

Artificial Intelligence: A Field of Synthesis of Breakthrough Ideas and Patenting of Intellectual Property

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Abstract

The analysis showed that “artificial intelligence” has become an intensively developing branch of science and technology aimed at the synthesis of breakthrough ideas and patenting of intellectual property. However, the Russian creators of intellectual property in the field of artificial intelligence are not intensively increasing their production and supply to the domestic market and, unfortunately, have a very weak export potential. When creating intellectual property in the field of artificial intelligence, Russian manufacturers do not pay enough attention to their patenting. In the considered branch of science and technology, the development of enterprises and production is necessary for the production of promising new generation intellectual property objects competitive in the markets. Their competitiveness can be enhanced by developing and patenting scientifically sound and fundamentally new intellectual property objects. The paper presents the features and directions of patenting intellectual property in the field of artificial intelligence, gives the most characteristic patents, identifies the main areas of application of methods and technologies of artificial intelligence in various fields of science and technology, gives a classification of patents for inventions and utility models in the context of branches of science and technology, identified organizations, developers of patentable intellectual property. The elements of the knowledge base in the field of artificial intelligence considered in this work can be used for analysis and can be used as analogues and prototypes in the synthesis and patenting of new original intellectual property objects.

Keywords: Artificial Intelligence, Intellectual Property, Patent, Patent Information Search, Results of Intellectual Activity.

1. INTRODUCTION

World trends indicate that in recent years the world market has increased attention to the justification, development and introduction of promising types of intellectual property in the field of artificial intelligence to the markets of various countries. It can be stated that “artificial intelligence” has turned into an intensively developing branch of science and

technology aimed at the synthesis of breakthrough ideas and patenting of intellectual property. Naturally, increased competition in this industry. It is no coincidence that scientists and manufacturers in many countries of the world are actively working in this branch of science and technology. However, the analysis showed that the creation of intellectual property by Russian manufacturers does not pay enough attention to patenting the results of intellectual activity in this area.

Russia, which has significant scientific and production potential, must ensure the development of domestic enterprises and industries for the production of promising new generation intellectual property objects that are competitive in the domestic market and in the markets of foreign countries. The competitiveness of such intellectual property can be enhanced by patenting scientifically sound and fundamentally new intellectual property. This justifies the need for research in the field of studying the features and directions of patenting of new intellectual property in the considered field of science and technology.

The authors formed the goal of research - to study the features and directions of patenting of new intellectual property in the field of artificial intelligence. The need was identified for the collection, synthesis and analysis of information and the formation of a knowledge base on the basis of an advanced patent information search in the artificial intelligence industry for use in the synthesis of breakthrough ideas and patenting of intellectual property in this industry.

2. LITERATURE REVIEW

The work of many Russian and foreign scientists [1; 5; 12; 47; 52; 70; 76] proved the versatility and the vastness of the problem of researching various theoretical and practical aspects of artificial intelligence.

Based on information retrieval and analysis of scientific literature, we consider the main areas of application of artificial intelligence methods and technologies in various fields of science and technology. They are used:

- to solve the problems of operational management and optimizing the functioning of enterprises, production

and technological complexes [11; 40; 54; 81], including robotics of industrial production [56; 64];

- to improve processes in mechanical engineering [71; 73; 79], including: diesel engineering [35]; optimization of high-speed cutting (milling) processes [32]; optimization of magnetic pulse processing [18];
- to improve processes in aircraft building, aircraft instrument making and aircraft operation [29; 44; 74];
- to improve the processes of railway transport and the construction of railways [69];
- to improve the processes of urban transport [88];
- to improve processes in the construction industry [16; 49; 58; 65];
- to improve processes in the agricultural sector [53];
- for processing liquid radioactive waste [37];
- for medicine, biomedicine, sanitation and narcology [2; 7; 34; 36; 39; 63; 68; 82; 91];
- for systems for collecting, processing, and transmitting information [83];
- for the refrigeration industry [3; 4];
- for cotton spinning and clothing industry [46; 72];
- for electronic libraries [75];
- to filter spam [13];
- for electric power systems [9; 28; 45; 66]; including managing them during major accidents [17];
- application of artificial intelligence to determine the particle size distribution of the material for the production of ceramic products [59];
- application of artificial intelligence methods in logistics [61];
- for distance learning and conducting distance competitions [10; 41];
- for the design and development of intellectual toys and game complexes [20; 50];
- for the synthesis of safe trajectories of divergence of vessels [21];
- for environmental forecasting [60];
- controlling the installation of wood pyrolysis with elements of artificial intelligence [8];
- the formation of intelligent forecasting systems [30];
- use of elements of artificial intelligence in navigation systems of surface ships [77];
- the use of artificial intelligence in the food industry in the production of multicomponent food products [84];
- the use of artificial intelligence methods in operational planning [19];
- for object recognition [23].

The above identified the need for the formulation and conduct of scientific and applied research in the field of studying the features and directions of patenting of new intellectual property objects and the formation of a knowledge base based on an extended patent-information search in the field of artificial

intelligence for use in the synthesis of breakthrough ideas and patenting of intellectual property in this area. It was necessary to highlight the elements of the database that can be used as analogues and prototypes in the synthesis and patenting of new original intellectual property objects.

According to the goal in this work, the following tasks are defined: a) evaluate the features and directions of patenting of intellectual property in the field of artificial intelligence; b) classify patents for inventions and utility models; c) identify organizations - owners of patented intellectual property in the field in the field of artificial intelligence.

3. MATERIALS AND METHODS

The aim of this work is to conduct research in the field of studying the features and directions of patenting of new intellectual property in the field of artificial intelligence. At this stage of the research, the research of the authors was limited to intellectual property patented in Russia.

The methodology for collecting, summarizing and analyzing information provided for the formation of a knowledge base based on an advanced patent information search and the use of the database of the Federal Institute of Industrial Property in the field of patenting Russian inventions and useful models of artificial intelligence as the main starting materials.

The studies were performed in two stages:

- the first is the collection and analysis of scientific publications on the subject under discussion, which showed that in the presence of serious and sufficiently large-scale research of Russian scientists in the field of artificial intelligence, serious patent research of intellectual property in the field of artificial intelligence is required;
- the second - a comprehensive patent search in the field of creating patentable intellectual property objects in Russia by universities, scientific, design organizations, private business entities and individuals and analysis of the features and directions of patenting inventions and utility models. At the second stage of the work, the experience gained by the authors in carrying out the research was used [92; 93].

When performing the first and second stages of the work, the authors limited the scope of research only to Russian search engines, in which special attention was paid to the databases of the Russian Science Citation Index (RSCI) and the Federal Institute of Industrial Property (FIIS). When performing these studies, consideration was excluded from the consideration of intellectual property in the field of the use of artificial intelligence in the development of robots, due to the fact that this is a separate area of research by the authors. A large amount of information was considered, since serious attention was paid to theoretical and practical aspects in the field of intellectual property in Russia, which was confirmed by the fact that in the RSCI knowledge base on the term "artificial intelligence" as of May 25, 2020, more than 122.4 thousand publications (articles, study guides, monographs, dissertations, conference proceedings, etc.). As of May 25, 2020, 101 Russian patents (77 inventions and 24 utility models) were considered in the FIIS knowledge base on the term "artificial intelligence". In

addition, the patent search was performed in other terms. For example, only the term “information technology in medicine” considered 18 patents of Russia (13 inventions and 5 utility models).

According to the goal in this work, the tasks were identified:

- evaluate the features and directions of patenting of intellectual property in the field of artificial intelligence;
- identified the main areas of application of methods and technologies of artificial intelligence in various fields of science and technology;
- classify patents for inventions and utility models by sectors of science and technology;
- identify organizations - owners of patented intellectual property in the field of artificial intelligence.

The results of the formulated goal, tasks and results of the first and second stages were used in the formation of the knowledge base on research areas of Russian scientists, as well as on patented intellectual property objects - Russian inventions and industrial models in the field of artificial intelligence. The obtained information can be used as analogues and prototypes in the synthesis of patentable intellectual property.

4. RESULTS AND DISCUSSION

The analysis examined the features of Russian inventions and utility models in the field of artificial intelligence.

To monitor traffic flows at hazardous production facilities, Gazprom Pererabotka Limited Liability Company patented an invention [38] for an analytical information management system. The system includes functionality for transmitting satellite monitoring information from navigation and communication systems, which is a subscriber terminal installed on vehicles using GLONASS/GPS technologies, and information from analog and digital sensors. Sensors are connected to subscriber terminals using motor vehicles. The information is transmitted via GPRS protocol through the Internet channel to the telematics server database and then transferred to the database "Vehicle Monitoring Systems" to transfer requests to the database of the "Vehicle Management" information system for the purpose of its analysis and decision-making on effective enterprise management. In real time, the data of GLONASS/GPS information flows and the data of primary production accounting are compared and automatically, based on the formulated algorithms, decisions are made on the compliance of GLONASS/GPS data with the data of primary production accounting.

When creating corporate geographically distributed production management systems, a technical solution may find application [27], the novelty of which is that the distribution of computing power, memory and resources occurs throughout the system's network - through Information nodes that process a lot of information for subsequent delivery of the necessary data to the user only for events that occurred in the information nodes.

A method for analyzing and monitoring the state of a technical

installation containing many dynamic systems is patented [86]. According to the method, using the dynamic model of the system, the output data and the need to improve the high-precision dynamic model of the system are determined, as well as the search for new dependencies using artificial intelligence methods and the integration of the identified dependencies into the corresponding expandable dynamic model of the system under consideration.

In the method [42], a predictive neural network with retraining is used - with a storage neural network capable of determining whether the incoming data belongs to the range of values of the training sample. Based on the forecast, if necessary, control actions are performed on the objects of the computer network, minimizing their downtime and increasing the efficiency of the computer network. The company "Fiberhom Telecommunication Technology Technologies Co., Ltd." (CN) patented the network architecture of the human-like network [85]. Variants of an artificial neuron are patented [6], which can be used as a structural and functional element of artificial neural networks for modeling biological neural networks, as well as for building parallel neurocomputers and other computing systems designed to solve various applied tasks, including the tasks of pattern recognition, data classification, image processing, mathematical operations and the creation of artificial intelligence.

The Russian Corporation of Rocket and Space Instrumentation and Information Systems has patented a ground-based automated spacecraft control complex [87]. ROTEC Joint-Stock Company has patented a method for remote monitoring and prediction of the state of individual units and complex technological complexes, consisting of individual units and / or subsystems of units, using semantically-oriented artificial intelligence [48]. The method is implemented on the basis of data on the functioning of aggregates and / or subsystems of aggregates. These data are presented in the form of indicators in various material forms that allow both digital and descriptive textual representation and characterize the technological parameters of the system and / or its subsystems. At the same time, semantically-oriented artificial intelligence has the ability of a set-theoretic comparison of digital and textual data. The method allows to analyze heterogeneous data from various measurement sources, facilitates and visualizes the work of an expert.

Nizhny Novgorod State Technical University R.E. Alekseeva patented a method for processing acoustic emission signals — AE [33]. Information from the generated database is used to train an artificial neural network for the clustering problem, where pulses are classified. Classes of pulses characterize the physical and mechanical processes occurring during the destruction, on the basis of which there is a prediction of structural stability. This signal processing method has a high degree of recognition of the information received, determining the parameters of the AE signal, creating a database of structural stability of materials.

The joint-stock company Novomet-Perm has patented a method for determining the flow rate of wells equipped with pumping units [67]. The technical result of the invention is to increase the accuracy of determining the flow rate of wells

equipped with pumping units using a technique involving a minimum set of input data known in the vast majority of wells.

Astrakhan State University has patented options for unmanned sailing vessels (catamarans), including a sailing catamaran [78].

The Research and Design Institute of Informatization, Automation and Communications in the Rail Transport has patented a system for the operational management of the train operation of a railway section on the basis of determining its throughput [31].

MEPhI National Research Nuclear University has patented a method for constructing an intelligent streaming computing and information-measuring system with a fuzzy computing environment based on an information model of an artificial neural network and neuron and a streaming model for obtaining calculation and measurement results [57].

Samsung Electronics Co., Ltd. (KR) obtained a patent of the Russian Federation related to recurrent neural networks [51] and a patent of the Russian Federation relating to distributed learning tools for machine learning models [43]. Samsung Electronics Co., Ltd. (KR) also received a patent of the Russian Federation to provide the possibility of obtaining two-dimensional images of the entire human body in different poses and from different points of view using artificial intelligence [89].

A device has been patented for the physical implementation of the N-layer perceptron [90]. Occupying a small space through the use of all three dimensions, the device is more compact than existing analog neural chips and allows you to get higher performance in the process of use than what the digital implementation of such networks offers.

Abi Production Limited Liability Company has patented a number of methods for recognizing characters using artificial intelligence, for example, [62].

The Intellectual limited liability company has also patented a medical decision support system using mathematical models for representing patients [22].

A method for remote recognition and correction using virtual reality of a person's psychoemotional state is patented [24]. The method of macroencephalometry of the cerebral hemispheres, taking into account their accommodation in the closed space surrounding a person, was patented by Moskvitina U.S. [55]. The method is patented [80] is intended for remote information support of the operating surgeon.

The Tushino engineering design bureau Soyuz patented a cruise missile for hitting targets [25]. The Central Research Institute of the Ministry of Defense of the Russian Federation has patented a set of automation tools for the combat weapon control system [26]. The expert system of the complex provides a solution to poorly formulated problems - to develop a control action based on information about heuristic methods of work of experts and the procedure for their use. Pacific Higher Naval School named after S.O. Makarova patented scalable systems for the detection and classification of marine targets with elements of artificial intelligence, including [14; 15].

It should be noted the widespread use of artificial intelligence technologies in robotics, which are considered by the authors in another work.

The above analysis allowed us to classify patents for inventions and utility models according to the following groups of branches of science and technology:

- *management of production processes of industrial and transport enterprises;*
- *providing a network architecture of a humanoid network combining artificial intelligence technology and network technology to improve network reliability, strengthen protection against network attacks, offer improved functionality and efficiency;*
- *development of the Bayesian rarefaction method for recurrent gate architectures;*
- *development of spacecraft control systems*
- *creation of intelligent virtual streaming computing and information-measuring systems;*
- *the formation of the layout of complex neural networks with the advantages in the speed of the analog system;*
- *development of unmanned vehicles*
- *determination of the flow rate of wells equipped with pumping units;*
- *development of methods of distributed machine learning;*
- *development of technologies and tools for remote monitoring and prediction of the status of individual units and complex technological complexes;*
- *development of technologies and means for recognizing characters and texts;*
- *development of medical decision-making technologies using mathematical models for representing patients;*
- *the development of technologies and tools for solving the problems of increasing defense capability and creating equipment based on the use of artificial intelligence, including the detection and classification of marine targets.*

The analysis identified the main Russian developers of intellectual property in the field of creating technologies and artificial intelligence. Among them, universities, scientific, design and scientific-production organizations prevail:

- *Astrakhan State University;*
- *Military Academy of Logistics, named after Army General A.V. Khruleva;*
- *Military Academy of Communications named after Marshal of the Soviet Union S.M. Budyonny;*
- *Research and development institute of informatization, automation and communication in railway transport;*
- *Scientific and Production Complex "ELARA" named after G.A. Ilyenko;*

- *National Research Nuclear University MEPhI;*
- *Nizhny Novgorod State Technical University named after R.E. Alekseeva;*
- *Russian Corporation of Rocket and Space Instrumentation and Information Systems;*
- *Pacific Higher Naval School named after S.O. Makarova;*
- *Tushino engineering design bureau Soyuz;*
- *Central Research Institute of the Ministry of Defense of the Russian Federation;*
- *South-Russian State Polytechnic University named after M.I. Platova.*

The objects of intellectual property in the considered area are also created by: joint-stock companies: Novomet-Perm; "ROTEK"; limited liability companies: "Abi Production"; Intellectual companies: Kilur Intelligent Systems, Inc.; Samsung Electronics Co., Ltd. "Fiberhom Telecommunication Technology Technologies Co., Ltd."

Obviously, Russia, which has significant scientific and production potential, must ensure the development of domestic enterprises and industries for the production of promising new generation intellectual property objects that are competitive in the domestic market and in the markets of foreign countries. Their competitiveness can be enhanced by developing and patenting scientifically sound and fundamentally new intellectual property objects.

The paper provides a classification of patents for inventions and utility models in the context of the branches of science and technology, in the context of obtaining effects from their use and in the context of the creators of intellectual property in the field of artificial intelligence.

It must be noted that, as studies have shown, in Russia, patenting in the field of artificial intelligence is carried out mainly by universities and research organizations, as well as individual business entities. The entry into the domestic market of intellectual property of foreign companies was noted.

5. CONCLUSIONS

World trends indicate that in the world market in recent years, increased attention has been paid to the solution of the justification, development and launch of promising types of intellectual property in the field of artificial intelligence on the markets of various countries. It can be stated that "artificial intelligence" has turned into an intensively developing branch of science and technology aimed at the synthesis of breakthrough ideas and patenting of intellectual property. It is no accident that scientists and manufacturers in many countries of the world are actively working in this branch of science and technology.

The analysis showed that in Russia serious attention was paid to theoretical and practical aspects in the field of intellectual property, which was confirmed by the fact that in the knowledge base of the Russian Science Citation Index (RSCI)

on the term "artificial intelligence" as of May 25, 2020, more than 122 4 thousand publications (articles, study guides, monographs, dissertations, conference materials, etc.). At the same time, as of May 25, 2020, the knowledge base of the Federal Institute of Industrial Property on the term "artificial intelligence" contained only 101 patents (77 inventions and 24 utility models). This fact convincingly indicates that when creating intellectual property in the field of artificial intelligence, Russian researchers, developers and manufacturers do not pay enough attention to their patenting. The last argument is confirmed by the fact that, as analysis has shown, the main patenting in Russia in this area is carried out by universities, which are often not sufficiently integrated into joint activities with manufacturers. Therefore, many university developments are proactive, are at the stage of exploratory research and have not passed the stage of filing patent applications.

The above identified the need for the formulation and conducts of scientific and applied research in the field of studying the features and directions of patenting of new intellectual property and the formation of a knowledge base based on an expanded patent information search in the field of patenting of Russian inventions and utility models in the analyzed field.

Based on the information search and analysis of scientific literature, the main directions of the application of artificial intelligence methods and technologies in various branches of science and technology are determined. They are used:

- *to solve the problems of operational management and optimize the functioning of enterprises, production and technological complexes; including an assessment of the competitiveness of enterprises;*
- *to improve processes in mechanical engineering, including: diesel engineering; optimization of high-speed cutting (milling) processes; optimization of magnetic pulse processing;*
- *to improve processes in the aircraft industry, aircraft instrumentation and aircraft operation;*
- *to improve the processes of railway transport and the construction of railways;*
- *to improve the processes of urban transport;*
- *to improve the processes in the construction complex;*
- *to improve the processes in the agricultural sector;*
- *for processing liquid radioactive waste;*
- *for medicine, biomedicine, sanitation and narcology;*
- *for systems for the collection, processing and transmission of information;*
- *for the refrigeration industry;*
- *for cotton spinning and clothing industry;*
- *for electronic libraries;*
- *to filter spam;*
- *for electric power systems, including their management in case of major accidents;*
- *application of artificial intelligence to determine the particle size distribution of the material for the*

production of ceramic products;

- *application of artificial intelligence methods in logistics;*
- *for distance learning and conducting distance contests;*
- *for the design and development of intellectual toys and game complexes;*
- *for the synthesis of safe trajectories of divergence of vessels;*
- *for environmental forecasting;*
- *controlling the installation of wood pyrolysis with elements of artificial intelligence;*
- *the formation of intelligent forecasting systems;*
- *the use of elements of artificial intelligence in the navigation systems of surface ships;*
- *the use of artificial intelligence in the food industry in the production of multicomponent food products;*
- *use of artificial intelligence methods in operational planning;*
- *for object recognition.*

According to the goal in this work, the following tasks are defined: a) evaluate the features and directions of patenting of intellectual property in the field of artificial intelligence; b) classify patents for inventions and utility models; c) identify organizations that hold patented intellectual property in the field of artificial intelligence.

The above analysis allowed us to classify patents for inventions and utility models according to the following groups of branches of science and technology:

- *providing a network architecture of a humanoid network combining artificial intelligence technology and network technology to improve network reliability, strengthen protection against network attacks, offer improved functionality and efficiency;*
- *development of the Bayesian rarefaction method for recurrent gate architectures;*
- *development of spacecraft control systems*
- *creation of intelligent virtual streaming computing and information-measuring systems;*
- *the formation of the layout of complex neural networks with the advantages in the speed of the analog system;*
- *development of unmanned vehicles*
- *determination of the flow rate of wells equipped with pumping units;*
- *development of methods of distributed machine learning;*
- *development of technologies and tools for remote monitoring and prediction of the status of individual units and complex technological complexes;*
- *development of technologies and means for recognizing characters and texts;*

- *development of technologies and equipment for medicine and biomedicine, including the adoption of medical decisions using mathematical models for representing patients;*
- *the development of technologies and tools for solving the problems of increasing defense capability and creating equipment based on the use of artificial intelligence, including the detection and classification of marine targets.*

Among the organizations - creators of intellectual property in the considered area: universities, scientific, design and scientific-industrial organizations: Astrakhan State University; Military Academy of Logistics named after Army General A.V. Khruleva; Military Communications Academy named after Marshal of the Soviet Union S.M. Budyonny; Research and Design Institute of Informatization, Automation and Communications in the railway sector; Scientific and Production Complex "ELARA" named after G.A. Ilyenko; National Research Nuclear University MEPhI; Nizhny Novgorod State Technical University R.E. Alekseeva; Russian Corporation of Rocket and Space Instrumentation and Information Systems; Pacific Higher Naval School named after S.O. Makarova; Tushino Engineering Design Bureau "Union"; Central Research Institute of the Ministry of Defense of the Russian Federation; South Russian State Polytechnic University named after M.I. Platova. The objects of intellectual property in the considered area are also created by: joint-stock companies: Novomet-Perm; "ROTEK"; limited liability companies: "Abi Production"; Intellectual companies: Kilur Intelligent Systems, Inc.; Samsung Electronics Co., Ltd. "Fiberhom Telecommunication Technology Technologies Co., Ltd."

The analysis showed the need for the development of enterprises and industries for the production of promising new generation intellectual property objects in the markets that are competitive. Their competitiveness can be enhanced by developing and patenting scientifically sound and fundamentally new intellectual property objects. The elements of the knowledge base considered in this work can be used to be used as analogues and prototypes in the synthesis and patenting of new original intellectual property objects in the field of artificial intelligence.

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