

Some Trends in Updating the Nomenclature of Specialties of Researchers in the Areas of Research Methods and Means of Intellectualization

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Abstract: for discussion, some features of understanding modern concepts in the extremely interesting developing field of breakthrough technologies are proposed, with the definition of characteristic (primary, verifiable, reliable, etc.) features and (also and/or later) elements of the so-called concept of “Artificial Intelligence”. From the standpoint of eliminating administrative restrictions, the main focus is on popularization and some trends in updating the nomenclature of specialists of researchers in the areas of research methods and means of intellectualization (Artificial Intelligence (AI), Machine Learning (ML), Intelligent Transport Systems (ITS), Robotic Systems (RS), and others).

Keywords: artificial intelligence, machine learning, intelligent transport systems, robotic systems, technological gap, administrative decisions, popularization, new technologies

I. INTRODUCTION

Few States currently have extensive knowledge and significant potential in the field of Artificial Intelligence (AI). At the same time, the development of new technologies based on AI ideas is proceeding at a very high pace, and therefore there are reasonable fears that in the foreseeable future the emerging technological gap will not only not decrease, but, on the contrary, rapidly increase. In addition, although the desired potential is concentrated only in limited subjects, the consequences of the introduction of AI are not limited and will not be limited only to those countries that have similar potential. So, in connection with the dynamic development of the situation that has arisen, a significant number of problematic issues appear, although many of them are obviously outside the IP policy, and are related, for example, to such areas as labor policy, ethics, human rights, etc. [1]. The given highlighted list of issues largely corresponds to the competencies of WIPO – in the context of intellectual property, innovation and the results of creative activity. However, the interesting question is “are there any other important areas of activity or additional ones in the field

of artificial and/or hybrid intelligence?”. We present several issues currently being discussed from the previously proposed positions of forming responsibility for administrative decisions in the theory and practice of AI [2].

It should be noted that since July 1, 2020, an experiment has been conducted in Moscow to establish special regulations to create the necessary conditions for the development and implementation of artificial intelligence technologies in the subject of the Russian Federation – the federal city of Moscow, as well as the subsequent possible use of the results of the use of artificial intelligence [3].

So, the structure of this discussion report contains the following key information points of AI popularization [4]:

- Artificial Intelligence (AI) and Machine Learning (ML);
- Intelligent Transport Systems (ITS);
- Robots, Mechatronics and Robotic Systems (RS);
- and some aspects of the problems of the Technological Gap in the field of Advanced Systems (new technologies) with reliable signs of Artificial Intelligence.

It should be especially noted that, along with our conference, the workshop “Maturity of artificial intelligence: system integration and management problems” successfully functions permanently as a development of the all-Moscow seminar “Control Science of Autonomous Systems”.

II. ACCENTUATION OF RESEARCH DIRECTIONS ARTIFICIAL INTELLIGENCE AND MACHINE LEARNING

In the context of the preferences of natural science research, we will begin to review the directions of AI and ML.

Field of science: natural sciences. Group of scientific specialties: 1.2. Computer science and informatics (the name of the branch of science in which academic degrees are awarded: Physical and mathematical sciences). At the current stage, according to the author, the formulations used in the draft nomenclature are very far from the academic level. However, it is precisely such a presentation that will presumably allow us to highlight the most important moments of the development of the subject area.

The section specifies key concepts and definitions, as well as lists the directions of AI and ML research according to the draft nomenclature of scientific specialties.

A. Basic concepts and definitions

For the purposes including this experiment, the relevant Federal Law (RF) uses the following basic concepts:

Artificial Intelligence (AI) is a complex of technological solutions that allows simulating human cognitive functions (including self-learning and finding solutions without a predetermined algorithm) and obtaining results comparable, at least, with the results of human intellectual activity when performing specific tasks.

The framework of such technological solutions includes information and communication infrastructure (including information systems, information and telecommunications networks, other technical means of information processing), software (including those that use ML methods), processes and services for data processing and solution search.

Artificial Intelligence Technologies are technologies based on the use of AI (including computer vision, natural language processing, speech recognition and synthesis, intelligent decision support and promising AI methods).

B. Research directions of the scientific specialty 1.2.1 Artificial Intelligence and Machine Learning

1. Natural science foundations and methods of artificial intelligence.

2. Research in the field of evaluating the quality and effectiveness of algorithmic and software solutions for artificial intelligence and machine learning systems. Methods of comparison and selection of algorithmic and software solutions under many criteria.

3. Methods and algorithms for modeling cognitive processes: reasoning, argumentation, recognition and classification, formation of concepts. Research in the field of neuromorphic methods of data analysis, simulation modeling of the structure and functions of

the brain, including using machine learning methods. Neuroinformatics and methods of modeling biological nervous systems.

4. Development of methods, algorithms and creation of artificial intelligence and machine learning systems for processing and analyzing texts in natural language, for images, speech, biomedicine and other special types of data.

5. Methods and technologies for the search, acquisition and use of knowledge and laws, including empirical ones, in artificial intelligence systems. Research in the field of joint application of machine learning methods and classical mathematical modeling. Methods and means of using expert knowledge.

6. Formalization and formulation of management tasks and (support) decision-making based on artificial intelligence and machine learning systems. Development of control systems using artificial intelligence systems and machine learning methods, including control of robots, cars, UAVs, etc.

7. Development of specialized mathematical, algorithmic and software for artificial intelligence and machine learning systems. Methods and means of interaction of artificial intelligence systems with other systems and a human operator.

8. Multi-agent systems and distributed AI.

9. Methods and means of using parallel, quantum computing, etc. for solving artificial intelligence and machine learning problems.

10. Research in the field of ethical problems related to the creation and implementation of AI systems, including modeling of expected social and economic consequences.

11. Research in the field of "strong AI", including the formation of a conceptual base and elements of mathematical formalism necessary for the construction of an algorithmic apparatus.

12. Research in the field of "trusted" AI class systems, including the problems of forming test samples of use cases, reliability, stability, retraining, etc.

13. Methods and means of generating arrays of data and use cases, including "big data", necessary for solving problems of artificial intelligence and machine learning. Problem-oriented data collections for important application areas.

14. Methods and means of forming arrays of conditionally real data and precedents necessary for solving problems of artificial intelligence and machine learning.

15. Mathematical research in the field of statistics, logic, algebra, topology, function analysis and other fields, focused on solving problems of artificial intelligence and machine learning.

16. Research in the field of special optimization methods, problems of complexity and elimination of iteration, dimension reduction.

17. Research in the field of multilayer algorithmic structures, including multilayer neural networks.

Related specialties (within the group of scientific specialties):

1.2.2 Mathematical modeling, numerical methods and software packages;

1.2.3 Theoretical computer science, cybernetics.

III. SUBSTANTIATION OF RESEARCH DIRECTIONS FOR INTELLIGENT TRANSPORT SYSTEMS AND ROBOTICS SYSTEMS

The section highlights the most interesting points of substantiation of the directions of research of Intelligent Transport Systems (ITS) and Robotics Systems (RS).

Field of science: Technical sciences. Groups of scientific specialties: 2.5. Mechanical engineering; 2.9. Transport systems (the name of the branch of science in which academic degrees are awarded: technical).

A. Research directions of the scientific specialty 2.9.8 Intelligent Transport Systems

1. Architectures of intelligent transport systems and their subsystems.

2. Integration platforms and buses of intelligent transport systems.

3. The life cycle of intelligent transport systems and intelligent road infrastructure.

4. Cooperative intelligent transport systems and their subsystems.

5. Subsystems, on-board and infrastructure telematics of intelligent transport systems.

6. Information and communication technologies and elements of artificial intelligence in intelligent transport systems.

7. Communication systems and means in intelligent transport subsystems.

8. Intelligent systems of technical diagnostics of elements and devices, control, monitoring, management of technological and production processes in transport.

9. Big data management in the transport complex.

10. Connected, highly automated and unmanned vehicles.

11. Elements of intelligent transport infrastructure, technical means of intelligent transport systems.

12. Traffic management and automated vehicle traffic control systems in intelligent transport systems, creation of highly automated and unmanned traffic systems.

13. Promising transport systems based on intelligent passenger and cargo mobility services, built on the tools of intelligent transport systems.

14. Transport planning and simulation of transport systems.

15. Digital models of linear objects of transport infrastructure and transport systems.

16. Digital doubles of roads and transport routes, transport infrastructure, vehicles, transport processes.

17. Systems for ensuring information, functional safety, as well as road safety in intelligent transport systems.

18. Human-machine interface of a highly automated and unmanned vehicle.

19. Transport psychology and psychophysiology.

20. Management of mobility in agglomerations and transport behavior.

21. Regulatory regulation of the development and implementation of intelligent transport systems.

Related specialties (within the group of scientific specialties):

2.9.1 Transport and transport-technological systems of the country, its regions and cities, organization of production in transport;

2.9.3 Railway rolling stock, train traction and electrification;

2.9.4 Management of transportation processes;

2.9.5 Operation of road transport;

2.9.6 Air navigation and operation of aviation equipment;

2.9.7 Operation of water transport, waterways and hydrography;

2.9.9 Logistics transport systems;

2.9.10 Technosphere safety in transport systems.

B. Research directions of the scientific specialty 2.5.4 Robots, Mechatronics and Robotic Systems

1. Development of theoretical foundations and methods of analysis, structural and parametric synthesis and computer-aided design of robots and robotic systems.

2. Theory and methods of creating robots and mechatronic devices based on new physical effects and phenomena, principles and methods of their construction for various conditions and environments of application.

3. Development of principles and methods of construction of mechatronic devices and systems as a result of the synergetic combination of precision mechanics units, electrical, electro-pneumatic, electrohydraulic, electronic and computer components to design and application of qualitatively new machines, systems and modules with highly efficient digital control of their functional motions.

4. Mathematical and semi-natural modeling of mechatronic and robotic systems, analysis of their characteristics based on the results of modeling.

5. Methods, algorithms, software and hardware for controlling robots, robotic and mechatronic systems, including adaptive, optimal, distributed, intelligent and supervisory control.

6. Mathematical and software, computer methods and means of information processing in real time in robots, robotic and mechatronic systems.

7. Methods of experimental research, creation of prototypes and experimental stands for the development of robots, robotic and mechatronic systems.

8. Planning and implementation of movements and actions, individual and group control of mobile robots of land, air, underwater and space-based.

9. Methods of calculation and design of mechatronic servos, executive, sensor and control components of robots, robotic and mechatronic systems.

10. Interfaces and methods of human interaction with robots. Methods of effective and safe joint work of humans and robots.

11. Research, improvement of the efficiency and safety of operation of automated technological processes created based on robotic and mechatronic systems, including in collaborative robotics. Methods and tools for computer-aided design, analysis and optimization of robotic complexes, cells and lines.

Related specialties (within the group of scientific specialties):

2.5.2 Machine Science;

2.5.11 Ground transport and technological facilities and complexes;

2.5.21 Machines, aggregates and technological processes.

IV. PRELIMINARY CONCLUSIONS

A. Related Research Areas

Considering the characteristic features of interdisciplinary research for the fields of science (1. Natural Sciences; 2. Technical Sciences), we will distinguish for groups of scientific specialties (1.2. Informatics and Computer Science; 2.5. Mechanical Engineering) related research areas in their respective specialties. For AI and RS – shown in Table I.

TABLE I. RELATED RESEARCH AREAS FOR AI AND RS

No. ^a	Scientific Specialty	
	<i>scientific specialty, name</i>	<i>the code of the nomenclature</i>
I	Mathematical modeling, numerical methods and software packages	1.2.2
	Theoretical Informatics, Cybernetics	1.2.3
II	Machine Science	2.5.2
	Ground transport and technological facilities and complexes	2.5.11
	Machines, aggregates and technological processes	2.5.21

^a. For the recommendation of scientific specialties in the dissertation councils being created

For interrelated scientific specialties (1.2.1 Artificial Intelligence and Machine Learning; 2.5.4 Robots, Mechatronics and Robotic Systems), respectively, – groups I and II. The summary Table II shows additional groups of scientific specialties in the context of ITS and IT.

TABLE II. RELATED RESEARCH AREAS FOR IT AND ITS

No. ^a	Scientific Specialty	
	<i>scientific specialty, name</i>	<i>the code of the nomenclature</i>
III	Vacuum and plasma electronics	2.2.1
	Technology and equipment for the production of materials and electronic devices	2.2.3
	Photonics	2.2.7
	Design and technology of instrumentation and radio-electronic equipment	2.2.9
IV	Automation and control of technological processes and production facilities	2.3.2

No. ^a	Scientific Specialty	
	<i>scientific specialty, name</i>	<i>the code of the nomenclature</i>
	Management in organizational systems	2.3.4
	Informatics and information processes	2.3.8
V	System analysis, control and processing of information	2.3.1
	Management in organizational systems	2.3.4
	Mathematical and software support of computers, complexes and computer networks	2.3.5
	Methods and systems of information protection, information security	2.3.6
VI	Automation and control of technological processes and production facilities	2.3.3
	Mathematical and software support of computers, complexes and computer networks	2.3.5
	Computer modeling and design automation	2.3.7
VII	Transport and transport-technological systems of the country, its regions and cities, organization of production in transport	2.9.1
	Railway rolling stock, train traction and electrification	2.9.3
	Management of transportation processes	2.9.4
	Operation of road transport	2.9.5
	Air navigation and operation of aviation equipment	2.9.6
	Operation of water transport, waterways and hydrography	2.9.7
	Logistics transport systems	2.9.9
	Technosphere safety in transport systems	2.9.10

Thus, we will summarize the preliminary result of comparing related research areas (the field of science:

2. Technical Sciences), for groups of scientific specialties:

2.2. Electronics, photonics, instrumentation and communications (scientific specialty:

2.2.2 Electronic component base of micro-and nanoelectronics, quantum devices);

2.3. Information technologies and telecommunications (scientific specialties:

2.3.1 System analysis, control and information processing;

2.3.2 Computer systems and their elements;

2.3.8 Informatics and information processes) and

2.9. Transport Systems (scientific specialty:

2.9.8 Intelligent Transport Systems). In the table, they are sequentially placed under the numbers from III to VIII. By the time of the conference, the content of the nomenclature can be significantly changed when clarifying the directions of research [4]. Factual data and illustrations will be argued in the presentation of this report. But at the conference, it is proposed to discuss the prospects for cooperation in the creation of joint dissertation councils in the presented areas. Other discussion points, due to the limited volume of the report, it is possible to submit for prolonged discussion within the log of the Workshop “Maturity of artificial intelligence: system integration and management problems,” in ResearchGate [<https://www.researchgate.net/~project/Workshop-Maturity-of-artificial-intelligence-system-integration-and-management-problems>].

B. Prefinals Clauses

Some features of understanding modern concepts in an extremely interesting emerging field are proposed for discussion: protection of intellectual property – objects related to the problem of breakthrough technologies to a greater or lesser extent with the definition of characteristic (primary, verifiable, reliable, etc.) features and elements of so-called AI systems [2]. The short-term perspective includes specialized accentuation [5–7]: Addresses the issue of Cognitive Semantics’ aspects that cannot be represented by traditional digital and logical means; Discusses necessary conditions for purposeful and sustainable convergence of Decision-Making.

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