Russian industrialists are quite conservative in technological updates. It was emphasized that robotics and automation, combined with the cybernation, mark a radical turning point in society. The importance of industrial automation in solving technical, technological, socio-economic and environmental problems is shown. Models of economic growth in industry, in particular P. Romer, confirm that the rate of economic growth is directly dependent on the amount of technological innovations. The negative aspects of automation, which consist in a sharp reduction in employment, are also emphasized, but long-term forecasts, on the contrary, indicate its increase, but a change in the structure of professions.

1. Introduction

The market of industrial robotics is developing steadily, and every year more and more companies appear that introduce various automated technologies in their production. Today, production in Russia as a whole remains quite conservative in terms of technological indicators. Many companies in the country prefer to "save" on the introduction of new technologies and remain on the same level of profitability, exploiting cheap equipment and human resources [1].

Today, improving the quality of industrial production, ensuring the production of competitive products in accordance with the world level of scientific and technological progress, is the most important prerequisite for the successful implementation of the Russian economy modernization [2]. This is a necessary condition for fulfilling the tasks of import substitution, which is a priority in the development strategy of the Russian Federation. Robotization and automation, combined with the introduction of computers, mark a radical turning point in people's attitudes towards the surrounding reality. All previous technical improvements only increased the physical strength of people [3].

2. Description of approach

The flexibility of the robotic system makes them indispensable in business development. Robotization of production processes allows us to solve a number of technical, technological, socio-economic and environmental problems (figure 1).



technical and technological	socio-economic	environmental
• ensuring high quality products and their competitiveness in the world market; • increase the speed and accuracy of operations; • elimination of defects and errors due to the virtual presentation of the product; • the network surpasses the hierarchy in all areas of activity.	• replacement of monotonous, routine human labor, as well as the replacement of people in hazardous industries; • significant increase in labor productivity; • reducing the time of the product manufacturing cycle, which ultimately reduces its cost;	• the possibility of creating industries that are independent of the places of concentration of labor, easily reprogrammed for new products; • human replacement in hazardous industries;

Figure 1. The value of industrial automation.

The combination of virtual and real world allows for extensive data analysis and proactive maintenance of systems to solve problems before they occur and prevent downtime. Using simulations also opens up new possibilities and more accurate planning for the future. The ultimate goal is to develop, test and manufacture products completely in a virtual environment, so that material production begins only when the product has already proven its functionality.

A person in general can be excluded from the production process, only control functions are retained behind him [4]. Their implementation due to computer networks sometimes does not even require the direct presence of people in the enterprise.

The current wave of automation and digitization is not only a change in individual work profiles. It changes the entire workflow, whether services, research and development, search, production or distribution [5]. Automation really replaces work - this is usually its goal. But automation also complements work and improves productivity in a way that leads to increased demand for work. Increased productivity should increase the standard of living of the entire world population [6].

The leaders of many Russian enterprises avoid the introduction of robotics due to the incorrect assessment of certain risk factors and not realizing that even if the plant has well-developed design and technological training, an outdated production base will not allow to produce products of the required quality now and in the future. Digital technologies allow companies to quickly scale up or scale down their operations, eroding the boundaries of companies and challenging previous production models [7].

Back in the middle of the 20th century, economic growth models of American industry researchers (G. Morbi, M. Brenner, B. Rushton, Z. Griliches, etc.) appeared, proving the relationship between the level of R&D spending, technological innovations and labor productivity growth, and also sales and profits in major US industrial corporations [6].

Consider a model of endogenous scientific and technological progress, in which technological changes are the most important factor in economic growth, and further use of the created technologies does not require additional costs from the manufacturer.

P. Romer divided the economy into three sectors: research, the production sector of the production means and the sector of final products production [8]. In the research sector, new knowledge is formed, which then materializes in the form of new technologies. The growth of new knowledge is expressed by the formula:

$$A = \delta H_A A \quad (1)$$

where δ - is the parameter of scientific productivity.

The manufacturing sector pays scientists to create new technologies in the first sector. The fee for using a unit of human capital is calculated by the formula:

$$\omega_H = \delta P_A A \quad (2)$$

where P - the price of new technology.

After acquiring and mastering a new technological idea, a firm in the second sector protects its monopoly on its use with a patent and arranges for the release of appropriate means of production for firms in the third sector. To produce one unit of equipment, h units of the final products of the third sector are consumed. Means of production are not for sale, but are leased for P_i rental.

In the third sector, based on the available production means x_i , labor costs L and human capital H_Y , output of final consumer goods is ensured. The production function has the form

$$Y = (H_Y, L, x) = H_Y^\alpha L^\beta \sum_{i=1}^{\infty} x_i^{1-\alpha-\beta} \quad (3)$$

where α, β - technological parameters.

The change in the total capital of a three-sector system is determined by the formula

$$K(t) = Y(t) - C(t) = \eta \sum_{i=1}^{\infty} x_i \quad (4)$$

where $C(t)$ – aggregated consumption function.

Manufacturers of final products build their relationships with manufacturers of means of production, based on the tasks of maximizing profits (output minus equipment costs):

$$H_Y^\alpha L^\beta \sum_{i=1}^{\infty} x_i^{1-\alpha-\beta} - \sum_{i=1}^{\infty} P_i x_i \rightarrow \max. \quad (5)$$

Hence, in conditions of market equilibrium, the inverse function of demand for new technologies

$$P_i = (1 - \alpha - \beta) H_Y^\alpha L^\beta x_i^{1-\alpha-\beta}. \quad (6)$$

Firms of the second sector, paying for work to create new technologies in the research sector, determine the volume of output for the third sector x_i , taking into account the maximization of their income minus variable costs:

$$\pi = \max_x P_i(x)x - r\mu x = \max_x (1 - \alpha - \beta) H_Y^\alpha L^\beta x_i^{1-\alpha-\beta} - r\mu x \quad (7)$$

where r – interest rate on capital.

For any point in time, the excess of income over marginal cost per unit time should cover interest payments by the amount of investment in the development of a new technology

$$\pi(t) = r(t) * P_A \quad (8)$$

For the equilibrium trajectory of balanced growth, the variables A , K and Y increase exponentially with the same constant speed g , and the value of L , H_Y and the average value

$$\bar{x}^{1-\alpha-\beta} = \frac{K}{\eta A} \quad (9)$$

fixed. Then the expected growth rate is estimated as follows:

$$g = \delta H_A = \delta H - \gamma r, \quad \gamma = \frac{\alpha}{(1 - \alpha - \beta) * (\alpha + \beta)} \quad (10)$$

where H – total human capital of the first and third sectors; g - is a constant depending only on the technological parameters α and β .

Thus, the rate of economic growth is directly dependent on the amount of human capital concentrated in the field of new knowledge and inversely dependent on bank interest rates. Technical progress is due to the activities of people. Without introducing the achievements of scientific and technological progress, it is hardly possible to count on the success of activities in the future.

3. Practical calculations

But automation is not limited to the manufacturing industry. It also plays an increasingly important role in other areas [9]. For example, doctors can use AI to significantly improve their results. Recent tests have shown that some forms of automatic image recognition can achieve up to 50 percent better results than a team of human radiologists in classifying malignant tumors using x-ray and computer scanning. On top of that, machines had a false negative of zero compared to seven percent for the human team [10].

Mobility is another example. Self-driving cars are the most famous example. Less well-known, but no less important is the impact of automation on other areas, for example, on automatic control systems for trains and subways. This improves punctuality and cycle time - and saves time for the driver, who, therefore, can focus more on passenger safety [11].

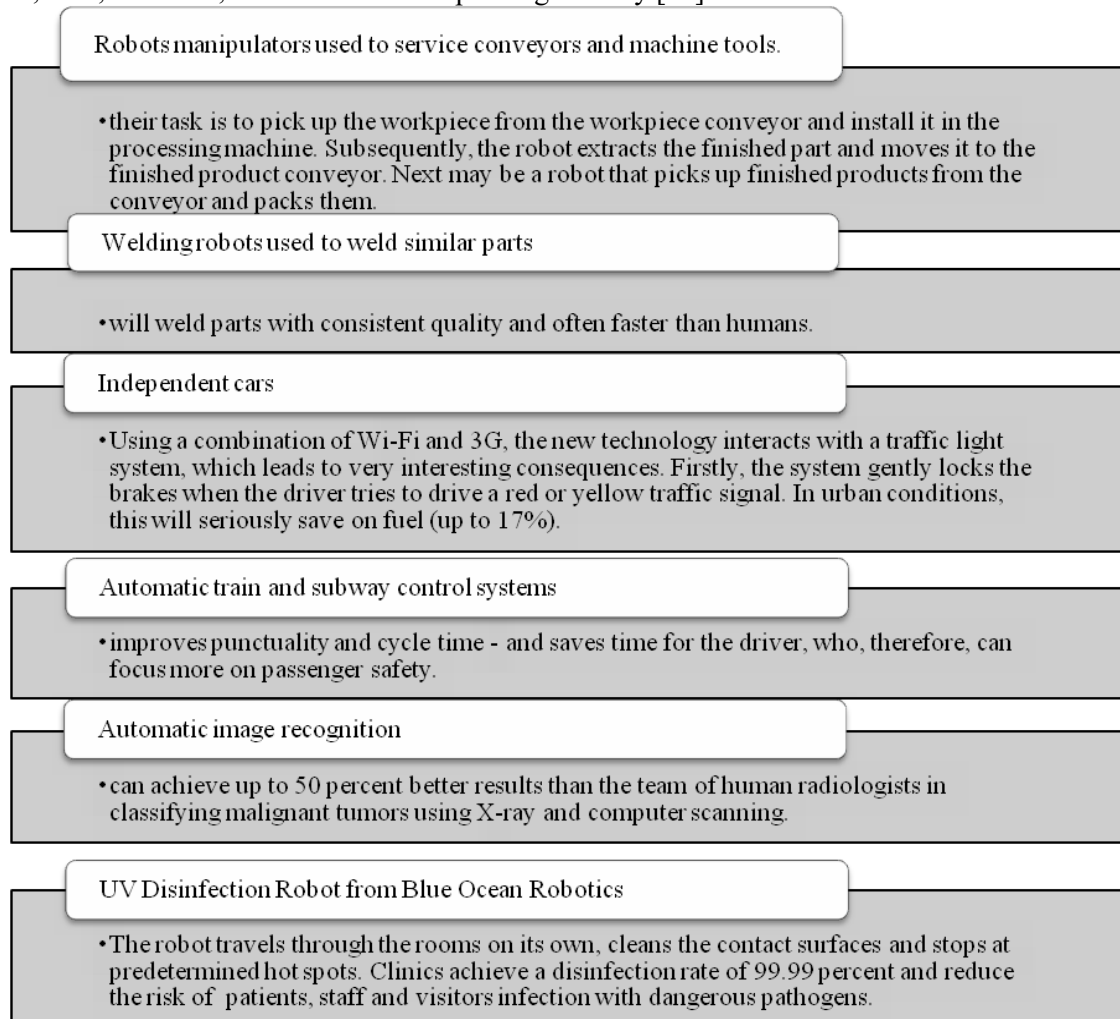


Figure 2. Examples of industrial automation.

The range of applications for robots is wide. To date, a large number of areas are covered by robotics. Enterprises of the industrial sector: welding production, nuclear energy, manufacturers of metal structures, automotive parts and others [12]. In the construction industry, a high level of accuracy is achieved due to a model based on an automated process, investments in the development stage are paid off by reusing production technologies [13]. Direct Digital Construction (DDC) is a technology-based operational management practice that aims to increase construction efficiency by reusing the project and reducing human perception. Furniture production, advertising and architectural

agencies: wood, plastic, stone, composite materials. Food production: palletizing, moving boxes, bottles, packaging. Aircraft and shipbuilding, repair of special equipment: surfacing and painting. Medicine: medicine movement, research (figure 2).

4. Discussion

A growing number of studies show a positive correlation between automation and jobs - not only in the past, but also in Industry 4.0. The positive effect that robots have on the labor market is evident, for example, in Germany, says Joe Gemma, chairman of the International Federation of Robotics (IFR). The German auto industry has the highest level of robotics in all industries in Europe: approximately 1,150 robots per 10,000 employees. "As a result," says Gemma, "the number of jobs in Germany's automotive industry grew by 93,000 between 2010 and 2015." [14] Similar trends can be seen in the United Kingdom and the United States. In China, the country has already surpassed the United States and Europe combined in the number of industrial robots [4]. Only in 2018, 154,032 of such machines were installed here. However, due to the huge number of human employees, the density of industrial robots in China remains low - only 97 per 100,000 workers [15]. For comparison, in the USA this figure is 200, and in South Korea - 710. The Chinese government plans to increase the density of robots to 150 this year. To avoid the negative effects of automation, the Academy of Social Sciences of China proposes to introduce a tax on the use of robots. The funds received from it will be used to finance the retraining of vulnerable workers [16]. This idea is already being introduced in South Korea.

5. Conclusion

In the digital economy, great importance is attached to such a competitive advantage factor as flexibility and the ability to change. We are already talking about hypercompetition, the optimal way to achieve success, depending on the continuous creation of new advantages and the continuous development and implementation of innovations demanded by the market. Hence the inevitability of automation in all areas of society. Robotization will lead to an improvement in the life and future of people all the world. This will positively affect the labor market, but the structure of professions will gradually change radically.

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