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ROBOTS IN MODERN WAR. PROSPECTS FOR THE DEVELOPMENT OF SMART AUTONOMOUS ROBOTS WITH ARTIFICIAL BRAIN

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Анотація. *У статті розглянуто роль штучного інтелекту та робототехніки у сучасній військовій сфері. Описується, як із початку XXI століття роботи стали невід'ємною частиною військових операцій, надаючи різноманітні можливості для армій різних країн. Розглядаються перспективи розробки автономних роботів із штучними мізками, які можуть діяти без безперервного людського управління. Проєкти моделювання мозку людини розглядаються в контексті створення електронних мізків та розумних систем, здатних імітувати і навіть перевершувати роботу біологічного мозку. Стисло розглядаються світові проєкти моделювання мозку людини та наводяться їх порівняльні характеристики. Описано український проєкт «Думаючий комп'ютер (Штучний мозок)». Проєкт являє собою новий напрям у комп'ютеризації на базі нової нетрадиційної технології одночасної обробки різних видів інформації в єдиній однорідній багатовимірній активній асоціативній нейроподібній структурі, що дозволяє створювати новий тип людиноподібних машин, що думають. У статті описуються технологічна основа проєкту, його цілі та завдання, а також ефект від впровадження запропонованої технології. У роботі докладно розповідається про принципи роботи та особливості нової технології багатозв'язкової, багатовимірної, рецепторно-ефекторної, активно асоціативної нейроподібної мережі, яка не має аналогів у сучасних нейронних мережах. Також пояснюється, які переваги мають комп'ютери, що думають, у порівнянні із традиційними обчислювальними машинами і які перспективи відкриває нова технологія для різних галузей людської діяльності. У статті демонструються результати досліджень та розробок щодо створення прототипу електронного мозку для людиноподібного робота, а також плани щодо організації промислового виробництва комп'ютерів, що думають. Також обґрунтовуються актуальність та необхідність реалізації проєкту «Думаючий комп'ютер» для підвищення конкурентоспроможності та безпеки України у світовому співтоваристві.*

Ключові слова: *штучний мозок, біологічний мозок, штучні нейронні мережі, нейроподібні зростаючі мережі.*

Abstract. *The article considers the role of artificial intelligence and robotics in the modern military sphere. It describes how since the beginning of the 21st century, robots have become an integral part of military operations, providing a wide variety of opportunities for the armies of various countries. The prospects for the development of autonomous robots with artificial brains that can operate without continuous human control are considered. Human brain modeling projects are considered in the context of creating electronic brains and smart systems capable of imitating and even surpassing the work of a biological brain. The world human brain modeling projects are briefly reviewed, and their comparative characteristics are given. The Ukrainian project Thinking Computer (Artificial Brain) is described in the paper. The project is a new approach in computerization based on the latest non-traditional technology for the simultaneous processing of various types of information in a single homogeneous multidimensional active associative neuron-like structure that allows creation of a new type of humanoid thinking machines. The article tells about the technological basis of the project, its goals and objectives, as well as the effect of the introduction of the proposed technology. The article describes in detail the principles of operation*

and features of the new technology of a multi-connected, multidimensional, receptor-effector actively associative neural-like growing network, which has no analogs in modern neural networks. It also explains what advantages thinking computers have over traditional ones, and what prospects the new technology opens up for various areas of human activity. The article demonstrates the research findings and developments regarding the creation of a prototype of an electronic brain for a humanoid robot, as well as plans for organizing the industrial production of thinking computers. In addition, it substantiates the relevance and necessity of implementing the Thinking Computer project to increase the competitiveness and security of Ukraine in the global community.
Keywords: *artificial brain, biological brain, artificial neural networks, neural-like growing networks.*

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1. Introduction

Since the end of World War II, the nature of military conflicts has changed significantly. Advances in technology and the expansion of the field of artificial intelligence have revolutionized the way we wage war. Now the front lines are less defined as attacks can come from various unexpected sources, including terrorist groups, drones, and even ballistic missiles. The realm of warfare has become an area where technological innovation and artificial intelligence play a key role.

Modern conflicts are largely dependent on technical means and automated systems. Artillery, ground, sea, and air robots have become an integral part of military operations. The skillful use of unmanned aerial vehicles gives armies the ability to quickly respond to changing environments and carry out reconnaissance missions without putting the lives of military personnel at risk. However, overcoming today's challenges requires further improvements. One of the significant drawbacks is the dependence on radio control. That means that enemies can easily undermine the effectiveness of robots using electronic means. In this case, control over the vehicles is lost, which may affect the success of the military operation. An important aspect also remains the fact that even with the use of technical means and unmanned aerial vehicles, the main losses in most cases fall on the infantry engaged in offensive operations and the liberation of the territory. This raises the question of the need to improve the safety of soldiers on the battlefield and minimize human casualties.

Robots have the ability to act under human control or autonomously, making decisions based on the information they collect. Autonomous robots provide a number of advantages over human soldiers, such as responsiveness, accuracy, stability, and the absence of emotional factors. However, they also present serious ethical and technological dilemmas related to the issues of responsibility, control, and unpredictability.

The aim of this article is to consider the use of robots in modern military operations with the rationale for the development of intelligent autonomous robots with an artificial brain similar to a human one for future military operations.

2. The use of robots in modern warfare

Since the beginning of the 21st century, robots have become an indispensable part of military operations, starting with their use in Afghanistan. Since then, their presence and variety have increased significantly in the armies of different countries. Military robots can be classified according to various parameters such as the type of movement – ground, air, underwater; the degree of autonomy – console, semi-autonomous, fully autonomous; and their functional purpose – reconnaissance, transport, military operations, etc.

Among the best-known examples of military robots are unmanned aerial vehicles (UAVs) that can be controlled from a distance or follow a predetermined route. These UAVs perform many tasks such as surveillance, reconnaissance, guidance assistance, bombing, and even dogfights with other drones [1].

Another interesting example of military robots is PackBot ground robot which is able to move on various surfaces and overcome obstacles. It is equipped with sensors, cameras, manipulators, and weapons. PackBot is used for explosive device detection and disposal, search and rescue, reconnaissance, and combat operations. It is capable of operating under the control of an operator or independently following the given routes and is considered one of the most common military robots in the world [2].

Another example of military robots is the Phalanx system, an autonomous close defense system. It is capable of detecting and hitting missiles, shells, and aircraft aimed at ships or bases. The Phalanx includes a radar, a computer, and a six-barrel machine gun capable of firing up to 4,500 rounds per minute. This system can operate both in manual and automatic mode, identifying targets and firing to kill. It is considered the last line of defense against the threat of anti-ship missiles and other attacks [3].

Thus, robots have become an important component of modern military operations, performing a variety of tasks in various fields, ranging from intelligence to active participation in hostilities.

3. Prospects for the development of smart autonomous robots with an artificial brain

The era of autonomous robots capable of operating without continuous human control has become a new stage in the evolution of military technology.

In the world of military technology, robots play the role of complex and multifunctional tools that security forces can use to expand their capabilities on the ground, especially in areas that are difficult to protect with standard patrols. They become a kind of additional «eyes» and «ears», providing information about the situation on the ground. A distinctive feature of military robots is their ability to see and hear much better than people do. Because of their tirelessness and autonomy, they can perform tasks that would otherwise be boring, dirty, or dangerous to humans. For night vision and detection of thermal traces or smoke, they are equipped with infrared cameras, microphones, thermal imaging cameras, as well as sensors for flame, smoke, temperature, gas, and radioactivity. The advantage of robots lies in their smooth operation. They are able to bypass obstacles and analyze video streams to detect anomalies more effectively than humans. Guard robots equipped with video cameras can detect and signal intrusions using loudspeakers or sirens and deter potential intruders. However, despite all the advantages, military robots still pose ethical and technical challenges. Autonomous weapon systems can take away human decision-making control, prompting debate about how safe it is to trust robots in making vital decisions. Despite the advances in artificial intelligence, robots also remain addicted to programming and can encounter situations that are difficult to foresee.

So that robots can successfully adapt to complex and constantly changing situations on the battlefield, it is necessary to create intelligent autonomous robots with an artificial brain similar to a human one. The concept of an artificial brain is to develop a computer system that can mimic the structure and function of a real human brain. An artificial brain can be based on a variety of approaches, including neural networks, genetic algorithms, or cognitive architectures. It has various characteristics such as memory, the ability to focus, emotions, language, and even consciousness. Such an artificial brain is implanted into the robot to give it intellectual abilities. The advantages of smart autonomous robots with an artificial brain are noticeable when compared to traditional machines. They are able to independently study the environment and their capabilities, develop new strategies and tactics to complete tasks, make decisions independently based on available information, as well as evaluate their actions and correct behavior. What's more, they can communicate and coordinate with other robots, allowing them to work together as a team.

All this opens up new horizons for the development of military equipment, making robots more adaptive and efficient in modern combat conditions.

4. Global human brain simulation projects

The concept of an electronic brain stems from understanding the functioning of the biological brain and attempts to create similar processes in intelligent systems. In the world where AI technologies continue to permeate all spheres of our life, the concept of the "electronic brain" has ceased to be utopian and is becoming the subject of real research and development. This concept concerns the creation of artificial systems that can mimic and even surpass the work of the biological brain. Modern developments in this area open up new horizons for medicine, technology, and science.

There are several large-scale global projects aimed at modeling the human brain. These are the following:

1. *Human Brain Project.* It aims at studying the human brain using information and communication technologies (ICT). It was started in 2013 in Geneva, Switzerland, and is coordinated by Henry Markram. The project is largely funded by the European Union and involves hundreds of scientists from 26 countries and 135 partner institutions. It has six ICT platforms in the fields of neuroinformatics, brain modeling, high-performance analytics and computing, medical informatics, neuromorphic computing, and neurorobotics. The platforms consist of prototype hardware, software, databases, and programming interfaces. These tools are available to researchers around the world [4].

2. *Blue Brain Project*. It aims to create a computer model of the brain based on biological data. Launched in July 2005, it is jointly run by IBM and the Swiss Federal Institute of Technology in Lausanne. The project uses the Blue Gene supercomputer to model neocortical columns that are the basic building blocks of the neocortex. Each column contains about 10^3-10^4 neurons whose dendrites span the entire height of the column. The new cortex and each of its columns consist of 6 layers. The project developed a new mesh structure model that automatically generates a neural network based on the biological data provided, a new modeling and self-regulation process that automatically performs systematic validation and calibration of the model, and the first cell-level column model built solely from biological data [5].

3. *Brain/MINDS Project.* It has been running in Japan since 2014 and aims to integrate neuroscientific data obtained from modeling studies on macaques into simulations of more complex human brain emulations. This is an interdisciplinary project that brings together researchers from various fields of science [6].

4. *Allen Institute for Brain Science Project.* Started by Paul Allen in the USA, it aims at gaining a comprehensive understanding of the function of the human brain. The activities of the institute are focused on the generation and public dissemination of large amounts of neuronal and genetic information [7].

5. *China Brain Project*. Launched in 2016, this Chinese project studies the structure and functions of the brain. Its goal is to expand our understanding of the human and animal brain, develop new methods for diagnosing and treating neurobiological disorders, and create new brain-based artificial intelligence technologies [8].

All of these projects have a common goal of understanding and modeling the human brain but they differ in their methods, scope, and applications.

4.1. Comparative characteristics of the projects

The Human Brain Project is the most ambitious and comprehensive project as it aims to integrate data from various sources and disciplines and create a single brain model that can be used for various purposes such as neuroscience, medicine, computing, and robotics. It provides a collaborative platform for researchers around the world to access and use the tools and data generated by the project. However, the project encounters the greatest challenges such as coordinating a large and diverse consortium of partners, managing a complex and dynamic budget, and dealing with the ethical and legal implications of its research.

Blue Brain Project is the most focused and advanced project since it aims to create a detailed and realistic model of the brain based on biological data. It uses a powerful supercomputer to model the neural circuits of the neocortex, which are the basic building blocks of the neocortex. The project has already achieved some results such as modeling one column of the rat neocortex and making some predictions about the structure and behavior of the chip. However, it also faces some limitations such as scaling the model to larger regions and higher levels of organization, validating the model based on experimental data, and integrating the model with other brain functions.

The Brain/MINDS project is a unique project that combines macaque modeling data with the simulation of more complex emulations of the human brain. This is an interdisciplinary project involving researchers from different fields of science. Its goal is to understand the neural mechanisms that underlie cognition, emotions, and behavior in primates and apply them to human brain disorders and artificial intelligence. However, it also faces some challenges such as obtaining high-quality data from invasive animal experiments, ensuring ethical standards for animal welfare, and bridging the gap between different species and scales.

Allen Institute for Brain Science is a private project. The institute is engaged in the creation and public dissemination of large amounts of neural and genetic information. It uses various methods such as gene expression mapping, cell type classification, connectivity mapping, electrophysiology, optical physiology, and computational modeling. It also collaborates with other institutions and initiatives to share data and resources. However, it encounters certain difficulties such as integrating data from different modalities and levels of analysis, ensuring data quality and reproducibility, and translating basic research into clinical applications.

The China Brain Project covers the following four main areas: cognitive neuroscience, neural mechanisms of mental disorders, brain-based computing systems, and the integration of brain and machine intelligence. However, it faces some challenges such as competing with other international projects, securing funding and resources, ensuring ethical standards for human and animal research, and balancing basic and applied research.

These are the main projects for modeling the human brain. All of them have their own strengths, weaknesses, opportunities, and threats. They contribute to the expansion of our knowledge about one of the most complex and mysterious phenomena in nature – the human mind.

5. The Thinking Computer project (Artificial Brain)

The Thinking Computer (Artificial Brain) project is a Ukrainian initiative that effectively represents a new direction in computerization based on a new non-traditional technology for the simultaneous processing of various types of information in a single homogeneous multidimensional active associative neural-like structure that allows the creation of a new type of human-like thinking machines.

5.1. The technological basis of the project

The new technology, a new type of neural network, is a multi-connected, multidimensional, receptor-effector, actively associative neural-like growing network (mren-GN), functioning analogously to the human brain, was developed in the Institute of Mathematical Machines and Systems Problems in the 1990s [9–14].

The technology is:

1. Multi-connected. Like biological neurons, neuron-like elements of mren-GN (neurons) have many interneuronal connections (synapses).

2. Multidimensional. In the structure of mren-GN, different types of information are processed simultaneously (for example, video, sound, text, etc.). There are no analogs.

3. Multilevel. Information is processed level by level as its complexity increases (for example, letters, words, sentences, phrases, texts, etc.). It is compressed at each level, which makes it possible to store an unlimited amount of information on the network. There are no analogs.

4. Receptor-effector. It has a receptor (sensory) zone that perceives and processes information and an effector (motor) zone that generates control signals for actuators. This structure allows the formation of unconditioned and acquires conditioned reflexes. There are no analogs.

5. Actively associative. Information is processed on the basis of actively associative choice.

6. Growing. The network structure is created and grows as information is received by the perceptual mechanisms of the system. There are no analogs.

Compared to classical neural network technology, the new technology differs in all the above-mentioned aspects and an unconventional universal growing structure formed by information, as well as a system architecture enabling massive parallelism through the simultaneous operation of all network neurons.

This technology allows the perception, analysis, synthesis, memorization, associative search, classification, and generalization of information presented in various dimensions (visual, sound, symbolic, tactile, etc.) of a growing neural network simultaneously. As a result of the analysis of the perceived information, the neuron-like structure generates control signals to the actuators, enabling the incorporation of unconditioned reflexes into the mren-GN structure.

During the system life cycle (thinking computer or electronic brain), on the basis of the interaction of unconditioned reflexes and external information coming from the environment, conditioned (acquired) reflexes and complex adaptive mechanisms of the system's behavior in this environment are formed. The conditioned reflex mechanism underlies the formation of any acquired skill and learning process. There are no analogs.

Currently, no architecture of classical neural networks has in its structure both sensory and motor zones and, accordingly, no conditioned reflex learning mechanism.

The technology consists of such components: a neuro-like element – an active, associative, growing, memory cell of a neural network; Patent UA 128 798 for a utility model, Ukraine, dated March 30, 2018; a neural network – a multidimensional, multiply connected, receptor-effector neuron-like growing network (patent pending).

5.2. Technology benefits

Classical neural networks have various rigidly defined structures and learning rules. Each structure successfully solves its own class of problems but does not have universality. No decision concerning merging structures has been made yet. In addition, the most successful deep learning neural networks require large training sets and powerful computers to function.

Smart machines created using the new Mren-GN technology are fundamentally different from conventional computers. The basis of smart machines is an analogy, associative and logical inference, and continuous improvement, i.e. following the principle of working as of human. Neural-like growing networks do not require powerful computers, because the neuron-like element is a simple conjunctive-disjunctive scheme.

Neural-like growing networks have massive parallelism in the perception and processing of information.

Neural-like growing networks provide ultra-fast system performance due to the simultaneous execution of operations throughout the entire volume of the neural-like structure. There is an interesting fact of an increase in the relative speed of information processing with an increase in the amount of information coming from the environment.

No programming. Smart machines solve problems with the help of previously acquired knowledge or acquired through self-learning, imitation, consultation, and the ability to learn from information, draw logical conclusions, and change their decisions in real time.

A high and continuously improving intelligence becomes more like human-level intellect. The technology acquires new knowledge. Based on the knowledge accumulated over many years, it identifies patterns that were not previously obvious to specialists. This is of great social importance for the development of the society. Smart machines will solve emerging problems and become reliable assistants. Already today, AI is changing entire business sectors, and in the future, smart machines will change civilization.

The other advantages include virtual immortality (the transfer of personality into the electronic brain), small size and low energy consumption, noise immunity, and reliability.

5.3. Goals and objectives of the project

Short-term goal. Stage 1 – to develop a β-version of the electronic brain prototype for a humanoid robot within the next 6-9 months in order to finalize and test the method.

Long-term goal. Stage 2 – to organize the industrial production of intelligent thinking computers within 1.5 years based on the new technology and the Electronic Brain prototype.

What has already been done: a new type of neural network – multi-connected, multidimensional, multi-level, receptor-effector actively associative neural-like growing network (mren-GN) – has been developed; the theory and methods for the development of smart intelligent systems – Thinking Computer and Electronic Brain for robots – have been created; a subsystem of a virtual robot (α-version of the robot electronic brain prototype) has been developed, as well as a subsystem of technical vision, a subsystem for recognizing various objects, and a subsystem for dialogues in natural language; based on the α-version of the robot electronic brain prototype, thorough testing and verification of the provisions of the Thinking Computer development theory was carried out; in addition, a patent for a neuron-like element – Patent UA 128 798 dated March 30, 2018 – was received.

What needs to be done: to develop a β-version of the Electronic Brain prototype for a real robot on the basis of the virtual robot subsystem; to carry out thorough testing of the β-version of the Electronic Brain prototype for a real robot; to develop a chip – the main element of the Thinking Computer structure – based on the β-version of the Electronic Brain prototype for a real robot; to carry out full-scale patenting; to develop and organize the industrial production of Thinking Computers.

Application area: in all fields of human activity.

5.4. Comparative characteristics of the Thinking Computer project

The Thinking Computer project is based on a new non-traditional technology for the simultaneous processing of different types of information in a single homogeneous multidimensional active associative neuron-like structure, which makes it possible to create a new generation of human-like thinking machines.

The project differs from other brain modeling projects in the following ways:

Previous projects are mainly focused on understanding and modeling the structure and function of the biological brain using various methods and tools such as neuroimaging, computer simulations, and artificial neural networks. The Thinking Computer project aims to create a new type of artificial brain using the new technology of a neural-like growing network that functions similarly to the human brain.

Previous projects are based on existing data and brain models that are often incomplete and sometimes inconsistent. The Thinking Computer project is based on a new technology that creates and grows its own structure based on information received from the environment. The structure of mren-GN is not predetermined or fixed; it adapts and develops in accordance with the needs of information processing.

Previous projects have been limited by the complexity and scalability of their models and simulations, which require large amounts of data, computational resources, and coordination. The Thinking Computer project is not limited by these factors as it uses a simple and versatile framework that can process different types of information simultaneously, in parallel, and at multiple levels of resolution. Mren-GN can also generate control signals for actuators, which allows it to form unconditioned and acquire conditioned reflexes.

5.5. The effect of the introduction of the proposed technology

The introduction of the proposed technology will make it possible to carry out an industrial revolution in the production of computers of a new type. It will allow us to join the countries leading in computer manufacturing.

It will also mean a significant reduction in the cost of solving the tasks (no programming required). It is known that a significant part of the cost of problem-solving and product manufacturing is attributed to software development. Therefore, the implementation of Thinking Computers and the introduction of the Electronic Brain in the production of robots and other intelligent systems for various purposes will bring huge profits. Acceleration/intellectualization and optimization of manufacturing processes and services are also among the advantages.

The technology is highly effective when used for intelligent information processing in super-large databases and knowledge and identifying patterns in them.

Moreover, the implementation of the technology will result in the development of new highly intelligent products and services. There are many application areas of the technology. Smart machines can prevent business emergencies, protect businesses and customers from fraud, respond to customer support requests, and read and understand millions of pages of information to help companies run businesses successfully.

Artificial Brain projects promise not only to improve understanding of how the human brain works but also bring new solutions to medicine, artificial intelligence, and robotics. Robots having this technology will be able to quickly adapt to a changing environment, learn new skills, and cope with the complex tasks of combat operations that require analysis and quick decision-making.

However, amidst these potential advantages, there are also ethical concerns. Preserving privacy, the possibility of unwanted intrusion into individual thoughts, and the risks of potential mind control raise doubts and concerns. In addition, despite the fact that robots with artificial brains promise to change the world, their appearance also has some risks. They can cause mass unemployment due to automation, the concentration of power in the hands of few people, and economic disruption. With the development of more complex artificial brains, there is a risk of losing control of AI. If systems become so complex and unpredictable, it may become difficult to understand how they make decisions and why. Autonomous weapons, threats to privacy, and cyberattacks all stand in the way of the development of AI robots, causing protests and calls to stop their development. It is necessary to provide for the possibility of independent external control of AI robots and a balance between innovation and risk to ensure a safe and ethical future.

6. Afterword

In this article, we have analyzed the use of robots in modern warfare and the prospects for the development of smart autonomous robots with artificial brain. Robots are playing an increasing role in military operations, performing various tasks such as mine clearance, reconnaissance, transportation, and combat. We have shown that in order for robots to adapt to complex and dynamic situations on the battlefield, they need not only high speed and accuracy but also the ability to learn, analyze the situation, have creativity, and be capable of decision-making and cooperation. It is necessary to make every effort to create smart autonomous robots with an artificial brain similar to a human. However, the development and utilization of such robots give rise to numerous technological, ethical, social, and philosophical issues. Given the current situation in Ukraine and the world, we believe that there is a need for a thorough study and discussion of these problems and risks by all interested parties.

7. Conclusions

The Thinking Computer project represents a revolutionary advance in computing with great potential to transform the world as we know it. It seeks to create intelligent machines that can not only analyze and process information but also simulate complex cognitive processes that are characteristic of the human brain. It is based on an innovative multidimensional, multi-level, receptor-effector actively associative neural-like growing network that opens doors to previously untapped possibilities.

The project promises to revolutionize almost all fields of human activity. From healthcare and education to industry and scientific research, the Thinking Computer can make data processing deeper, more analytical, and creative.

Modern events and challenges taking place in the world prove the urgent need to develop our own technological solutions. The use of Thinking Computer can play a key role in the military sphere, where the use of smart autonomous weapons systems can minimize human losses in conflicts. Replacing soldiers with machines with undeniable advantages such as the absence of emotional factors and higher reliability may even contribute to the prevention of armed conflicts.

The Thinking Computer project also provides Ukraine with an opportunity to strengthen its position in the global community. The creation and implementation of such an advanced technology can significantly increase the national competitiveness and security of the country. Thanks to this project, Ukraine will be able not only to enrich its scientific and technological potential but also to become an important player on the world stage, capable of bringing significant innovations and solutions to various fields of activity.

Thus, the Thinking Computer is not just a technological project, it is a chance to create a future in which artificial intelligence can empathize, analyze, and make decisions based on highly developed cognitive functions. This project can give society a tool to help solve complex problems, reduce suffering, and ensure sustainable development towards a brighter future.

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