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# ТЕНДЕНЦИИ ВНЕДРЕНИЯ ТЕХНОЛОГИЙ ИСКУССТВЕННОГО ИНТЕЛЛЕКТА И РОБОТОТЕХНИКИ В АРКТИКЕ: ОПЫТ РОССИЙСКОЙ ФЕДЕРАЦИИ

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***Аннотация:*** искусственный интеллект (ИИ) позволяет компьютерам обучаться на собственном опыте, решая трудно формализуемые задачи, адаптируясь к новым параметрам и условиям. В большинстве случаев для решения задач ИИ крайне важна возможность глубокого обучения и обработки естественного языка. Благодаря этим технологиям компьютеры можно «научить» выявлению закономерностей на основе обработки большого объема данных и использования их для принятия решений. В исследовании проводится анализ тенденций внедрения ИИ и робототехники в Арктической зоне Российской Федерации (АЗРФ), их перспективы, с целью определиться в каких направлениях необходимо продвигаться для осуществления цифровизации Арктического региона, что уже следует применять к реализации развития этой части Земли, от которой зависит и будущее России. Исследование основывается на истории и сферах применения ИИ и робототехники в АЗРФ, с учетом состояния окружающей среды и экологической обстановки этого региона.

***Ключевые слова:*** Арктика, Russian Arctic, искусственный интеллект, робототехника.

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## Trends in artificial intelligence and robotics technologiesin the Arctic: the Russian experience

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***Abstract:*** Artificial intelligence (AI) allows computers to learn from their own experience, solve hard-to-formalize tasks, and adapt to new parameters and conditions. In most cases, deep learning and natural language processing capabilities are extremely important for solving AI tasks. Thanks to these technologies, computers can be “taught” to identify patterns based on the processing of large amounts of data and use them to make decisions. The study analyses trends and prospects for the introduction of AI and robotics in the Arctic zone belonging to the Russian Federation (AZRF). Its aim is to identify the directions that the digitalization of the Arctic region should move in, determine what already needs to be implemented for the development of this part of the Earth, on which the future of the country largely depends. The study is based on the history and applications of AI and robotics in the Russian Arctic, taking into account the state of the environment and the environmental situation of this region.

***Key words:*** Arctic, Арктическая Российской федерации, artificial intelligence, robotics.

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## Introduction

In the Russian Federation, work on the development of the Arctic region and the intellectualization of technologies used in the Russian Arctic is based on two strategies: the state policy of the Russian Federation in the Arctic **until 2035** [64] and the strategy for the development of artificial intelligence in the Russian Federation until 2030 [65].

Today, the Russian North provides a significant share of the country's export revenues, and is of critical strategic and geopolitical importance for modern Russia [66]. Over the past thirty years, more than two dozen fields have been discovered on the territory of the Russian Arctic shelf [9]. These reserves, according to estimates of the Institute of Petroleum Geology and Geophysics of the Russian Academy of Sciences, amount to about 10 billion tons of oil. The total resources of the Russian shelf as a whole are estimated by domestic experts at about 100 billion tons of equivalent fuel [2]. According to other expert estimates [37], oil reserves in the Arctic zone of the Russian Federation amount to 7.3 billion tons and 55 trillion cubic meters of natural gas. It is the development of minerals that is the main component of the development of the Arctic [45, 46].

Along with this, the introduction of AI and robotics will simplify the solution of a number of problems related to mining, transportation and logistics in the difficult climatic conditions [54, 71].

Therefore, research in the AI field is an urgent problem and a priority of public policy [65].

## 1. Methods

The methodological basis of the study is based principles such as objectivity, consistency and scientific analysis. The systematic approach allowed us to consider the main trends in the development and application of AI and robotics systems as a set of measures necessary for the successful development of the Russian Arctic. This study also describes various aspects of the natural environment from the perspective of robotics, recent developments in this sphere and the prospects for advancing.

### *1.1 History of AI application in the Arctic*

Currently, there are three chronological stages in the introduction of AI in technology for the Far North regions.

The first stage began in the mid-1960s, when programs for autonomous systems were first created [29].

The second stage began in 1984, when an integrated approach to Arctic development was introduced in the USA (Interagency Arctic Research Policy Committee, Arctic Research and Policy Act of 1984 (ARPA), Public Law 98—373 of 07/31/1984). To implement the strategy of federal coordination and U. S. global leadership in the exploration of the Arctic, the Arctic Research Commission (ARC) and the Interdepartmental Committee on Arctic Research Policy (IARPC) were established.

The third stage develops in the present and dates back to 1984, when other states set out the tasks of developing the Northern Territories.

### *1.2 Areas of application of artificial intelligence*

The main directions of AI application in human economic activities in the Arctic will be the following: in mining and mineral processing , search and rescue operations, medicine, transport and logistics, construction, housing and communal services, energy [29].

**Mining.** A global trend in the development of oil and gas sector is the introduction of the "Intelligent field" and "Digitalization" concepts. Intellectualization extends to many stages across a wide range of IT components that are interconnected [7, 33, 50].

With the help of digitalization of technological processes, it is planned to reduce the costs associated with the exploration and production of hydrocarbons in difficult regional conditions, as well as with the development and production of special equipment [38, 72].

At the same time, thanks to this, it is possible to reduce environmental consequences [70], minimizing human presence in the region, and, ideally, reducing it to zero, ensuring technological and environmental safety, by transferring competencies to the level of robotic systems [41].

Digitalization of the mining industry, including in the Arctic region, is not possible without the creation of fully automatic systems with AI elements, working without human participation. The main trends are considered in the work of A. Makhovikov, E. Katuntsov, O. Kosarev, P. Tsvetkov "Digital transformation in oil and gas extraction" [38], and a specific example of implementation is presented in the paper "Modeling of industrial IoT complex for underground space scanning on the base of Arduino-based platform 'Topical issues of rational use of natural resources'" [35].

**Intelligent automated process control systems**. Gas production in the Arctic is associated with the need to solve a problems. An example is the problem of hydrate formation in gas collecting plumes for gas production companies. Its solution is found by feeding methanol into the pipelines. To minimize methanol consumption, OOO Gazprom Dobycha Yamburg has developed an innovative technology for preventing hydrate formation, implemented by an intelligent automated process control system [8, 14].

**Safety**. Along with the implementation of the Fundamentals of State Policy of the Russian Federation in the sphere of protection of population and territories from emergencies until 2030 and the Strategy for the Development of Civil Defence , protection of the population and Territories from emergencies, special attention is paid to the problematic issues of ensuring safety in the Arctic zone of the Russian Federation [26]. Since the peculiarity of the region does not allow the use of traditional methods and technologies of response to the occurrence/prevention of emergencies when assistance is required, there is a need to introduce robots. That is why the creation of effective robotic unmanned rescue systems (RURS) is an urgent task. Innovative directions of the development of such systems are, first of all, the ability to long-term autonomy with the possibility of remote control [19]. Such a rescue service based on robots, drones and AI was created jointly by the Ministry of Emergency Situations of Russia and the Central Research Institute of RTK. Two types of robots are used — ground-based and airborne. These drones will be able to scout the route and create an electronic map of the territory in real time. A ground unit in the form of robotic platforms will search for and transport people in distress. It is assumed that one drone will be able to evacuate up to twenty people [17].

**Medical care**. One of the main problems in the Russian Arctic is the poor quality of medical care and shortage of staff and medical facilities, especially in hard-to-reach areas where indigenous peoples live. Based on this and desperate for solutions, regional state authorities are turning to modern remote methods such as telemedicine, which makes it possible to diagnose and prescribe treatment from a distance [27]. In Russia, there are few ready-made solutions to this situation based on the results of AI. One of them is the work on speech recognition and online diagnosis of diseases based on medical images [12, 24].

**Transport**. Over the past five years, various Russian agencies and research centers have announced their intention and readiness to create fully automated vehicles and logistics solutions to be used in the Arctic [29, 48, 49, 53, 55, 58, 61]. Most important is the use of unmanned technologies. The Center for Advanced Research is developing an unmanned aerial transportation system (T-BAS), thanks to which companies and residents of the Far North will be able to quickly deliver and receive cargo, while scientists, for example, will be able to study from the air metrological characteristics and their changes, as well as the migration of animals[6]. It is necessary to note the work of scientists at the Russian Federal Nuclear Center, who are developing a digital model of a crewless marine vessel, the advantage of which is the increased efficiency and safety of maritime transportation in the Arctic [5].

**Construction**. An in-depth study of innovative technologies in the sphere of construction using AI is already being implemented on construction sites not only abroad, but also in Russia; it is becoming more and more in demand. According to experts, AI can manage Smart Cities in the Far North. The concept of a "smart city" with energy efficiency, self-sustaining efficiency of the territory makes the basis for the future of the Arctic cities [18, 20].

**Power supply.** The idea of energy development in the Russian Arctic implies the creation of a full-fledged energy infrastructure, the ability of which is to ensure high reliability of power supply and the possibility of stimulating new industrial development in the region [73, 75]. Rosatom State Corporation has developed about 20 projects of power plants based on small nuclear reactors, showing considerable interest in the power supply in the Arctic. The best known is the 70 MW Academik Lomonosov floating nuclear power plant (NPP) ". This project is based on the development of a new reactor plant for the "Arctica" nuclear icebreaker, currently under construction. The peculiarity of the reactor is its operability for 7—10 years without the need of nuclear fuel elements to be maintained [21].

Another phenomenon worth highlighting is the technology of autonomous power supply based on traditional and renewable energy sources developed by Peter the Great St. Petersburg Polytechnic University (SPbPU) for harsh climatic conditions, as well as a 200 kW diesel generator for Arctic conditions, presented by their partner company President-Neva Energy Center. The machine has an intelligent automatic control system. The solutions are claimed to have no analogues in the world [10, 28].

Modern power supply systems are needed to improve the stability of information technology systems functioning in the Arctic region. One approach to improving such systems involving elements of intellectualization is described in the paper by S. Kryltsov, A. Makhovikov, M. Korobitsyna "Novel approach to collect and process power quality data in medium-voltage distribution grids"

[36]. Another important aspect in this area is the decentralized energy supply, which can be carried out with the help of low-tonnage production of liquefied natural gas. The economic aspects of this approach are considered in the work of P. Tsvetkov, A. Cherepovitsyn, A. Makhovikov "Economic assessment of heat and power generation from low-tonnage liquefied natural gas in Russia" [43].

**History, archaeology, tourism.** The development of tourism in the Arctic zone of the Russian Federation is determined not only by the creation of new infrastructure facilities, but also by the introduction of modern digital services. Virtual tourism in the Arctic is a new trend with the use of virtual and augmented reality technologies, creating digital doubles of the territories. The use of space monitoring, panoramic photography and photogrammetry from manned and unmanned aerial vehicles for the virtual Arctic tourism will make cultural and natural objects of the Russian Arctic more accessible and attract new Russian and foreign tourists for a real visit to the polar regions. Virtual Reality (VR) is a world created by technical means (objects and subjects) andtransmitted to a person through his/her senses: vision, hearing, smell, touch and others. Augmented Reality (AR) includes digital objects, which are the result of introducing any sensory data into the sphere of perception in order to supplement information about the environment and improve perception of the information, while the outside world does not change in any way. The closest to the reality sensations is Mixed Reality (MR), the environment that is created using the software taking into account the situation in the real world, when the coexistence of real and virtual objects, the superimposition of non-existent virtual objects on the human environment [51].

**Robotic systems application.** Marine robotics is actively developing in Russia [60]. One of the key regions for the application of new robotic systems is the Arctic. The leading positions in the development of robotic complexes for marine applications are occupied by St. Petersburg State Marine Technical University, the Institute of Marine Technology Problems (Far Eastern Branch of the Russian Academy of Sciences), as well as the Research and Production Enterprise of Underwater Technologies Oceanos [31]. Recently, the latest classes of underwater robots have been implemented, for example, underwater gliders with the hydrostatic principle of motion, vehicles with the ability to stay underwater for a long time, capable of working among thin ice, surfacing and penetrating under ice masses, solving problems of operational oceanology and hydrography, and as data repeaters for civil data processing centers and for facilities of the Russian Ministry of Defense [13]. Speaking of robotics, it should be noted that more than 1.5 million industrial robots work in the world, which indicates their great potential for the future, in particular for the Arctic [4, 15, 23].

**The use of digital doubles.** The creation of integrated infrastructure monitoring systems in the oil and gas producing regions of the Far North, based on the use of heterogeneous mathematical models (digital twins), is a promising science-intensive direction [34, 44].

**Forecasting the ship logistics parameters.** Here the progress of Russian science is evident, achievements in this sphere, for example, are listed in [47], namely — various approaches to modeling the movement of ships in ice and determining the duration of voyages are analyzed; semi-empirical models for calculating ice resistance, numerical methods of modeling ship-ice interaction, as well as statistical models based on regression ratios or artificial intelligence methods are considered. The concept of creating a universal calculation model, which could be used as a part of modern software systems which provide intellectual support for Arctic navigation, is proposed.

**Monitoring and control, geoinformation systems.** The works [52, 59, 62] describe the intellectual property objects patented in Russia for monitoring and control in the conditions of the Arctic and the Far North. They also present a dispute on promising directions for the development of such systems; these tasks are linked to visualization on electronic interactive maps in real time [74].

**Environment.** It should be noted that AI, due to its autonomous operation, requires significant energy costs, resulting in problems with the well-being of the environment of the region [42]. Due to the natural and geographical features of the Arctic, there is a high probability that the existing environmental problems will grow from regional to global. Therefore, the development and subsequent introduction of robots in oceanographic, hydrographic, environmental and geological research in the Russian Arctic should ensure the safety of the ecosystem of this region.

The main measures to implement the state policy to ensure environmental safety in the Arctic Zone of the Russian Federation are : the establishment of special regimes of environmental management and environmental protection, including monitoring of its pollution; disposal of toxic industrial waste, reclamation of natural landscapes, as well as ensuring chemical safety. It is worth noting that in the Arctic there are many facilities that pose a potential radiation hazard. For example, the Kola NPP, where nuclear-powered surface and submarine ships of the civilian and naval fleets are based and repaired, a significant part of which is subject to disposal. Moreover, on the coast of the Barents and White Seas, there are facilities for storageof irradiated nuclear fuel.

The basic principles and mechanisms of state policy implementation are based on “maximum preservation of the environment (application of environmental standards and technologies)”. The list of main activities of this program planned for 2021 – 2023includes the construction of an environmentally safe fleet to ensure federal state environmental supervision in the seas and on the continental shelf in the Russian Arctic. However, there yet are no clear methods of combating environmental risks in the state program [56, 57].

## 2. Results and discussion

As a summary, one should single out some modern know-hows that are of the most important socio-economic importance for the country, as well as admit the experience of foreign partners in the implementation of robotics for oceanographic, hydrographic, environmental and geological research in the Arctic. As a summary, we should highlight some modern know-how of crucial socio-economic importance for the country, as well as recognize the experience of foreign partners in implementing robotics for oceanographic, hydrographic, environmental and geological research in the Arctic.

### *2.1. Oceanos marine robots for environmental monitoring*

The traditional monitoring system based on the use of ships, lowered and towed sensors, long-term stationary and floating buoys, is becoming increasingly inapplicable due to the harsh climate and difficult natural conditions of the Arctic. It is indisputable thatthe Arctic region currently establishes and dictates a significant need for the facilities with the following properties: ability to perform tasks clearly, high autonomy, no need for frequent lifting, minimized costs when providing operations from the surface. Thus, within the framework of this concept and based on the fundamental requirements, the system should consist of a group of autonomous underwater vehicles of various types and a system for their support.

Oceanos Underwater Technology Research and Production Enterprise is developing such a system, namely a group of efficient marine robotic vehicles for environmental monitoring, oceanographic observations and sampling of water and soil anywhere in the World Ocean, including the Arctic region. They design, manufacture and test examples of underwater robotics with hydrodynamic and hybrid principles of motion [1].

Oceanos works in cooperation with St. Petersburg State Marine Technical University as well as with many leading Russian companies. Since 2011, the company has been conducting and implementing its own developments of autonomous uninhabited underwater vehicles of the glider type, capable of diving to a depth of up to 1000 m and having autonomy of 6 months or more, marine robots specially trained for the harsh Arctic conditions. In 2015—2017, during the practical tests — descents of the device, scientists determined the requirements for navigation, maneuverability and speed of the robotic vehicle, developed the optimal mode of passage of the specified points and achieving the optimal energy efficiency planning mode [3].

Modern developments will be applied within the framework of the EcoCleanOcean international project, focused on cooperation in the sphere of ecosystem restoration and cleaning of the oceans, elimination of garbage islands. In 2020, within EcoCleanOcean project and with the support of the UN Environment Programme Assistance Committee UNEPCOM, Oceanos conducted tests of glider-type ANPAs. They worked out new algorithms of the mission planner and control systems, modes of ANPA movement along complex spatial trajectories, including detecting obstacles and maintaining the optimal trajectory of the vehicle. At the next stage, it is planned to integrate the obtained results into the system of group control over heterogeneous robotic means and conduct full-scale tests of the system [3].

***2.2. The "Iceberg" Project***

The Central Design Bureau of Marine Engineering "Rubin" took up the unique unimplemented projects of the 1980s to create underwater systems for exploration of minerals in the Arctic seas, namely the "Iceberg cipher", their extraction and delivery. This project consisted of a number of projects united by the common task of creating technologies and technical means to ensure fully underwater development of hydrocarbon deposits in the zone of permanent ice cover. In order to ensure the functioning of the technical means of underwater development of hydrocarbons, a nuclear power plant in the form of an autonomous underwater unmanned structure was developed jointly with the Afrikantov Experimental Design Bureau of Mechanical Engineering. The useful electrical capacity of the module is 16 MW (can be increased to 25 MW), autonomy is up to 1 year (without maintenance), and the total lifetime of up to 30 years. Reliability of operation of the submerged unmanned structure without the presence of operating maintenance personnel and without maintenance itself during the period of continuous operation is ensured by the use of reactor unit integral type with fully natural circulation of primary circuit coolant over the entire power range, the use of cassette-type core, a reduction in the auxiliary systems composition and the nuclear power plant equipment, as well as the use of highly automated control, protection, radiation and technological systems [11].

It will be accompanied by an underwater autonomous drilling complex, an underwater seismic survey vessel, an underwater transport and installation and maintenance complex. In terms of development level, the project and the technologies implemented in it are close to the space industry and, if successfully implemented, "Iceberg" will create a new and very important technological reserve for the Russian industry. At the moment, 3D modeling of future objects of the underwater complex has already been performed, which is very important. The Rosatom structures, the Ministry of Defense of Russia, Gazprom, the United Shipbuilding Corporation and the already mentioned Rubin Central Design Bureau for Marine Engineering participate in its creation. The work has been underway since 2015. Implementation of these research and development works (R&D) will give a powerful impetus to the development of technologies in oil and gas production, nuclear energy, seismic exploration and other related spheres.

According to the developers, the Iceberg project will solve two main tasks, the implementation of which is hampered by the ice cover in the Far North — seismic exploration and drilling. For seismic prospecting it is proposed to use underwater towed seismic pumps. The situation with underwater drilling is much more complicated. At the moment, there are no analogues of such drilling complexes. It was also proposed to use the technology of continuous drilling with constant flushing of wells. This, in its turn, will significantly reduce developers' risks associated with the labor intensity of the technological process. The project of the drilling complex is currently at the stage of preliminary design [22].

The following overall characteristics of the complex are given. The total displacement is 17670 cubic meters, length — 100.7 m, width — 35 m, height — 16.5 m. In the above — water position, the draft of the complex is 8.1 m. The transportation zone is 48.6 m long, which allows to transport cargoes weighing up to 300 tons. Immersion depth is up to 400 m, speed in transition mode is 7 knots. Its autonomy is 90 days. In the current plan, the Icebergproject will consist of five modules: the powe module, the drilling module, the module with the technical means of integrated safety system, the module with the technical means of seismic exploration, the underwater towed capsule with seismic cables (stranded cables for transmitting signals from seismic receivers to the seismic station) [22].

### *2.3. Robotic underwater and surface vehicle*

Another interesting project for the Arctic is a robotic underwater-surface vehicle with increased autonomy with variable hull geometry. The device was presented by engineers of St. Petersburg State Marine Technical University. The aim of the project is to conduct various studies, including those in the northern seas. These can be oceanographic, hydrographic, environmental and geological studies. In particular, the robotic device is designed to study the development, protection and extraction of biological resources; conduct search and rescue operations and perform tasks of the coastal guard; collect information about the ice and hydrometeorological conditions; as well as to provide information support for navigation on the Northern Sea Route. Given the demand for transport and logistics in the Arctic region in recent years, this area may be particularly relevant [22].

The multifunctionality of an underwater surface vehicle with variable hull geometry consists in performing all the functions and tasks that are currently being performed and solved separately by surface, semi-submersible and underwater unmanned civilian and military vehicles. In addition, the vehicle is capaable of operating effectively in the harsh conditions of the Arctic [67, 68].

### *2.4. The Tan'so 4500 autonomous underwater robot*

In October of this year, Chinese scientists announced the successful completion of research work in the Arctic: they created an autonomous deep-sea robot Tan'so 4500. It was developed by the Shenyang Institute of Automation unde the Chinese Academy of Sciences as part of a pilot strategic science and technology project called "Metabolism and Energy in the Tropical Area of the Western Pacific Ocean and Its Impact". The robot was technically modernized and modified, adapted to the new, cold environment, and conFig.d for navigation in the high-latitude zone. The research was carried out within the framework of the 12th Chinese scientific expedition in the high-latitude zone. Four researchers studied the Arctic shelf on the expedition icebreaker "Xuelong-2" [25]. Thanks to the successful immersion of the Tan'so 4500, the Arctic zone received the most important statistical data necessary for more detailed research, understanding of geological processes, studying the multicyclicity of energy and substance exchange in the Mid-Atlantic Ridge area. The project became the scientific basis for China's active participation in the protection of the Arctic environment.

Due to the high density of ice in the area of the Arctic scientific expedition, a group of researchers developed an innovative technology for extracting samples from under the ice. It consists of acoustic remote control and automatic guidance, allowing the underwater robot to overcome various obstacles caused by the fast moving ice and a limited area of open sea to return to the ship. Thanks to this robotic technology, diving of the underwater robot in the high-latitude zone of the Arctic seas covered by dense ice was successfully completed, as well as its safe return to the ship [25].

Staying near the bottom, the Tan'so 4500 collected data necessary to study the topographic and geomorphological features of the Mid-Atlantic Ridge, its magma and hydrothermal activity.

### *2.5. IceNet — a new prediction tool with artificial intelligence*

In the *Nature Communications* journal, an international team of researcher, led by the British Antarctic Survey and the Alan Turing Institute, describes a new AI tool called IceNet. IceNet has the potential to predict the sea ice situation and, according to the authors, works thousands of times faster than traditional methods. The tool can predict the presence of sea ice two months ahead with an accuracy of 95%. Unlike conventional prediction systems that try to directly model the laws of physics, IceNet is based on the concept of deep learning. Researchers uploaded decades of ice sea level observations, as well as thousands of years of climate modeling data into the artificial intelligence tool. This makes IceNet a dynamic forecasting tool that continues to learn and adapt [39].

The next goal of scientists is to develop a model that will estimate the amount of ice in real time, similar to a weather forecast. This could work as an early warning system of the risks associated with rapid loss of sea ice. As we know, this is currently an urgent problem, which, in its turn, affects climate change not only in the Arctic region, but also on the planet.

### 3. Conclusions

The following conclusions were made as a result of the study. According to the potential of the Arctic, and today it is the export income of the country, the greatest attention is paid to the extraction and processing of minerals, while the current Iceberg project is aimed specifically at the underwater system of mineral exploration in the Arctic zone of the Russian Federation. Given that this project is still under completion, it already claims to be a success, as well as the following projects: robots for marine environmental monitoring Oceanos, a robotic underwater and surface vehicle of increased autonomy with variable hull geometry demonstrate a significant advancs towards a successful future of the development of the Arctic. With the use of digital technologies in the fuel and energy complex and intelligent, robotic automation of production, this area of AI implementation is taking the lead over everything else. In other areas, painstaking work is being carried out, and a general concept of using AI and robotics in Russia's Arctic zone has been suggested and id being promoted.

It is worth noting the significant progress of our foreign partners, such asthe autonomous underwater robot Tan'so 4500 from China and the forecasting tool with artificial intelligence — IceNet from England. Obviously, the West is ahead of Russia in the development of intelligent technologies due to good funding from the state and a strong advantage in their quality [69, 76]. Despite the work which already began to introduce AI and robotics i in the Arctic, as well as the scale of all projects and ideas, in Russia the work process will be more difficult and it will take years to implement all the projects initiated. Moreover, despite the experts' opinion on the prospects of AI by 2030, the use and gradual introduction of AI and robotics in the Arctic zone of the Russian Federation will happen later, taking into account all the factors of the socio-economic sphere development of the whole Russia, the pace of decision-making, the implementation of each concept.

Since the Arctic is extremely rich in minerals, and a significant part of the country's fossil resources are already being extracted in the Russian Arctic, the struggle and conflicts of the Arctic countries are quite intense. However, on the environmental side, additional agreements and global conventions are being signed to protect the environment and the environmental situation in the Far North, such as the Reykjavik Declaration of 2021, which contains instructions and calls for enhanced conservation of biodiversity and increased viability for 2021—2035 in the Arctic; the importance of the ecosystem approach to managing the Arctic marine environment; the importance of the the Arctic Marine Environment Protection Strategic Plan for 2015—2025 [40].

First of all, when implementing projects to introduce robotics, it is necessary to take into account all the risks affecting climate change in this region [77, 78], which subsequently leads to melting of Arctic ice, pollution of northern seas with oil and chemical compounds, and these problems, in their turn, affect the whole world. Therefore, it is extremely important for Russia, as well as for all the Arctic countries, to unite their efforts according to certain standards in order to avoid natural disasters.

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