formed as one of the most strategic technologies of the 21st century. How we approach AI will determine the world in which we live.

In the face of fierce global competition, Ukraine's AI research and innovation agenda will contribute to the successful development of all our citizens and businesses, while ensuring high ethical standards and an inclusive approach. Ukraine must take a prominent place in the field of information technology and, in particular, AI technology.

Object is for all citizens to experience the benefits of AI in everyday life - from optimizing traffic and autonomous driving to reducing everyday stress and significantly reducing the number of accidents, to truly intuitive AI-based systems that adapt to human needs. to support them in solving specific tasks, improving their working conditions and making the technology easy to use for everyone, not even AI experts. In addition, society as a whole will benefit from artificial intelligence solutions to optimize the life cycle of resources (energy, food, etc.) and make them more environmentally and economically sustainable - from production to distribution and use. Physicians will be able to seek the support of powerful machine learning, which requires large amounts of data, to help them make decisions about diagnosis and therapy. Firefighters will receive support from robots to approach dangerous areas of intervention. In general, progress in the field of artificial intelligence and robotics should be fully used to promote Ukraine in the markets of innovative solutions and technological breakthroughs in leading fields of science and industry; and bring all its potential benefits to other industries, such as health, agriculture, manufacturing, energy, transportation, and the environment.

The introduction of artificial intelligence and autonomous behavior algorithms in complex systems that are important for security and time, such as systems used in large transport networks, aviation, health and industrial purposes, is a technological challenge, but also a significant business opportunity for Ukraine. It is necessary to use human-oriented ethical and reliable AI, which will be crucial for its implementation, and the brand of AI, developed in Ukraine.

To subsection 7.5. Artificial intelligence in transport and infrastructure

Logistic. Development of technologies for detection and localization of objects using unmanned aerial vehicles

The development of technologies for detection and localization of objects using UAVs is one of the current and promising areas of application of artificial intelligence technologies. This makes it possible to solve a number of state, economic and defense tasks and, in particular, to create three-dimensional reconstructions of the area (buildings, landscapes), as well as to make accurate measurements with LIDAR and RGBD cameras.

Object. Use UAVs to detect obstacles and identify objects in the environment in real time.

Rationale for research and main tasks

Demand for technology for autonomous vehicles has increased with the development of IT and artificial intelligence. Requirements for autonomous driving, research on the detection / avoidance of obstacles and the recognition of surrounding objects - traffic signs and pedestrians have increased. The use of unmanned aerial vehicles has also become important in areas such as natural disaster monitoring, shipping and construction disturbances, intelligent flight and object recognition techniques.

Limited technologies available:

- *low accuracy of sensors due to limited characteristics;*
- *limited technology of synthesis of heterogeneous sensors;*
- *limitations of image recognition technology.*

Task. It is necessary to develop adaptive algorithms for assessing the accuracy of heterogeneous sensors (HS), which will assess the accuracy of each sensor by the characteristics of interference: brightness, depth, position, dynamics of change.

Object. To develop two-tier real-time object recognition algorithms based on YOLO and HS data that can speed up RoI search without losing accuracy. To avoid the limitations of available technologies, interference detection algorithms for the use of heterogeneous sensors and object recognition (RO) for real-time autonomous flight are proposed with the following two modules: interference detection module (MRP) using 1D-LIDAR sensors and camera, and also a two-level object recognition module (MRO) in real time, using data from heterogeneous sensors.

Research and development strategy

Based on the following strategies, developed new methods that provide both versatility for unmanned aerial vehicles and specialization in UAVs. • Development of core technologies to support any new adaptive heterogeneous sensor technology depending on different interference characteristics.

- Development of a strategy to overcome significant limitations of existing technology.
- Creating an open source technology development strategy that reflects new technological trends.
- Use of international infrastructure.
- Creating a business strategy based on technology sharing and business suitability.
- Creating a system of research and design through the analysis of the sequence of tests and data exchange.

Research plan

Stage 1: basic system design

- Analysis of sensor accuracy, collision risk measurement and training experiments for different obstacle characteristics.
- Development of an algorithm for detecting interference based on inhomogeneous sensors.
- Algorithm for recognizing multiple objects based on data from an adaptive sensor.

Stage 2: module optimization, adaptation and testing in different situations • Implementation and evaluation of UAV effectiveness

- Addition of heterogeneous sensor technology to autonomous operation of UAVs.
- Analysis and optimization of modules for embedded environments.

Expected use of the results of detection technologies and localization of objects using unmanned aerial vehicles

Real-time interference detection and object recognition technology, which is based on the convergence of data from heterogeneous sensors for unmanned aerial vehicles, can be used both in the unmanned vehicle and directly in the field of UAV. This work can be used in a variety of situations, including to prevent social disasters and to deliver goods by private companies.

- **PR:** press release, taking into account the key technologies of this service platform
- **Technical exhibition:** exhibition of technical exhibits to respond to various technical consultations related to task definition technology
- **Demonstration and pre-commercialization:** advancement through pre-commercialization based on this technology.

Development of integrated, smart, secure, affordable and inclusive mobility systems

Ukraine must maintain the competitiveness of its transport sector and manage the transformation of supply-based transport into demand-driven services, safe and sustainable mobility services. Relevant research and innovation initiatives will help prepare for such transformations. New digital technologies, such as big data (BigData), Internet of Things (IoT), artificial intelligence and advanced satellite navigation services (Galileo / EGNOS), offer great potential for the development of connected and automated transport and traffic management throughout the transport

network. This can provide significant benefits in terms of safety, environment, economy and social situation by reducing accidents caused by human error, reducing traffic congestion, reducing energy consumption and vehicle emissions, improving the efficiency and productivity of transport operations, improving working conditions, creating new jobs, and promoting social cohesion. To succeed in this transformation, Ukraine's aging (and not always sustainable) transport infrastructure needs to be prepared to function more efficiently and intelligently. The results of research and innovation will create the basis for future standards, creating European and global markets, as well as adapting and modernizing the overall regulatory framework. To maximize social, environmental and economic benefits, in addition to technological solutions, it is important to consider the following human and social aspects: analysis of mobility factors and patterns, representation of different social groups and inclusion of new solutions, capacity building and public acceptance.

Securiy and competitiveness of automated road transport system

Task. Implement the goals of joint, connected and automated road mobility at the national level.

Object: to outline public benefits, strengthen the competitiveness of Ukrainian industry and properly manage the long transition to a highly connected and automated transport system in a safe and secure way, promoting social integration and overall efficiency, taking into account personal mobility while reducing overall environmental impact.

Potential tasks and research topics

- Interaction of automated vehicles with the environment, physical and digital infrastructure, interfaces with other modes of transport.
- Technical and non-technical tools: smart sensors, 3D HD maps, advanced satellite navigation technologies, data analysis, artificial intelligence, ethics, confidentiality, security, responsibility for cybersecurity, user and public acceptance, management and international cooperation.
- Impact of automated road transport system on society and the environment (economic, environmental, social, educational, qualification aspects, employment).
- Large-scale cross-border demonstrations to gain insight into the capabilities of automated driving systems and their limitations, as well as for deployment.

Development of efficient and innovative transport infrastructure

Task. Innovative infrastructures will be vital for the implementation of the TEN-T network and the technological transition to effective reduction of greenhouse gas emissions. Thus, there is a need for new solutions to provide, despite the existing budget constraints, Ukraine's transport infrastructure. It can be maintained, upgraded and expanded to ensure efficiency. Climate change forecasting is crucial for the development of new types of innovative transport infrastructure for 2050, where the problem of sustainability and environmental impact is growing. Moreover, focusing on new modes of transport and customs is a key to improving connectivity and therefore increasing competitiveness and quality of service.

Object. Development and approval of new solutions to increase the efficiency, intermodality and safety of the transport system for passengers and goods. At the same time, reduce greenhouse gas emissions from transport operations and improve the environmental performance of transport maintenance and upgrades throughout the infrastructure life cycle.

Potential tasks and research topics

- To develop and to test new methods of supporting and modernizing transport infrastructure to increase safety, climate resilience and environmental impact (including habitat and biodiversity) and develop new solutions to ensure mobility.
- Support the development of transport infrastructure that will ensure the deployment of new and modes of transport and improve the integration of (national, regional) transport infrastructure and energy systems through the deployment of appropriate infrastructure.
- Integration of physical and secure digital infrastructure, including aspects of cybersecurity.

- To develop tools for information collection and data management to monitor infrastructure performance (asset utilization rate) and effective management of mixed fleets on road networks.
- To develop and test management, regulatory, public procurement models and new contract performance indicators and incentives to maintain and upgrade infrastructure.

Implementation. Potential challenges and research topics will be addressed through collaborative research and innovation.

Development of the future transport network and integrated traffic management

Task. The lack of timely information, reliability, multimodal coordination, safety, passenger comfort and the availability of collective mobility, which is exacerbated by inefficient freight traffic, leads to an increase in the use of individual transport. Overcoming system-wide capacity constraints will improve the management of passenger and freight traffic flows, ensuring uninterrupted mobility and door-to-door transport, which will lead to optimal traffic and circumvention of temporary capacity constraints.

Object. To develop and to prepare for the deployment of an advanced multimodal network and integrated traffic management system to ensure uninterrupted door-to-door mobility, increase safety, reduce congestion and emissions from transport.

Potential tasks and research topics

- Architecture and operation concept for an efficient, robust and adaptable multimodal network and traffic management system (NTM) using advanced digital technology solutions and satellite navigation services.
- Integration of service networks with cooperative and connected vehicles to improve traffic management and the overall higher percentage of information about mobile travelers.
- Verification of next-generation NTM multimodal systems (including intramodal optimization and interface development).
- Problems of data exchange: models of data exchange and use by different public and private stakeholders, the need for common approaches and rules;
- Optimization of the movement of conventional, automated and unmanned vehicles in the multimodal NTM system.
- Provision of co-modal freight transport services at the level of Ukraine, connected to global supply chains within a well-synchronized, intelligent and uninterrupted network.
- Include soft / active mobility provisions (bicycles + walking).

Implementation. Potential challenges and research topics will be addressed through collaborative research and innovation.

Multimodal freight logistics services and passenger mobility services

Task. New mobility services for people with disabilities are needed to ensure equitable access to new technologies. Public and private transport operators are developing their service models - blurring the traditional distinction between public transport and private mobility and between different modes of transport.

Object. Ensure the competitiveness of Ukraine in the field of logistics and mobility services, while reducing the impact of climate and environment in accordance with the Paris Agreement. To develop and to approve new, low-carbon approaches to the freight transport system and logistics operations throughout the life cycle. To develop and to approve people-oriented smart public transport and sustainable mobility services in all types of rural and urban areas.

Potential tasks and research topics

- New digital infrastructures, their interconnection and interaction with satellite navigation of Ukraine to increase the efficiency of logistics chains.
- To assess new business and operational models, their employment and social implications (eg the need for skills development and retraining), taking into account new digital and

space technologies, vehicles (eg unmanned aerial vehicles), new mobility models and new global trends.
- To assess the impact and opportunities of cooperative, connected and automated mobility on multimodal freight logistics based on digital technologies and satellite navigation services of Ukraine, open platforms and data standards / formats.
- To develop and define new management models for affordable, smart mobility services for all.
- Requirements arising from the future interaction of physical, digital, technical, social (health, education, etc.) and spatial systems.
- Adaptation of the data ecosystem / IoT to integrate new technologies from different sources (including non-transport) and integrate new mobility needs (models).

Implementation. Potential challenges and research topics will be addressed through collaborative research and innovation.

Improving transport safety - by mode and between modes

Task. Safety is a top priority of any transport system in the country. The basis of security research is technology, regulations and the human factor (individual and organizational aspects, including interaction with automation). The research process must take into account risks and systems, including vehicles, infrastructure (eg railway stations, airports and ports), the physical environment (eg weather) and various actors (eg. manufacturers, regulators, operators, users), and also all their interfaces. Specific issues for each mode of transport and synergies between modes of transport will be addressed, in particular on safety culture, data use and security / cybersecurity interaction. Particular attention will be paid to low-frequency incidents with high consequences (for example, passenger ship accidents) and emergencies that require rapid investigation to accelerate safety. Interaction will be used in research at the national, European and international levels, together with national authorities, agencies and international organizations, to improve rule-making, promote security and control.

Object. Contribute to a significant reduction in accidents and incidents, fatalities, injuries and environmental damage.

Potential tasks and research topics
- Construction, data analysis and exchange of security and security intelligence data.
- Understanding and predictive assessment of safety risks for system design, operation and efficiency.
- Human factors, including social behavior, new models of mobility, information perception, situational awareness, and interaction with automation.
- Smooth interaction between all users, their vehicles, infrastructure and physical environment in a secure system approach.
- New security technologies and solutions, taking into account emerging risks and opportunities (eg artificial intelligence).
- Improved preparation, verification, monitoring and implementation of safety norms, rules, standards, safety management systems and training, study of the potential of space technologies in Ukraine.
- Accident management and rapid response;

Implementation. Potential challenges and research topics will be addressed through collaborative research and innovation.

To Section 8. Scientific, personnel and material support of the national artificial intelligence ecosystem

The main **directions** of increasing the level of provision of the market of artificial intelligence technologies with qualified personnel and the level of public awareness about the possible areas of use of such technologies are:

- creation of an open organizational and technical ecosystem of topical fundamental and applied problems and tasks that require the use of artificial intelligence; use of the corresponding register of **problems and tasks as a top priority** for the choice of topics of diploma and dissertation works of the corresponding specialties and specializations;
- priority implementation of the **model of dual master's and postgraduate studies** in the field of AI using the experience of existing pilot projects of knowledge-intensive dual programs and involvement in planning and implementation of interested leading international companies with research branches in Ukraine;
- creation of normative and factual conditions for **stimulation of joint innovation-incubation activity (start-up infrastructure)** in the field of AI of teachers-researchers, students and business representatives at institutions of higher education of Ukraine;
- creating conditions for the return of leading Ukrainian AI scientists and specialists living and working abroad;
- identification of **technological research priorities taking into account limited resources** - in particular those that require **small investments**, while giving a significant competitive advantage in world markets due to widespread use - AI on devices (On-DeviceAI), new machine learning algorithms for systems with significant limitations in resources and so on;
- identification of ***priority related fields*** in applied physics, mathematics, materials science, neuroscience, mathematical linguistics, etc. - as real competition in the field of AI occurs, including in interdisciplinary areas for the creation of new computing architectures.

A.L. Fisunenko

To Section 1. Paradigm

Ukraine's place in the global artificial intelligence ecosystem. Basic decisions and measures

In order for Ukraine to play a leading role in the global AI ecosystem, it is necessary to identify such measures.

1. To create an open organizational and technical ecosystem of current fundamental and applied problems and tasks that arise in government and commercial organizations that are candidates for solving methods of artificial intelligence. To recommend the use of the appropriate register of **problems and tasks as a priority** for the selection of topics of diploma and dissertation works of relevant specialties and specializations.
2. To give high priority to the model of dual **master's degree and PhD in the field of AI**, involving in the planning and implementation of relevant training and research programs:
    a) experience of existing pilot projects of knowledge-intensive dual programs;
    b) interested leading international companies that have research branches in Ukraine.
3. ***Collegially,*** with the involvement of leading universities, state and commercial, Ukrainian and international research centers in the field of AI, determine the list of ***conferences and magazines*** that will be recognized for PhD (and above), and, conversely, the list of conferences and journals that are indexed by Scopus and other scientometric databases, but are "predatory" and should not be allowed for formal degree criteria. Accordingly, reduce the quantitative burden of PhD and doctoral criteria in favor of quality, which will be confirmed by the international community.
4. To stimulate partial employment of teachers in real commercial, state and international projects in the field of AI.

5. To create normative and factual conditions for stimulating joint **innovation and incubation activity (startup infrastructure)** of teachers-researchers, students and business representatives at universities.
6. To define **technological priorities of research** ***taking into account the limited resource***. For example, as modern data centers and computing clusters require significant investment, focus on areas that are **accessible and relevant in Ukraine and require little investment**, while giving a significant competitive advantage in global markets due to mass use: AI on devices (On-DeviceAI), new machine learning algorithms for systems with significant resource constraints and so on.

To identify priority related areas, not only in computer science and IT, but also in applied physics, mathematics, materials science, neuroscience, as real competition in the field of AI is including interdisciplinary areas to create new computing architectures.

To introduce the following key quantitative indicators for measuring the implementation of the Artificial Intelligence Development Strategy in Ukraine:

- quantity of presentations at leading conferences and publications in journals (according to the list of item 3).
- quantity of international patents in the field of AI
- quantity of masters, candidates and doctors of sciences specializing in AI and related (annual graduation and cumulative indicators)
- quantity of international conferences (IEEE, ACM) held by Ukrainian organizers.
- quantity of research projects with AI elements that have been successfully completed, implemented and used in companies and government agencies (annual indicator).
- quantity of immigrants specializing in AI in other countries.

Examples of the implementation of measures of the Strategy for the Development of Artificial Intelligence in Ukraine (2022-2030) in the form of applied developments and technologies

Intelligent technology for controlling a swarm of unmanned underwater vehicles

The project is aimed at solving the applied problem of navigation in environments with limited light supply and difficult radio signal transmission. When solving this problem, two problems are also solved: the first is the security and defense capability of the country, the second is the protection of nature from biological and chemical pollution of water bodies, which can cause man-made disasters.

The goal of the project is to create a universal hardware and software system for managing the tasks of a swarm of underwater robots with intelligent means of reconfiguring the interaction between them and the possibility of autonomous on-board navigation.

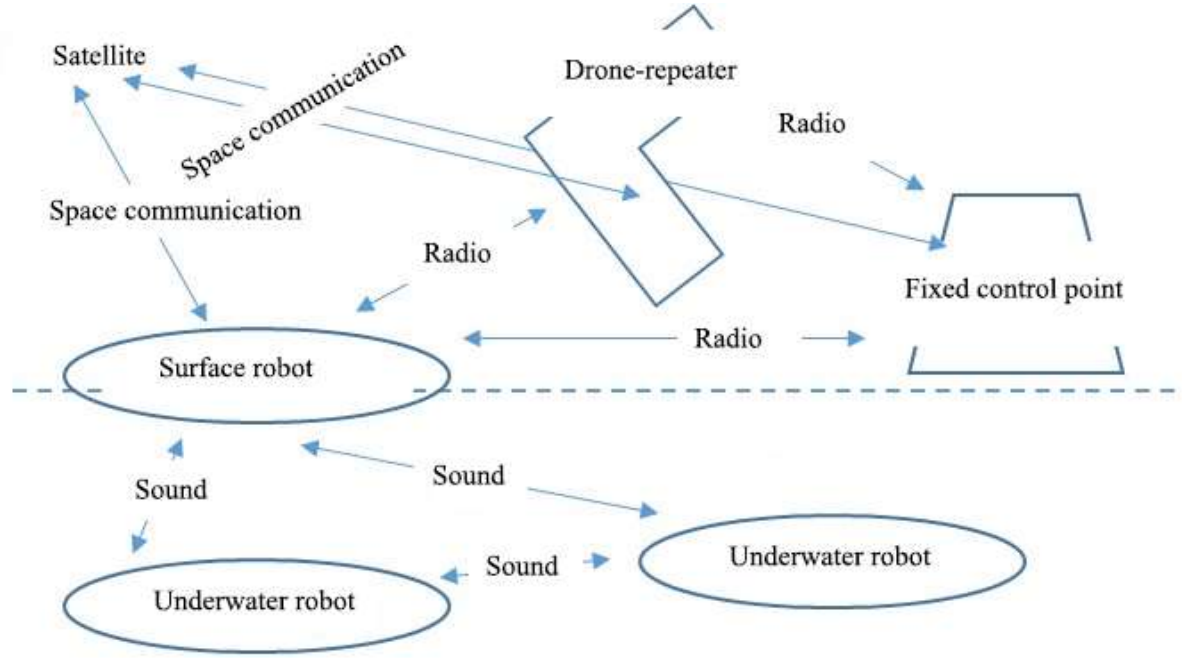

Fig. 3. – Conceptual structure of a universal complex of underwater robots

The architecture of the system includes 4 main elements: the operator's workplace (a multi-platform program), a central node of interaction (a server or a set of cloud services), a basic repeater (a hardware-software solution for exchanging data above and in the water surface), and an underwater drone. The proposed architecture allows operators to manually control selected underwater drones or assign tasks to groups of drones, combining them into a network-centric swarm. Drones perform data exchange with a basic repeater, but are able to interact with each other to implement swarm intelligence schemes.

The autonomous navigation subsystem of an underwater robot is being developed based on the processing and conversion of data from a set of onboard system sensors. The implementation of this subsystem consists in the preliminary development of methods of aggregation, filtering of data from sensors (sonar, camera, gyroscope, accelerometer, compass, altimeter, anemometer, thermometer, etc.) and creation of streaming data analysis models. A method of route analysis and planning is proposed, taking into account the factors that affect the increase in the error coefficient. This method will make it possible to create a map of the route based on the discrete data of the calibration buoy.

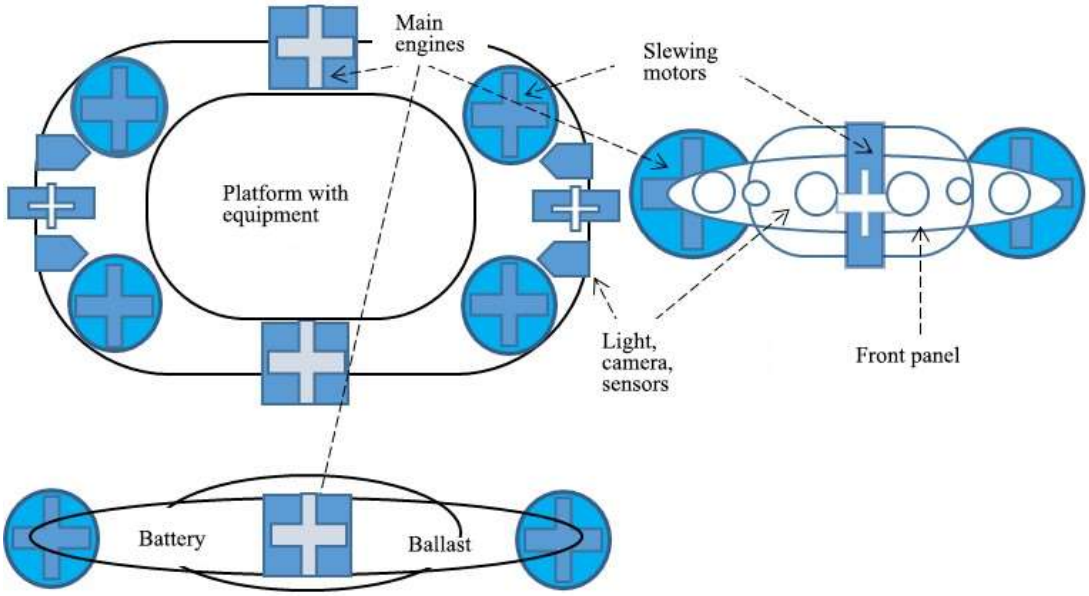

Fig. 4. – Sketch of an underwater robot model

It is proposed to create a method for classifying potentially dangerous objects and tracking a potentially dangerous target based on sonar and camera data, as well as temperature and depth data. Using machine learning methods, the system will be able to classify the behavior and parameters of the object. During the autonomous mode of operation, the system will make a decision to observe a suspicious object. In the process of observation, the system will also be able to reclassify the object.

A method of calibrating an autonomous underwater robot using calibration buoys with the implementation of data exchange protocols is proposed. This method is necessary to ensure a stable communication channel with the coordination center, as well as to ensure reliable navigation without the need for frequent pop-ups of the autonomous robot. As a buoy, it is possible to use a floating control station, which performs the general function of underwater robots and relays their signals to the control center.

State of development: prototypes of the repeater and drone are being created, research into the underwater communication system is ongoing, prototypes of the operator's workplace and the interaction node have been created, methods of the on-board autonomous underwater navigation system have been implemented under conditions of loss of communication or when performing tasks in silent mode.

A long-term defensive point with intelligent means of tracking and destroying ground targets

The project is aimed at solving an important problem of national security and defense, preserving people's lives by creating an intelligent system for recognizing and identifying moving targets in the ground space of operational surveillance, determining their coordinates, physical size, speed and direction of movement, followed by automated control of means of firing at damage.

The goal of the project is to create a prototype of an intelligent defense system that allows you to control robotic complexes remotely and remove a person from the contour of combat operations to reduce personnel losses and increase the effectiveness of small arms.

The idea of the project is to combine information from robotic video cameras with different spectrum ranges, means of distance measurement and knowledge about the processes of human visual perception of physical objects with known parameters, their location and behavior in space, ontological analysis of information about objects in the surrounding world. Such an approach, in combination with remote control systems for robotic mechanical military devices and decision-making systems in the tasks of managing defense devices, is relevant for increasing the state's

defense capability, creating innovative systems that remove people from the combat zone, reduce personnel losses, and contribute to the creation of new competitive types of weapons.

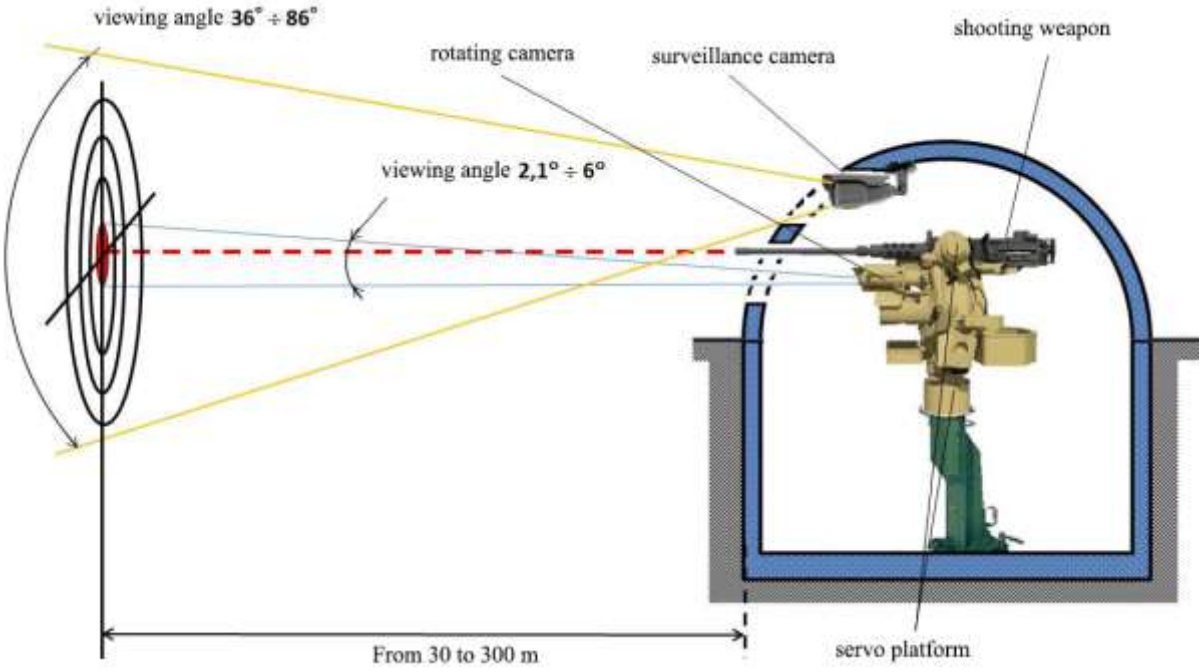

Fig. 5. – Scheme of an intelligent system of tracking and destroying ground targets

Hardware-wise, the system consists of a computing unit (single-board computer), which controls a rotary system with small arms, and receives video sequences from two cameras (at a minimum, the use of additional sensors is possible). The surveillance camera is fixed to the fixed common platform of the defense point. The rotating camera is aimed at a selective direction within the frame of the viewing camera and is placed on a servo platform, which in turn is fixed on a fixed common platform.

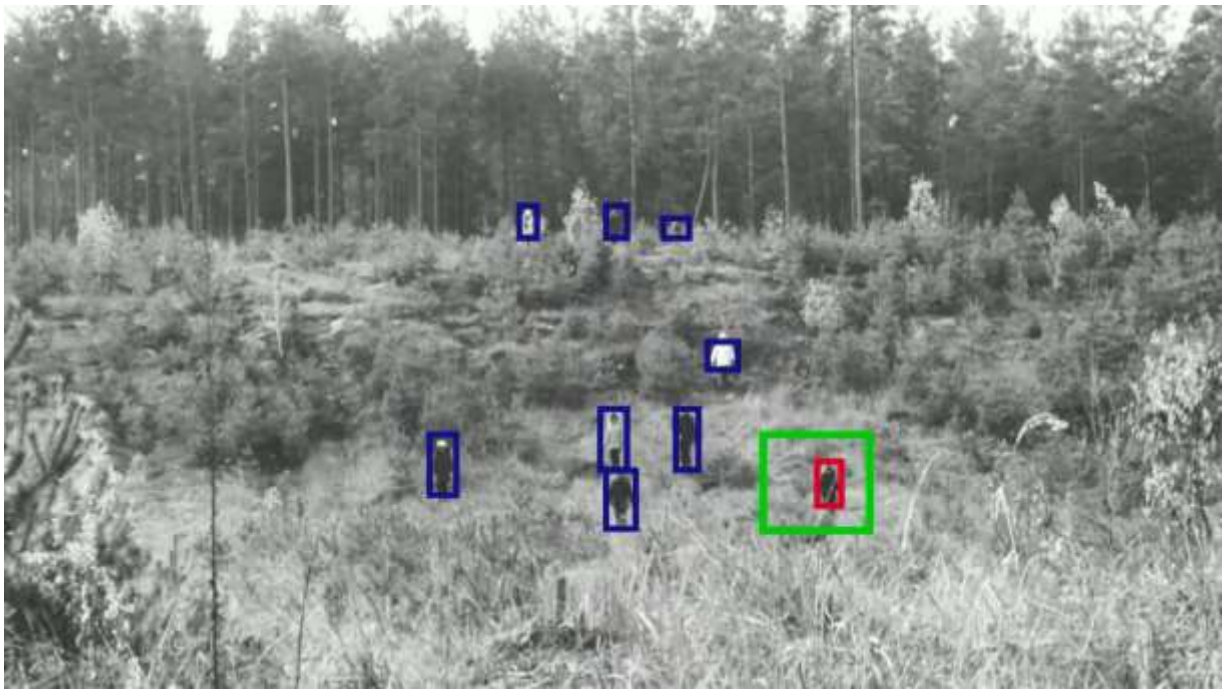

Fig. 6. – Simulation of the operation of the technology: tracking of moving objects (blue rectangles), aiming small arms at the current target (red rectangle) with its tracking by a rotating camera (green rectangle)

A simulator of the surveillance and rotating camera system has been developed based on the use of video captured by a fixed camera with a constant focal length. A software prototype of an intelligent fire system in an armored case with automated recognition and destruction of ground targets was implemented, which was tested on a simulator.

Technical characteristics of the object tracking system prototype:

- The number of target objects: limited by the resolution of the frame and the lack of overlapping objects from the viewing angle (up to 300 for a FullHD frame);
- The speed of target objects in the video stream in the image plane is no more than 25 pixels/sec;
- The minimum size of the object is 20x20 pixels (surrounding camera) and 10x10 pixels (rotating camera);
- Resource-efficient background selection: quasi-stable background (grass, forest, clouds);
- Surveillance camera: stationary placement in the direction of operative observation, viewing angle 86° ÷ 30°, resolution from 1920x1080 pixels, fast transmission of a video stream without compression and coding (HD-SDI/HD CCTV), progressive scan;
- Rotating camera: camera viewing angle 25° ÷ 17°, optical stabilization, resolution from 1280x720 pixels, fast transmission of video stream without compression. The real-time resolution of the rotating camera (frequency 25 frames per second) is 720x480 pixels;
- Operating modes: operator (user selects objects for tracking and damage), autonomous (tracking of all moving objects).

New and improved methods. The procedure for tracking the target object with a rotary camera, the procedure for correcting the direction of the rotary camera based on the comparison of the images of its video sequence with the images of the video sequence of the surveillance camera has been developed. On the basis of the developed search procedure between images of video sequences, a procedure for automatic calibration of the system of surveillance and rotary cameras is proposed. A method of formal description of images and video sequences in the form of a set of structural elements, properties of the function of modification of the description of tracked objects from frame to frame, which is necessary for tracking, has been developed. A procedure for detecting moving objects has been developed based on the selection of connected subsets of structural elements that have a similar interframe displacement. The developed methods of tracking target objects have been adapted for use on a video stream with a moving background inherent in a rotating camera.

A helmet for psychophysiological correction of the human condition in extreme conditions

The development is an intellectual system, which includes a set of methods of diagnosis and correction of the psychophysiological state and software and technical means for their implementation. Purpose: psychophysiological rehabilitation of a person in extreme conditions using a complex of methods; massage using innovative techniques and feedback control of the psychophysiological state.

The goal of the project is the development of theoretical provisions and practical implementation of means and methods of assessment and correction of human functional states in normal, extreme and emergency situations and environmental conditions, using feedback and adaptation mechanisms. The result is an intellectual system for adjusting the psychophysiological state of a person when making decisions in emergency situations, the features of which are autonomy, ease of use without the involvement of a specialist, modification of existing programs and creation of new ones. A scheme and methods have been developed for adjusting the functional working conditions of a human operator when making decisions at the level of performers of various ranks, including in military units. Informational models of the influence of psychophysiological and psychophysical characteristics on the intellectual characteristics of a

person when in situations of varying complexity and depending on different conditions of performance of assigned tasks are developed and described.

Fig. 7. – General view of the helmet and control unit on the demo stand (left) and testing the prototype helmet (right)

Principle of operation. Signals about the psychophysiological state of the body are sent to the intelligent system, the system controls the formation of appropriate feedback signals that purposefully affect the biologically active areas of the head surface with audio-visual accompaniment to increase the effectiveness of the effect. Basic types of programs: excitation or calming of the nervous system, software tools have also been created for the possibility of developing programs to increase attention during educational activities.

Components of the device: protective helmet, vibrocatuators (40 pcs.), microprocessor control system for vibration sources and sound accompaniment, virtual reality glasses ("Gear VR"), smartphone, stereo telephones, control panel, software and means of connection to a personal computer, means of autonomous power supply and recharging.

Available functions: selection of a program of the sequence of activation of vibration sources or creation of your own program; selection of audio and video accompaniment; control of the current physiological state; the possibility of saving and exporting information about the state of the body; expert system of selection and adaptation of procedures for psychophysiological correction of the human condition.

A chat-bot with artificial intelligence for the psychological rehabilitation of combatants

The goal of the project is to improve the effectiveness of the rehabilitation of combatants by means of trauma-focused cognitive behavioral therapy (TF-CBT) by automating these sessions using an intelligent system of a virtual interlocutor (chat bot).

Automation of elements of therapy is a way to solve the problem of quick provision of psychotherapeutic help. The leading chat bots available today have significant shortcomings: purposeful dialogue models (closed domain) implement separate TF-CPT scenarios without taking into account the user's characteristics and supporting arbitrary communication, which significantly reduces the therapeutic effect of using the development; open dialogue models (open domain) are close to natural communication, but due to the lack of forming a therapy scenario, they are used exclusively as a virtual interlocutor. Thus, current developments have a narrow range of tasks to be solved and cannot be used for autonomous rehabilitation of combatants.

The result of the project is a set of software that allows you to conduct a dialogue with the user in natural language by means of text or voice messages. The system takes into account the context of the conversation and implements TF-CPT methods to alleviate the consequences of being in stressful situations (in particular, combatants and military personnel). The specificity of the chatbot system lies in the need to ensure the required level of quality of responses to user requests, which are required to maintain dialogue and solve user problems. With this in mind, the structure of

the system includes a number of mechanisms that control the relevance of responses. The system is implemented in the microservice paradigm.

The work uses leading methods and technologies of machine learning: KeyBERT for identification of names, characteristics and events in the text, Cosmica for identification of emotions in expressions. Grammatical error correction using the BERT Gector model is included in the pre-processing of input information. DialoGPT is used to generate relevant answers and support dialogue, which is necessary for conducting psychotherapeutic sessions with the user in real time. Response quality is ensured by collecting clean, consistent data, fine-tuning the model, and integrating DialoRTP to evaluate the quality of chatbot responses and improve the existing dialog generation model by re-ranking generated response candidates.

A significant volume of possible training scripts on various topics and user requests complicates the task of configuring and training machine learning models with the required amount and quality of data for the desired topics of customers. In this regard, a feedback approach and a moderating mechanism with deferred regular retraining, taking into account the quality assessment and corrections of the moderators, are proposed for the organization of setting up and training the machine learning model.

To eliminate incorrect chatbot answers, which are possible after the use of different models, components and dependencies of various psychotherapeutic tasks set to the system, or insufficient volume of training data on the selected topic, and in order to improve the quality of answers, a context synchronization mechanism is implemented, which brings data to a single format supported by third-party models, and a mechanism for assessing the relevance of chatbot output data, which automatically evaluates, aggregates, accumulates results, and packs data for retraining the model.

State of development. The interaction of subsystems and machine learning models was designed and implemented with the help of a scheduler and a task router, which increases the efficiency of data processing due to the parallel processing of data by the mechanisms selected by the router. A web interface and a software prototype for dialogue in English have been created. The practical use of the developed system is currently expedient with constant moderation by experts of irrelevant chatbot responses during a psychotherapy session with users. The continuation of this work is the improvement of the context synchronization mechanism and the automation of the mentioned procedures, which require the involvement of the operator. This will allow in the future to abandon the moderation of user replicas and the vast majority of TF-CBT system session methods.

Conclusions

The Strategy for the Development of Artificial Intelligence in Ukraine is an important document that regulates the main areas of conducting fundamental research and obtaining new knowledge for the creation of breakthrough technologies in this field, taking into account Ukrainian realities. We consider the adoption of such a document an important state matter.

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