



INTERNATIONAL
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CATALOG

IITU RESEARCH PROJECTS

ISSUE 1



www.iitu.edu.kz



Almaty, Manas st. 34/1

Almaty, 2021

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PASSPORT

OF THE SCIENCE RESEARCH PROJECT

1. Program/project name

IRN №BR05236517 «Platform of digital transformation of business processes of national economy» (Program-targeted funding of the Ministry of Education and Science of the Republic of Kazakhstan on scientific, scientific and technical programs for 2018-2020)

2. Project supervisor, contacts

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3. Title of priority direction of science development

Information, telecommunication and space technologies.

4. The aim of the project

Creation of a scientific and technical base for the digital transformation of the national economy in order to ensure the effective use of national resources for the development of the country's production and ICT potential.

5. Brief abstract of the project

According to the analysis of the subject area, the existing platforms are not intended to generate specific practical systems based on specific objects of labor and means of labor, or their ability to generate new systems for new processes, the problem of the area is low, i.e. limited. Therefore, a lot of work is required to adapt to new processes. In order to build a platform that eliminates the shortcomings of existing platforms, an adequate model must be found. This project proposes building a platform based on a new concept or model of a business process. This model should ensure the generation of a business process model, and then, based on this business process model, the generation of a business process automation system.

Direction: Development and creation of a platform that forms breakthrough trends in the development of information and communication technologies, which will improve the quality of innovation and technology management in various sectors of the economy of Kazakhstan. The developed platform can be used as a service environment for a transport and logistics

cluster, the research results can be used to meet the information needs of the scientific community and for any other information and analytical purposes. The capabilities of the system for processing big data allows us to conclude that their use can facilitate the activities of the services of companies whose work is related to customer service, marketing, competitive intelligence, external and internal corporate communications, the processing of analytical financial information, etc.

Scientific novelty: in the development of mathematical and software for computers, complexes and computer networks, one of the most important tasks is the creation and maintenance of software for various purposes, including software designed to organize the interaction of programs and software systems. One of the areas of research carried out in this area is the study of the service-oriented approach and technology of web services in relation to the construction of loosely coupled systems that ensure the interaction of information systems of one platform. The novelty of the research is the development of methods and algorithms that increase the efficiency of the functioning of software tools by integrating web services and at the data level.

Application area. The target consumers of the results obtained are the logistics sector of the economy of Kazakhstan.

6. Description of a significant scientific achievement

During the study, scientific developments were obtained in the field of digitalization of business processes of the national economy. So, in the first year of the study, as a result of analytical reviews of the features of business processes and on the basis of the constructed incremental-iterative methodology for simplifying the goal and research methodology, the study was reduced to the fact that as a subject and problem area for research in order to create an automation platform (a not forming the description and automation of business processes in general), the problem area of logistics is accepted. In the first year of the study, tasks were identified for the development of a digital logistics platform, an analytical review of platforms for automating logistics business processes was carried out. The structure

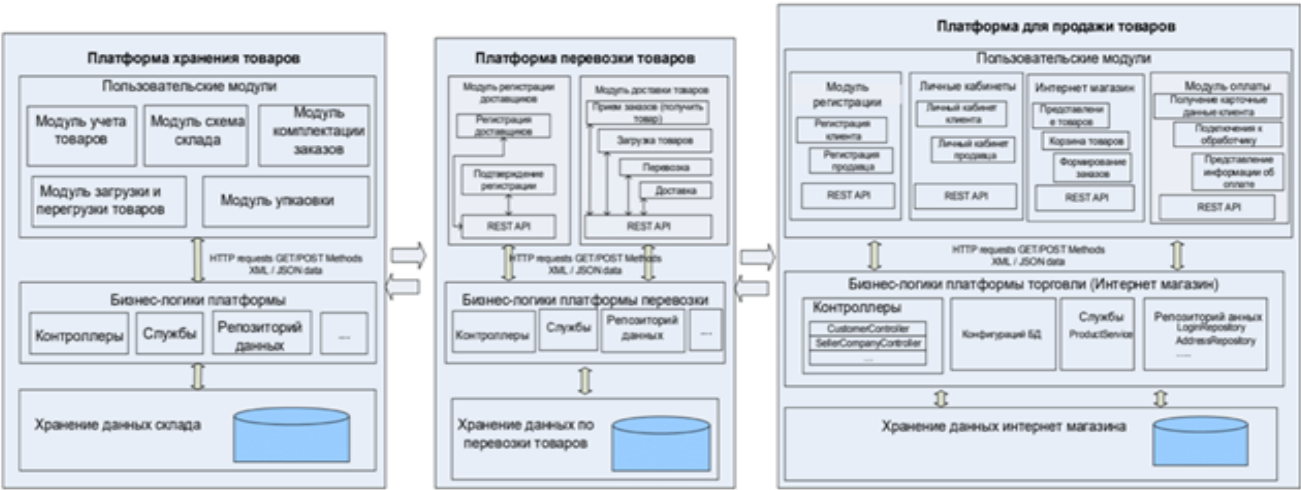


Figure 1 - Integrated Logistics Platform Architecture

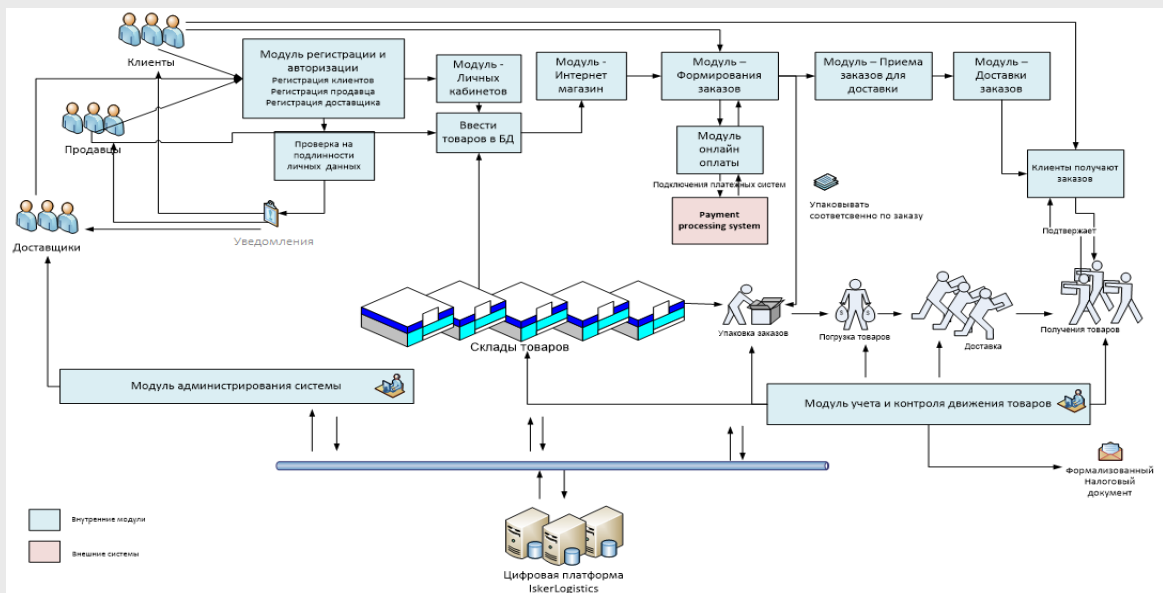


Figure 2-Functional architecture of the integrated logistics platform

and architecture of the platform have been determined, which make it possible to more effectively support the process of creating automation systems for logistics business processes.

In the second year of the research, an analysis of issues and

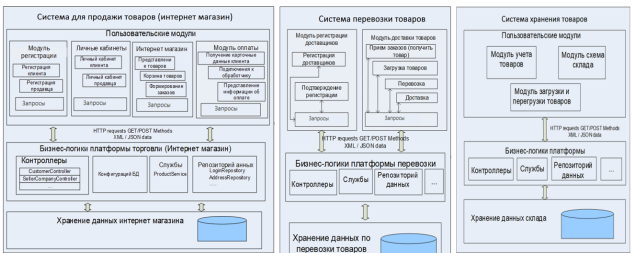


Figure 3 - Architecture of an integrated logistics platform

scenarios (schemes) of automation was carried out, an effective way of solving the automation problem was found. Due to the wide variety of logistics processes, it was decided that it would be more expedient to build a platform for different instances of the problem area. A methodology for creating systems is proposed that covers all stages of the process. A methodology for creating systems is proposed, which consists of a combination of known methods used in the process and technology of creating systems. Also, a comparative and critical analysis of software tools that provide the creation and automation of processes for creating automation systems for performing practical tasks was carried out.

In the third year, an integration study was carried out. The result was the integration of systems at the data level, at the web service level (based on orchestration and choreography), and at the software level. The next step in the study was the analysis of the tools that are used to visualize data and reports. For the visualization of logistics data, the technology was used - OLAP (Online Analytical Processing) - multidimensional operational data processing using a multidimensional data model.

According to the results of the project, 25 articles were published, including 17 articles indexed in the Web of Science

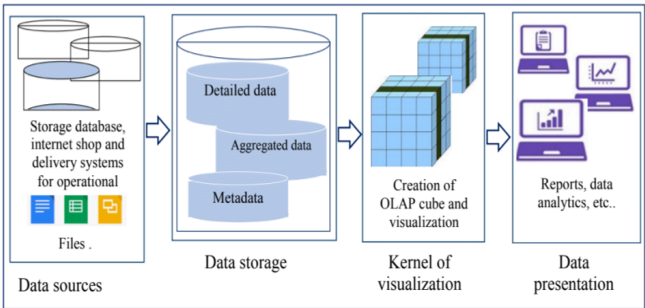


Figure 4 - Processes of data visualization of the logistics system

and Scopus databases, 8 articles included in the list of publications recommended by Committee for Control in the sphere of Education and Science of MES RK; 2 textbooks and workshops, 5 acts of testing, approbation and implementation were received.

7. Status of legal protection

There are 3 certificates of inclusion of information in the state register of rights to objects protected by copyright:
- № 13985 dated "December 21", 2020 "System of electronic trading platform and transportation of goods "Isker Logistics". Uskenbaeva R.K., Kuandykov A.A., Uatbaev M.M., Tolegenov A.M., Mukazhanov N.K., Kalpeeva Zh. B., Mustafina A.K., Kasymova A.B.
- №13949 dated "20" December 2020 "Mobile application for electronic trading platform and transportation of goods "Mobile Isker Logistics". Uskenbaeva R.K., Kuandykov A.A., Rakhmetulaeva S.B., Karabaliev E. N., Adibek T.K., Bolshibaeva A.K.
- №13969 of "December 21", 2020 "Smart warehouse system "Isker Warehouse". Uskenbaeva R.K., Kuandykov A.A., Satybal-dieva R.J., Moldagulova A.N., Alipbekov A. S., Baybatyrov D.A., Bolshibaeva A.K.

8. Commercialization/practical application possibilities

This project is subject to further commercialization.

PASSPORT

OF THE SCIENCE RESEARCH PROJECT

1. Program/project name

IRN №APO5132546 «Basic and derivative objects for ordered and generic structures and their elementary theories (GF)» (grant funding from the Ministry of Education and Science of the Republic of Kazakhstan for scientific and (or) scientific and technical projects for 2018-2020)

2. Project supervisor, contacts

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3. Title of priority direction of science development

Information, telecommunication and space technologies, scientific researches in natural sciences field.

4. The aim of the project

Studying model - theoretical properties of ordered and generic structures and their elementary theories, their description and classification on the basis of derivative objects.

5. Brief abstract of the project

The project subjects concern to one of important branches of mathematical logic – the model theory studying relations between formal language and its interpretations, or models.

The project is directed on solving the problem of classification of algebraic systems and their elementary theories as a whole, concerning basic characteristics, and for a series of basic classes of algebraic systems, such as various kinds of weakly o-minimal structures, universal algebras and groups. Within the framework of the project it is supposed: obtaining a classification of algebraic systems on the basis of their derivative structures; a classifying the algebras of distributions of formulas of a theory; an estimating an expressive power of generic classes and their influence on structural properties of theories; classifying the countable models of complete theories. Themes of researches of the project are actual now for development of the theory of algebraic systems and are intensively studied in the leading world mathematical centers. The importance of the project in a national scale is determined by preparation of highly skilled scientific specialists in the field of mathematical logic. The importance of the project in an international scale is determined by obtaining new scientific results which will be submitted for publication to international peer-reviewed journals.

Results obtained in the framework of the present project will encourage a further development of the general model theory that influences on science development in the field of knowledge. Expected social and economic effect will be in rising the intellectual potential of the country, preparing new personnel and possible further applying obtained results to such applied fields of knowledge as the general theory of relational databases and formal methods of developing the software.

6. Description of a significant scientific achievement

We prove a theorem which confirms Vaught's Conjecture for

weakly o-minimal theories of finite convexity rank:

Theorem 1. Let T be a weakly o-minimal theory of finite convexity rank in a countable language. Then exactly one of the following possibilities holds:

- (1) T is countably categorical;
- (2) T is Ehrenfeucht, namely T has k countable models, where $3 \leq k < \omega$;
- (3) T has countably many countable models;
- (4) T has a continuum of countable models.

7. Status of legal protection

All results are published in the open press and do not require patenting.

8. Commercialization/practical application possibilities

The research carried out was of a purely theoretical, fundamental nature. The results obtained can be used for further research in model theory, as well as in other branches of mathematics. Research results are applicable in such areas of computer science as general theory of relational databases, hybrid systems and formal methods of researching information systems.

Processes of the university's organizational structure in accordance with the IDEF01 notation:

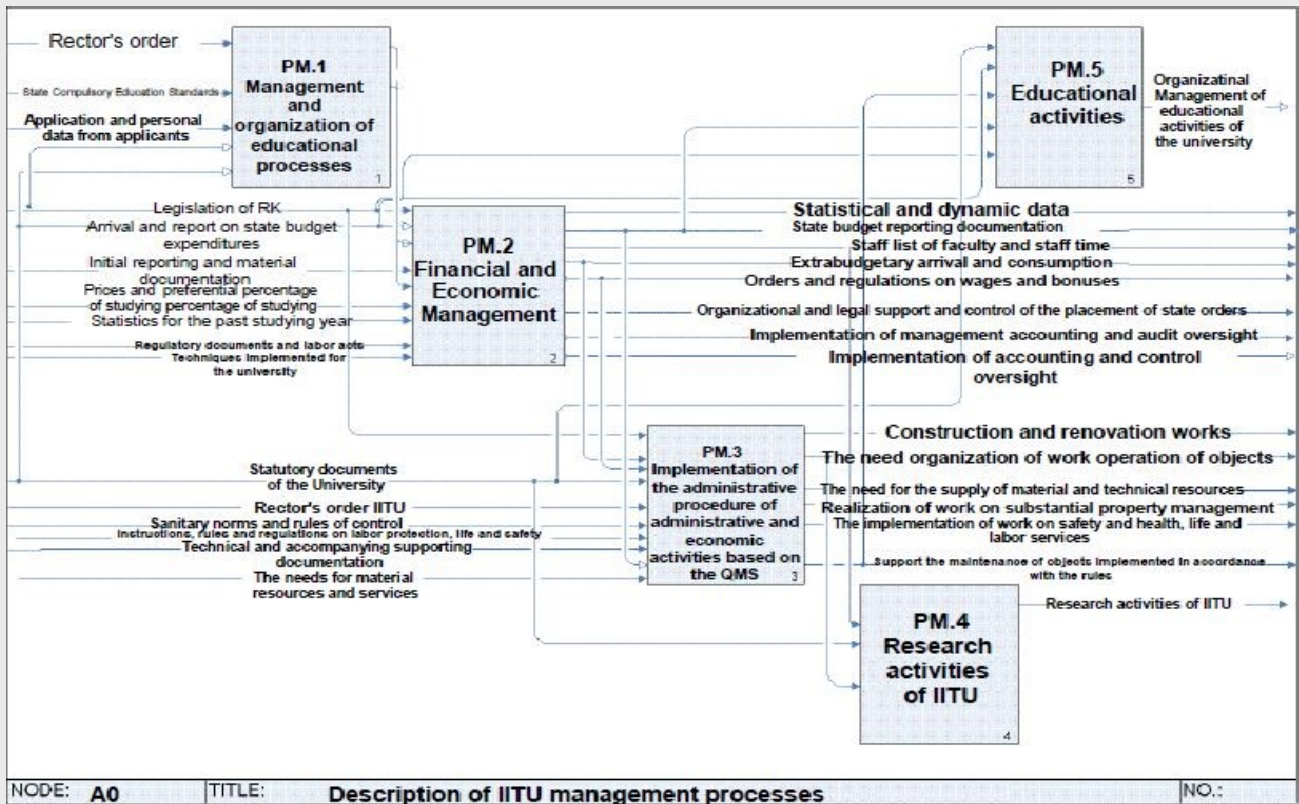


Figure 5 - IDFO model of process management of IITU University

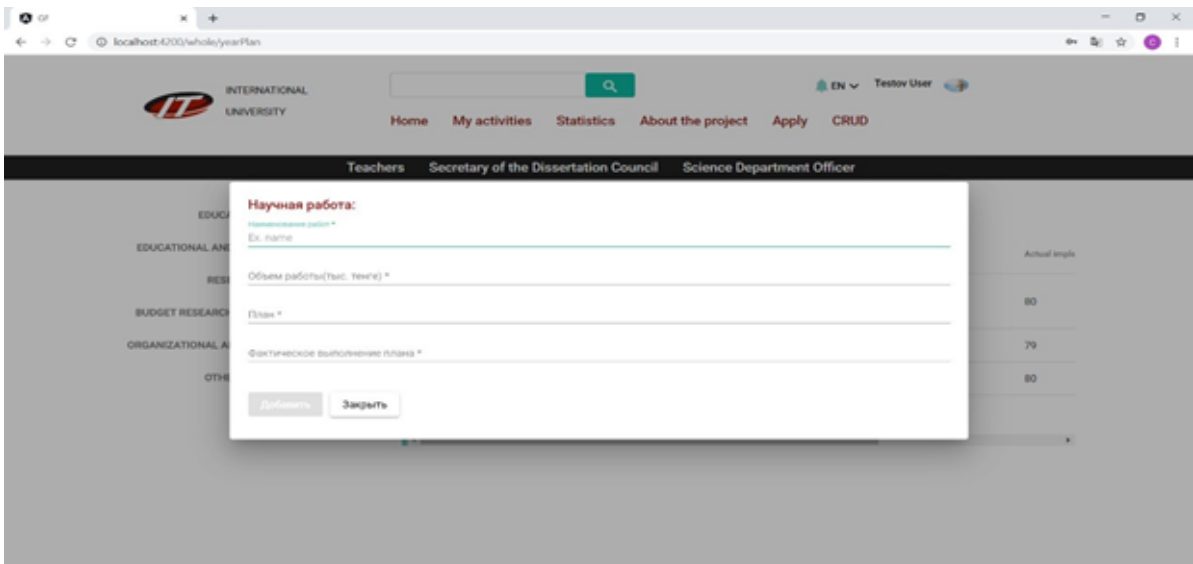


Figure 6 - User interface when entering scientific papers

7. Status of legal protection

According to the results of the research, a Certificate of entering information into the state register of rights to objects protected by copyright No. 13560 of November 27, 2020 "SAM System" was obtained. Uskenbayeva R. K. Kuandykov A. A., Satybaldieva R.Zh., Moldagulova A.N., Kalpeeva Zh.B., Kasymova A.B., Kuanys R.K., Abilmazhinov S.T., Zhetpisbayeva S.D., Abdualiev D.G.

8. Commercialization/practical application possibilities

The results of the project can be commercialized

PASSPORT

OF THE SCIENCE RESEARCH PROJECT

1. Program/project name

IRN № AP05132050 «Development of the “improved” tools promoting qualitative and efficient analysis of unstructured data» (grant funding from the Ministry of Education and Science of the Republic of Kazakhstan for scientific and (or) scientific and technical projects for 2018-2020)

2. Project supervisor, contacts (e-mail)

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3. Title of priority direction of science development

Information, Telecommunication and Space Technologies, Natural Sciences Research.

4. The aim of the project

The scientific novelty of the work is as follows:

- 1) formalizing the problem of existing approaches, methods, and tools to the problem of finding the structure of big data;
- 2) development of a methodology, standardized interfaces of data presentation from various sources;
- 3) development of algorithms for data analysis that contribute to the definition of objects/characteristics;
- 4) development of a tool that allows solving problems of searching for structure in data using classical and modern machine learning algorithms.

Field of application: e-commerce, e-retail, online banking, Internet

acquiring, mining and metallurgical complex and oil and gas industry, etc.

6. Description of a significant scientific achievement (include illustrative material: figures, graphs, tables, etc.)

1. As part of the implementation of the research project, we made an overview of the largest online stores such as Ikea, Alibaba, Amazon, Mediamarket, Kaspi.kz, Technodom, etc. The analysis showed that the product catalog contains hidden information about the relationships between entities, types, and values of properties of entities, abstract models, and properties characteristic of each format that together can be used to create a predictive model for detecting a structure from a certainly unknown catalog. Thus, it becomes possible to automate the process of data transformation from one format to another that will enable the online store to significantly increase its supplier base and product catalog:

– a systematic analysis of the features of existing methods, technologies, and tools when working with an in-depth analysis of big data was carried out;

– the problem was formulated and the corresponding requirements for a unified format for converting data from various sources by storage of heterogeneous data characterized by various scenarios were formalized;

– a technical specification for the designed interfaces has

been developed;

– we have formed the main idea, i.e. to classify a new unknown early product in a known early format based on static information textual and digital (statistical data inference) and compare it with the models in the system;

– we formalized the problem statement. The Naive Bayes method is taken as the basis for formalizing the problem statement.

2. A clustering algorithm which includes the sequential application of algorithms for lemmatization, tokenization, stop-lists, tf-idf, singular value decomposition was developed. To find cluster groups, an algorithm based on the DBSCAN method and the use of Euclidean distance to determine the distance between objects was developed. The study has proved that the accuracy of clustering depends on the ratio of the number of clusters to the number of objects in one cluster. The number of clusters is determined by the radius of each document, and the number of objects in one cluster is determined by the average number of general objects (words or terms, in this case). The clustering algorithm described by us can be used not only for classifying groups but also for other purposes, such as finding association rules and groups of documents that are similar in semantic text, etc.

The effectiveness of the developed machine learning technologies in various business cases has been experimentally analyzed. Based on the calculated quality scores, the most effective machine-learning model was selected for each of the cases.

3. Developed an information system prototype as a tool that contributes to high-quality data analysis to implement a solution to the task; to do this, a microservice architecture based on Spring Cloud was used (Figure 7).

The purpose of our tool is to obtain multi-format data from all the proposed sources and to categorize into the basic format with subsequent implementation in the database in a single form.

To solve this task, testing was carried out in the following stages: testing and evaluating the results within the selected key indicators. Data collection, data categorization process, data formatting, results collection, insertion of data into a template were carried out.

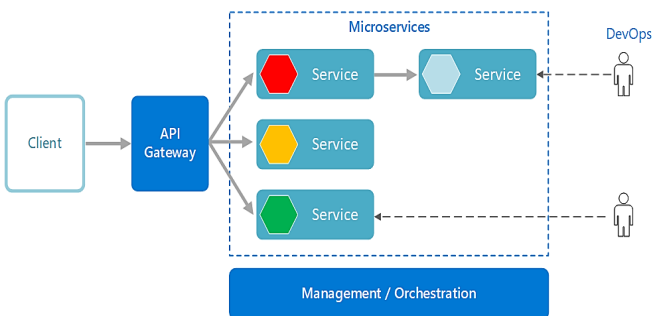


Figure 7 – Microservice architecture based on Spring Cloud

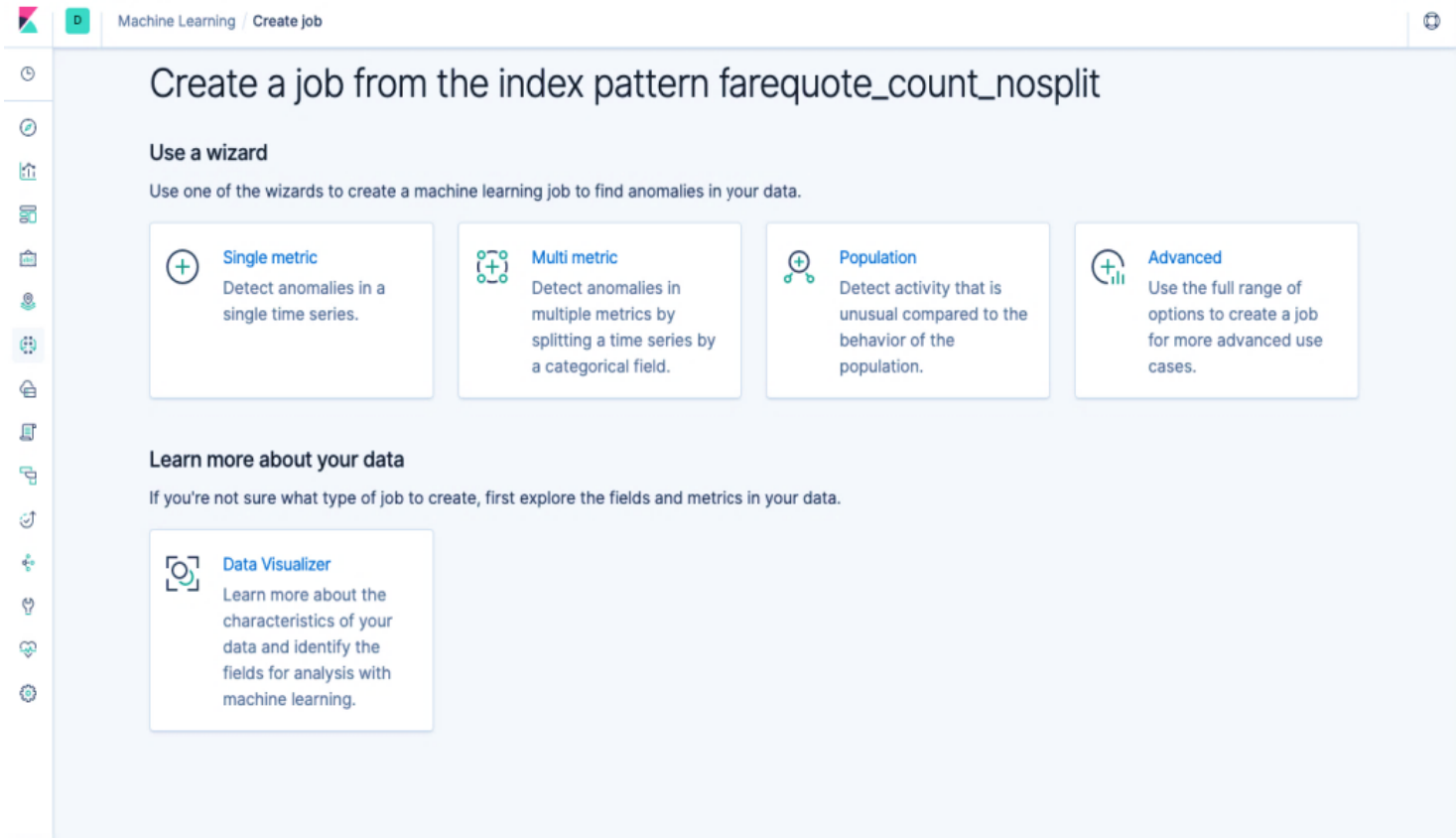


Figure 8 – System testing algorithm

04. Experimental analysis and verification of the developed models, methods, algorithms, and software package on the formed business problem, taking into account the correlation of various metrics, was carried out. As a result of testing the developed models, algorithms, and software complex, the data correlation analysis was obtained. To date, the result has shown over 70%. Also, an experimental check of the developed models, methods, algorithms was carried out using the built-in ELK functionality for data import. Using the built-in ELK functionality for importing data, we will embed the data for processing (Figure 8).

In the process, technologies were used such as Python, Java, Elastic Search, Kibana Elasticsearch (E – elastic, L – logstash, K – kibana), a replicated free software search engine developed by Elastic, together with related projects, a mechanism for collecting data and analyzing logs Logstash and Kibana analytics and visualization platform; these three products are intended to be used as an integrated solution called «Elastic Stack».

5. As a result of the scientific research, articles were published in scientific journals recommended by Committee for Control in the sphere of Education and Science of MES RK the MES RK and in peer-reviewed foreign scientific journals indexed in the Scopus and Web of Science database.

7. Status of legal protection

According to the research results:

- 1. Bektemyssova G.U. "Improved" tool promoting qualitative and efficient analysis of unstructured data. Certificate of entering information to the State Register of Rights to objects, protected by the Copyright. No. 13562 of November 27, 2020.
- 2. "Improved" tool promoting qualitative and efficient analysis of unstructured data. Implementation act of November 10, 2020.

8. Commercialization/practical application possibilities

Project results can be commercialized.

PASSPORT

OF THE SCIENCE RESEARCH PROJECT

1. Program/project name

IRN № AP05132736 «The modeling of soil degradation process and the development of autonomous measuring equipment, which is non-destructive of monitoring and equipped with software package in real time» (grant funding from the Ministry of Education and Science of the Republic of Kazakhstan for scientific and (or) scientific and technical projects for 2018-2020)

2. Project supervisor, contacts

Rysbaiuly Bolatbek, d.ph.-m.s. Professor, e-mail: b.rysbaiuly@iitu.edu.kz

3. Title of priority direction of science development

Information, telecommunication and space technologies, scientific research in natural sciences

Scientific research in natural sciences: mathematical and computer modeling in mathematics, physics and astronomy.

4. The aim of the project

The purpose of the work is to develop an iterative method for calculating the heat and mass exchange process in the soil, namely:

- a) construct a nonlinear direct and conjugate difference problem for the system of heat and moisture conductivity of the soil,
- b) to build an approximate formula for calculating the coefficient of heat and moisture conductivity of the soil based on the measured data on the earth's surface and the system of equations for heat and mass transfer,
- c) build a pilot version of a measuring device that can output temperature and moisture content at the available border of the investigated area,
- d) to carry out numerical calculations confirming the convergence of the developed methods.

5. Brief abstract of the project

The novelty of the project is as follows:

- a) direct and conjugate difference problems for a nonlinear equation with partial derivatives of moisture and heat transfer are constructed,
- b) an approximate method for calculating the coefficient of thermal conductivity of soil is built, based on a system of differential equations for the transfer of moisture and heat, and measured data on the earth's surface,
- c) a pilot version of a measuring device capable of delivering temperature and moisture content at the accessible border of the investigated area has been developed;
- d) a priori estimates are obtained for solving the nonlinear direct and conjugate difference problem, on the basis of which the convergence and stability of the difference problems are proved, and the boundedness of the approximate values of the sought parameters is proved,

e) a software product that can find an approximate formula for calculating the coefficient of heat and moisture conductivity of the soil is compiled and numerical calculations are performed.

Analogues: there are methods for finding the thermal conductivity coefficient based on the thermal conductivity equation, and the soil diffusion coefficient is based on the moisture transfer equations.

Advantages over well-known analogues: The method of simultaneous determination of the thermal conductivity coefficient and the soil diffusion coefficient based on the heat-mass transfer equations was first time developed in this project.

Field of application: heat engineering, agrochemistry, soil science, construction, scientific research.

6. Description of a significant scientific achievement

The following results were obtained for the years 2018-2020:

- 1) on the basis of the model of heat and moisture transfer and the measured value of moisture and heat, an approximate iterative method for calculating the coefficients of thermal conductivity and moisture conductivity of soil has been developed,
- 2) developed a software product capable of finding the coefficients of thermal conductivity and moisture conductivity of the soil,
- 3) using experimental data, numerical calculations were carried out to determine the desired soil parameters,
- 4) a priori estimates are obtained for solving direct and conjugate difference problems,
- 5) the convergence and stability of difference schemes are proved,
- 6) the boundedness of the approximate values of the coefficients of thermal conductivity and moisture conductivity of a porous medium has been proved,
- 7) a schematic diagram of a device capable of simultaneously measuring moisture and temperatures of the soil and the environment has been developed,
- 8) the control and measuring device is provided with its own software product capable of processing measured data and outputting the result to an external medium.

As a result of the scientific research, 7 master's theses were defended, and one PhD doctoral dissertation is also being prepared for completion. 5 articles were published: 1 article in a peer-reviewed scientific journal with CiteScore 8.2 in the Scopus database of percentile 96% (Web of Science, Q-1, IF 4.947); 3 articles in a peer-reviewed scientific journal with CiteScore percentile in the Scopus database; 1 article in

scientific publications recommended by the Committee for Quality Assurance in Education and Science of the Ministry of Education and Science of the Republic of Kazakhstan. Also, the results of the research were reported in the Republican and 7 International scientific conferences and symposium. 1 copyright certificate and 1 certificate of entering information into the state register of rights to objects were received. 1 monograph was published.

7. Status of legal protection

List of copyright certificates:

1 Copyright certificate N 3852. Iterative method for calculating the linear coefficient of soil moisture conductivity (Итерационный метод расчета нелинейного коэффициента влагопроводности почвы) // A.D. Adamova, A.A. Adamov, B. Rysbaiuly: publ. 04.06.2019.

2 Certificate of entering information into the state register of rights to objects protected by copyright N 11486. Iterative method of calculation for the system of nonlinear diffusion coefficients and moisture conductivity of soil moisture (Итерационный метод расчета для системы нелинейных коэффициентов диффузий и влагопроводности почвенной влаги) // A.D. Adamova, A.A. Adamov, B. Rysbaiuly: publ. 30.07.2020.

8. Commercialization/practical application possibilities

After the final version of the measuring device is completed, the issue of commercializing the project result can be considered.

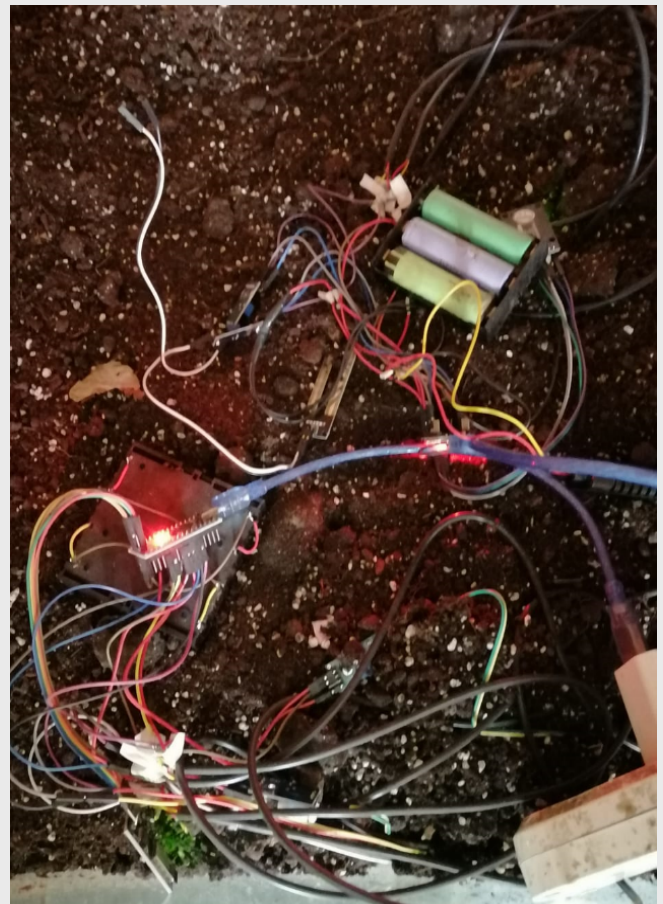


Figure 9 - Pilot version of the measuring device

PASSPORT

OF THE SCIENCE RESEARCH PROJECT

1. Program/project name

IRN № AP05135692 «The development of virtual electronic laboratories with elements of augmented and virtual reality technologies for studying physics in secondary educational institutions (GF)» (grant funding from the Ministry of Education and Science of the Republic of Kazakhstan for scientific and (or) scientific and technical projects for 2018-2020)

2. Project supervisor, contacts

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3. Title of priority direction of science development

Information, telecommunications and space technologies, scientific research in the field of natural sciences

4. The aim of the project

To develop a virtual electronic laboratory with a set of practical and theoretical tasks, as well as animations with elements of augmented and virtual reality technologies for studying physics in secondary educational institutions.

5. Brief abstract of the project

Methodology: Flexible software development methodologies, methods of computer modeling and object-oriented programming.

Novelty: Within the framework of the project, a virtual electronic laboratory has been developed, which provides access to theoretical and practical tasks in physics, as well as animations from the high school program, implemented in the form of computer applications with elements of augmented and virtual reality for a more detailed study of the physical processes taking place using three-dimensional visualization.

Brief description of the results: The developed virtual electronic laboratory is presented, which includes practical and theoretical tasks in physics of the secondary school program, as well as a set of animations. Tasks are implemented as separate applications that provide access to three-dimensional visualization of the studied processes using augmented and virtual reality technologies, as well as ready-made solutions to problems. A set of 3D animations is presented in the form of an electronic textbook.

Scope of application: The main field of application of the developed virtual electronic laboratory is secondary educational institutions.

6. Description of a significant scientific achievement

As a result of the project, a software application of a virtual electronic laboratory with elements of augmented and virtual reality technologies was developed, which includes a set of theoretical tasks in physics in the form of laboratory works, tasks, animations and tests. All components of the virtual electronic laboratory are made in the form of separate modules with three-dimensional visualization of the studied

processes and phenomena. A framework was developed that allowed us to expand the set of recognized gestures of the Leap Motion motion controller. We also wrote documentation on the work done, a description of each laboratory work and the entire system as a whole. The results of the implementation of the developed virtual laboratory in the educational process are presented, as well as the assessment of the results achieved by analyzing the performance and assimilation of the material when using a virtual electronic laboratory using virtual and augmented reality technologies.

7. Status of legal protection

Bases of testing and implementation of the results obtained:



Figure 10 – The main window of the developed application with the interface in English

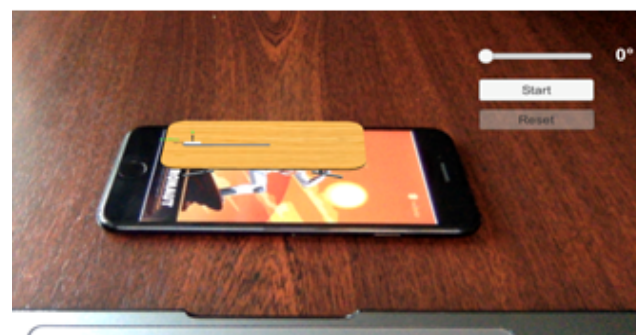


Figure 11 – Task visualization window in augmented reality mode



Figure 12 – 3D scene of the laboratory work
«Comparison of molar heat capacities of metals»

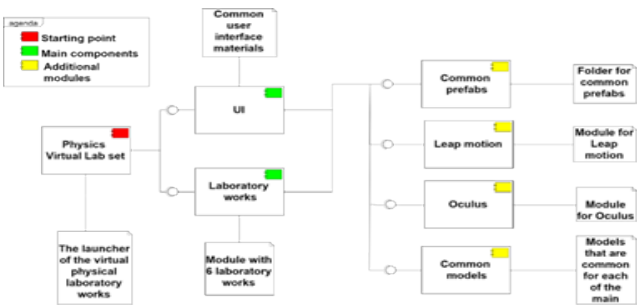


Figure 13 – Diagram of the components of the virtual physical laboratory

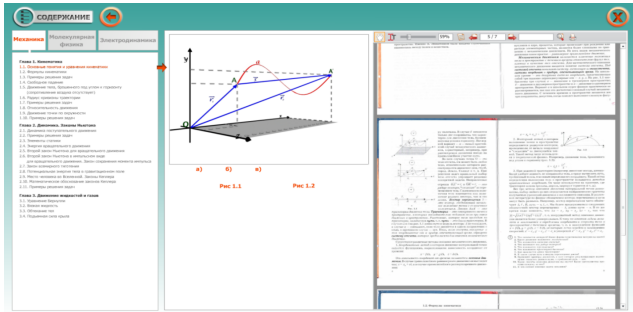


Figure 14– Tutorial window with animation demonstration (start of the process)



Figure 15 – Screenshot of the theoretical task

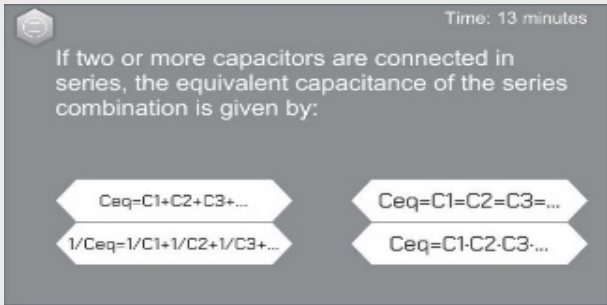
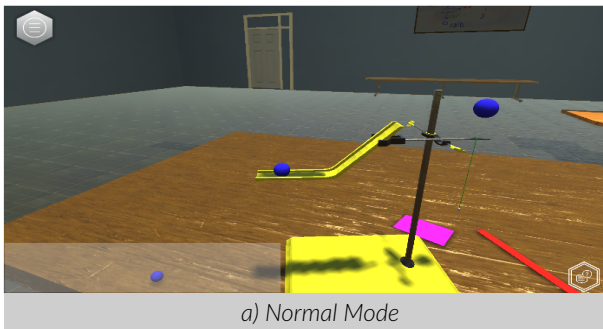
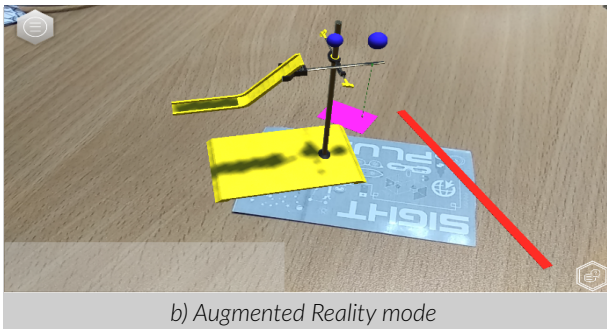


Figure 16-Screenshot of the test task



a) Normal Mode

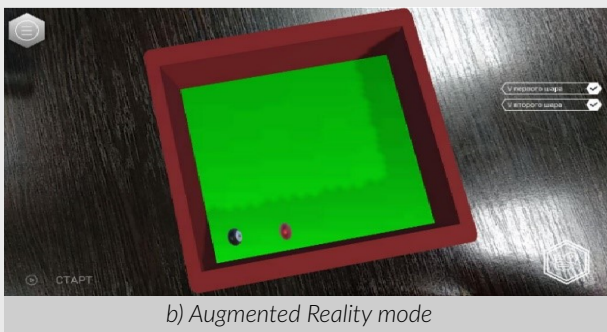


b) Augmented Reality mode

Figure 17 - Laboratory work «Determining the moment of inertia of the ball»



a) Normal Mode



b) Augmented Reality mode

Figure 18 – Task from the software package

NC JSC «Republican School of Physics and Mathematics» (Almaty) and Secondary School-Gymnasium named after Kadyrgali Kosymovich Zhalaïri (Almaty region, Koksu district), as well as in foreign and domestic rating scientific publications and international scientific and practical conferences.

According to the results of the work for 2018-2020, 54 papers were published, including 6 articles in journals indexed by Scopus and WoS, 11 articles in journals recommended by CCSES, 17 articles published in collections of International conferences and 7 articles in journals of Kazakhstan. 7 certificates of state registration for copyright objects (computer

program) were obtained. 4 implementation certificates were received.

8. Commercialization/practical application possibilities

This project is subject to further commercialization.

PASSPORT

OF THE SCIENCE RESEARCH PROJECT

1. Program/project name

IRN №AR05134597 « "Software and hardware complex for the analysis and monitoring of climate and environmental changes" (grant funding of the Ministry of Education and Science of the Republic of Kazakhstan for scientific and (or) scientific and technical projects for 2018-2020)

Project supervisor, contacts

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2. Title of priority direction of science development

Information, telecommunications and space technologies, scientific research in the field of natural sciences.

3. The aim of the project

Creation of a system for monitoring the climatic and ecological state of the environment using stationary and mobile sensors for data collection, transmission and processing (Big Data). Climate and environmental monitoring, as well as data collection services related to climate changes and fluctuations, require the use and development of modern technical means of observation (remote, radio-electronic), mobile and automated data transmission and processing systems

4. Brief abstract of the project

The authors have developed high-performance algorithms and tools for intelligent processing of big data (Bigdata). During the implementation of the project, tools for analyzing large-volume data were created, which served to further develop high-performance intelligent technologies in Kazakhstan. The successful achievement of the project results created the prerequisites for improving the competitiveness of the information technology market of the Republic of Kazakhstan through the use of its own scientific personnel and material and technical resources. The results of the study were used to meet the information needs of the scientific community and for any other information and analytical purposes. The capabilities of Big Data processing systems implemented in the project facilitate the activities of the services of companies whose work is related to customer service, marketing, competitive intelligence, external and internal corporate communications, processing of analytical financial information, etc., which confirms the practical significance of the project. The social effect of the Project is to train scientific personnel, to increase the interest and broad involvement of young scientists in the field of research, as well as to use scientific and applied research results in the educational process.

5. Description of a significant scientific achievement

Topology of LoRa Data Network (Figure 19) have been developed.

Measuring stations collect data from sensors and transmit it to the nearest gateway. In addition to the gateways, LoRa has a control server that organizes the transmission of data from end devices to the consumer and from the consumer to the end devices.

The atmospheric observation network expects to use 20 stationary observation posts in the city of Almaty.

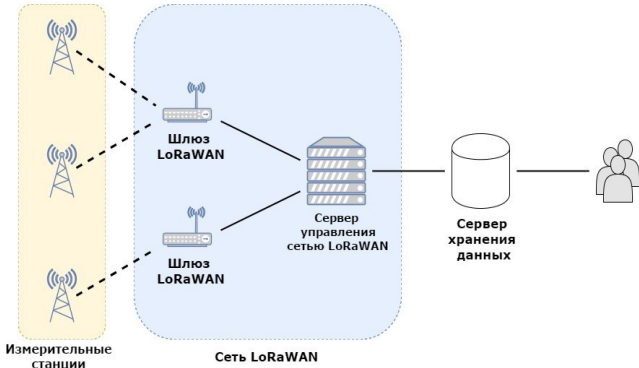


Figure 22 - Topology of LoRa Data Network

Atmospheric air monitoring can be carried out:

- incomplete program
(3 times a day - 07, 13, 19 hours local time);
 - complete program
(4 times a day - 01, 07, 13, 19 hours local time);
 - in continuous mode.

Assess the capabilities of LPWAN communications networks to transmit data from fixed and mobile posts that collect key-indicators.

The developed scheme, implemented on a modern elemental base, will provide the statistics necessary for the analysis of the automatic network to collect environmental and meteorological information at different times of the day, under different weather conditions (Figure 20a).

To test the parameters of the data module the SemtechLora-Calculator program (Figure 20b) is used.

For visual statistics GoogleColaboratory were used. This cloud service, aimed at simplifying research in the field of machine and deep learning.

Air pollution data is presented as a csv file with 11,403 samples of training data (Figure 20c).

A real physical model of pollution spread, and numerical simulations of pollution spread is built (Figure 21).

Once the activation procedures have been completed, the final node is ready to transmit sensor readings at a set interval. Once connected, the data is converted into a payload format in the form of hex code (HEX).

The scientific and practical results of the project are reflected in 10 articles in the journals recommended by MES RK and 11 articles in the journals indexed in the databases of WoS and Scopus.

6. Status of legal protection

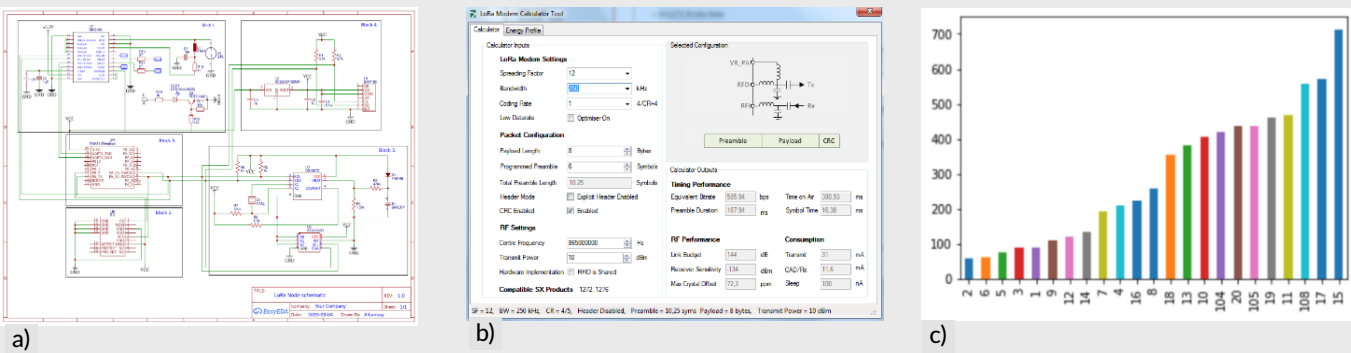


Figure 20 - (a) LoRa Node (End Device),b) SemtechLoraCalculator User Interface, (c) Air Pollution Data

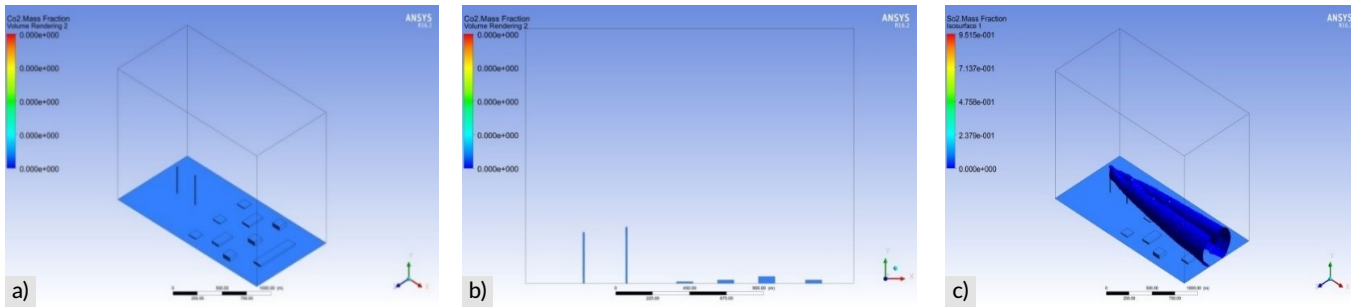


Figure 21- Pipe Geometry: (a) XY, (b) XY plane. (c) Analysis of the movement of the pollutant gas plume on a scale of 1: 1 (SO2 concentration isolini), in the event of obstacles

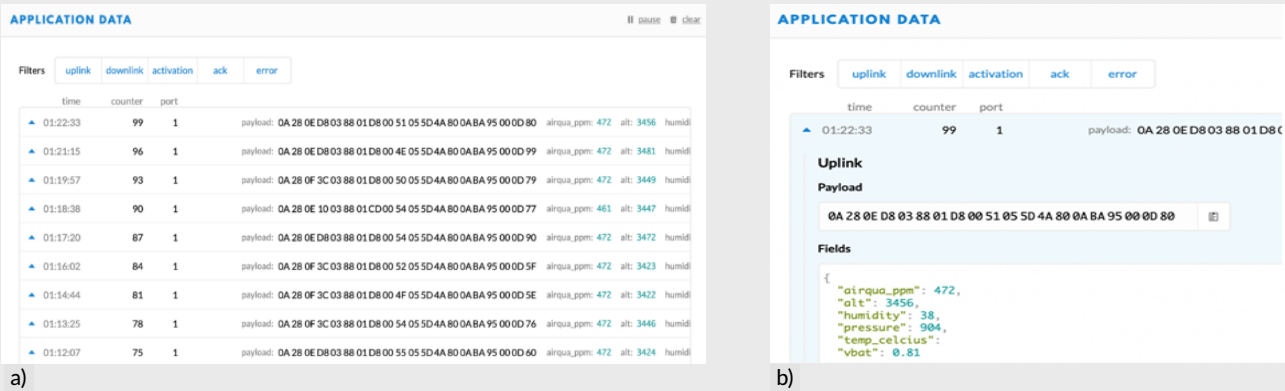


Figure 22 - (a) A payload in TTN, b) The payload received on the console of the TTN app from the end site.

7. Commercialization/practical application possibilities

Operational decision-making based on big data processing (Bigdata) with the use of mathematical models of advanced

monitoring and forecasting leads to rational planning and use of natural resources, to reduce costs, thereby allowing to obtain a significant economic effect.



Figure 26 - Copyright certificate

PASSPORT

OF THE SCIENCE RESEARCH PROJECT

1. Program/project name

IRN №AP08857604 «Boundary and inverse problems for the Navier-Stokes equations of homogeneous, inhomogeneous fluids, thermal convection and Kelvin-Voigt equation» (grant funding from the Ministry of Education and Science of the Republic of Kazakhstan for scientific and (or) scientific and technical projects for 2020-2022)

2. Project supervisor, contacts

Otelbaev Mukhtarbay, Academician of the National Academy of Sciences of the Republic of Kazakhstan, Doctor of Physical and Mathematical Sciences, Professor (otelbaevm@mail.ru)

3. Title of priority direction of science development

Scientific research in natural sciences. Fundamental and applied research in mathematics and mechanics.

4. The aim of the project

Aim of the project is to develop the theory of direct and inverse Navier-Stokes problems for homogeneous and inhomogeneous fluids, the Kelvin-Voigt system, thermal convection and magnetohydrodynamics, as well as their approximate solution. On this basis, methods for solving these problems will be developed.

5. Brief abstract of the project

Relevance: Navier-Stokes's equations describing the flow of a viscous incompressible fluid have attracted attention of scientists dealing with problems of solvability of partial differential equations and specialists in the field of numerical analysis for many decades due to their numerous applications. Despite this interest, the question of existence and uniqueness of solution of the non-stationary Navier-Stokes's equations in the case of three spatial variables is still open. Although the theoretical study of boundary value problems for stationary and nonstationary Navier-Stokes's equations has been devoted, starting with the famous works of the French mathematician J. Leray [1-3], published in the 30s of the last century, several thousand or tens of thousands of works, in the theory of Navier-Stokes's equations there are still many "white spots". Researchers have not yet been able to establish a functional class in which it would be possible to prove the global (that is, on any interval $[0, T]$ of time) solvability and uniqueness of solution to an initial-boundary value problem, for example, the Dirichlet problem on the boundary of flow region for three-dimensional unsteady Navier-Stokes's equations. This problem turned out to be so important, complex, and confusing that it was included in the famous list of the seven most important problems of the XXI century ("Millennium Prize Problems").

It is supposed to prove global existence and uniqueness theorems for solution of the initial-boundary value problem (9) - (12). Having previously modified appropriately the generalized method of Gunther-Lichtenstein successive approximations, it is considered to obtain classical solutions of the problem. For this, it is necessary to obtain a priori estimates sufficient for constructing the Green operator, by using the potential estimates and the corresponding S.L. Sobolev embedding theorems. Mathematical model of the considered problem (9) - (12) contains Euler type equation for an incompressible fluid, it is known that the theorem of global

existence and uniqueness of solution in the three-dimensional case has not yet been proved.

For the system considered here, it is expected that the results will be significantly simplified and improved in comparison with the system of Euler equations, due to the modification of the Gunther-Lichtenstein successive approximation methods, which we tested in the theory of other problems and in computational practice. This is due to the better smoothing properties of the control operator, which is here expressed in terms of the Green operator of the Stokes system.

Research on the topic has mainly theoretical and fundamental nature. Their scientific significance is due precisely to the deep level of fundamental nature of the obtained results. Moreover, scientific significance of the proposed research is due to the possible use of deep, modern results of the theory of differential operators for modeling technological processes and the creation of new proprietary research and analysis methods. In Kazakhstan, in recent years, there has been a rapid growth in social demand for fundamental scientific research. This project meets this social demand.

Significance of the project on national and international scale lies in the fact that the studied objects - the Navier-Stokes equations for homogeneous and inhomogeneous liquids and, on the one hand, are of great importance in mathematical science, in mechanics, physics, geophysics, chemistry and other natural scientific disciplines. On the other hand, there is substantial interest in such problems from a purely mathematical point of view. Therefore, the obtained results are relevant and will be understandable to scientists all over the world. And they can be used by them for further research. This allows us to speak about the international scale of the project's significance.

This project is a direct continuation of previously conducted research by the authors, program code AP05132041 (Theory and methods for solving direct and inverse problems for Navier-Stokes's equations and partial differential equations, 2018-2020), grant funding from the Ministry of Education and Science of the Republic of Kazakhstan.

PASSPORT

OF THE SCIENCE RESEARCH PROJECT

1. Program/project name

IRN №AP08857146 «Development of a digital educational platform for remote virtual laboratory work on the study of modern radio systems ultra-high frequencies and extremely high frequency bands using virtual reality technology. (ГФ)» (grant funding from the Ministry of Education and Science of the Republic of Kazakhstan for scientific and (or) scientific and technical projects for 2020-2022)

2. Project supervisor, contacts

Daineko Evgeniya Aleksandrovna, PhD, Associate professor,
e-mail: y.daineko@iitu.edu.kz

3. Title of priority direction of science development

Information, telecommunications, and space technologies. Intelligent Information Technology. Smart technologies in scientific and electronic educational processes.

4. The aim of the project

Development of a digital multilingual educational platform (Kazakh, Russian, English) for remote laboratory work on the study of modern radio systems of ultra-high frequencies and extremely high frequency bands using virtual reality technology.

5. Brief abstract of the project

Methodology: flexible software development methodologies, methods of computer modeling and object-oriented programming.

Novelty: it consists in developing a methodology and creating a digital educational environment for remote study of radio signals of centimeter and millimeter waves, structures and characteristics of radio channel elements, methods for measuring the main characteristics of systems of ranges ultra-high frequencies and extremely high frequency. The functioning of all measuring equipment, as well as the studied elements and devices, will be described using computer models and the corresponding mathematical apparatus.

Brief description of the results: The digital educational platform developed in this project will allow you to study and explore the complex processes of transmitting radio signals of centimeter and millimeter waves, to study the design and characteristics of radio channel elements, to study methods for measuring the main characteristics of systems in the ultra-high frequencies and extremely high frequency bands. Laboratory work will be implemented with remote access using virtual reality technology and will have a user interface identical to real equipment from well-known world manufacturers.

Scope of application: The main field of application of the virtual electronic laboratory being developed is higher education institutions.

6. Description of a significant scientific achievement

As part of the implementation of the stages of the first year of the project, an analysis of the world experience in the development and implementation of a digital educational platform for the study of modern radio systems of the A and B bands,

as well as general requirements for the software package of a digital educational platform operating on a personal computer and intended for remote performance of special radio engineering laboratory work, was presented.

As a result of this stage of work, the ideology of transforming an autonomous virtual laboratory into a laboratory with remote access has been developed.

The method of its division into parts and their adaptation to work in the client-server architecture is proposed.

A variant of the protocol for the interaction of client-server modules of measuring devices and devices with each other and a method for exchanging data over the network has been developed.

In addition, the main requirements for the created software package of the digital educational platform are defined:

- The client part of the software must function on the user's device running any OS (Windows, Android);
- The client part should function on most mobile devices;
- the client part should have the minimum possible volume and not depend on the number of laboratory work, the software implementation of the main part of the measuring devices and the devices under study;
- the server part of the software should allow for a simple upgrade of the models of measuring devices and the devices under study;
- the virtual laboratory should allow for simple modernization and expansion, i.e. the addition of new measuring instruments and devices should not lead to significant processing of the program code;
- virtual laboratory work should adequately describe all the physical processes occurring in the studied devices.

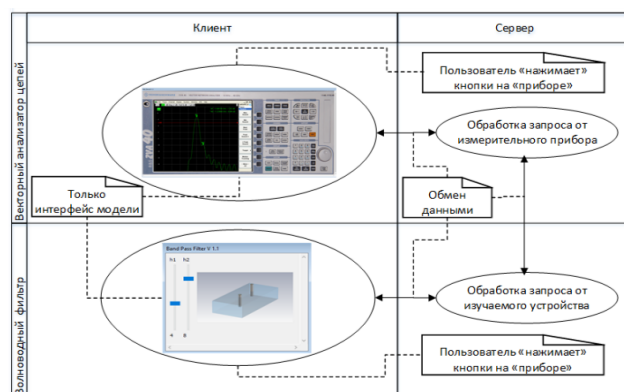


Figure 24-Interaction of device models in a virtual lab

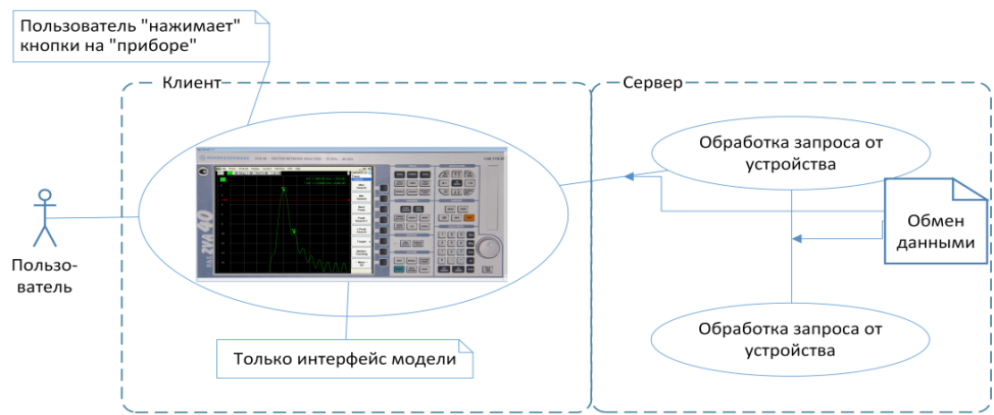


Figure 25 - Splitting the existing device model into two parts for working in a client-server architecture

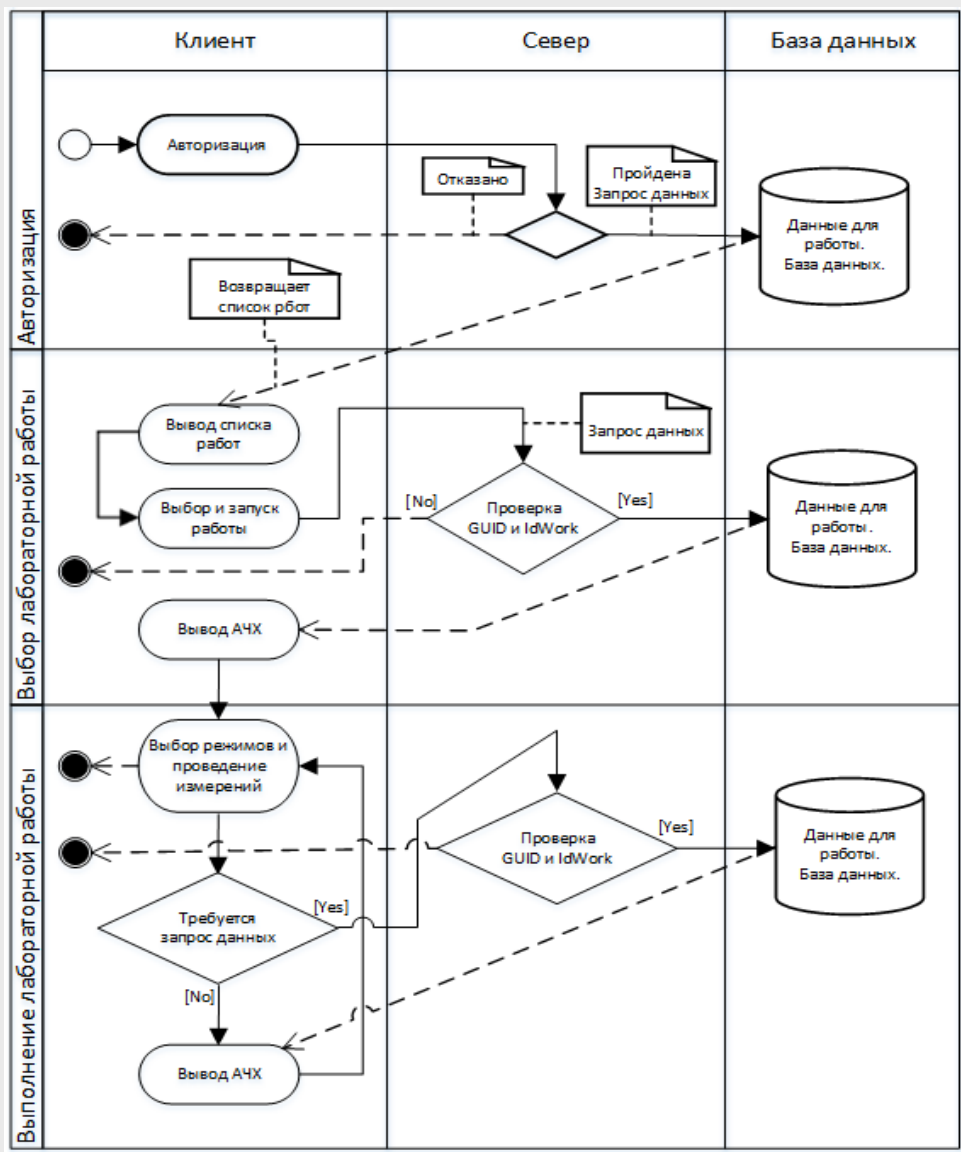


Figure 26 - Diagram of the interaction of the client-server parts of the software

7. Status of legal protection (patent, know-how, patent application filed, certificate of registration of database, computer programs, etc.)

8. Commercialization/practical application possibilities

This project is subject to further commercialization.

PASSPORT

OF THE SCIENCE RESEARCH PROJECT

1. Program/project name

IRN N°AP08855955 «Development of machine learning methods and iterative methods for finding a complex of thermophysical parameters of a heterogeneous medium, creating a program complex» (grant funding from the Ministry of Education and Science of the Republic of Kazakhstan for scientific and (or) scientific and technical projects for 2020-2022)

2. Project supervisor, contacts

Rysbaiuly Bolatbek, d.ph.-m.s. Professor, e-mail: b.rysbaiuly@edu.iitu.kz

3. Title of priority direction of science development

Information, telecommunication and space technologies

4. The aim of the project

Development of methods for finding the thermophysical parameters of a multilayer medium of non-destructive testing, proof of the stability and convergence of the developed methods, measurement work to determine the initial data, compilation and debugging of a software product and test the developed methods.

5. Brief abstract of the project

Thermophysical characteristics of the soil vary depending on the human impact on the soil. Without knowledge of these characteristics, operational prediction of heat transfer in the soil becomes a problem. Therefore, the development of

methods for calculating all the thermophysical parameters of a multilayer medium and the automation of finding these parameters becomes an urgent task.

Methodology of scientific research. The main research method is mathematical and computer modeling and machine learning. The essence of this powerful means of scientific knowledge consists of three inextricable stages of research: model - algorithm - program. Therefore, the method of mathematical modeling and machine learning were chosen to achieve the goal.

6. Description of a significant scientific achievement (include illustrative material: figures, graphs, tables, etc.)

A program code has been developed to find the thermal conductivity and heat capacity of the material.

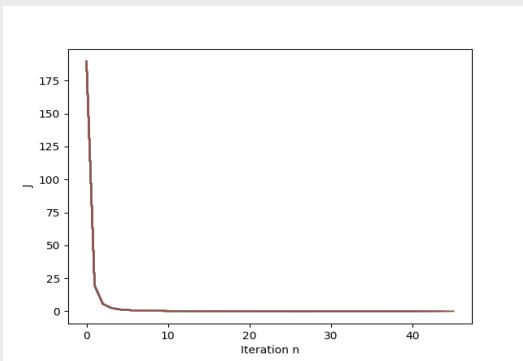
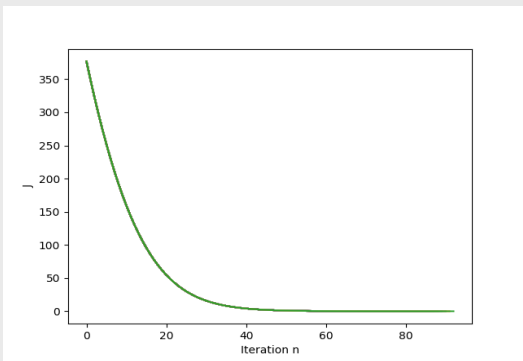
7. Status of legal protection

No

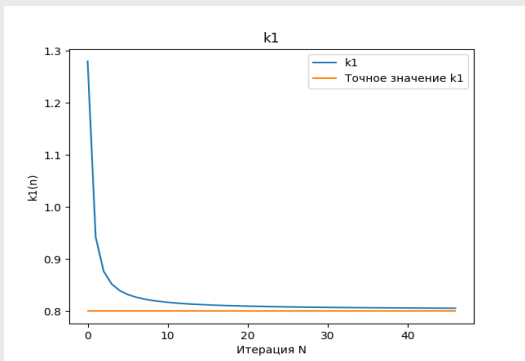
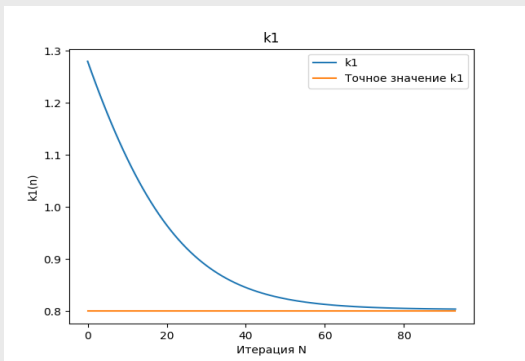
8. Возможность коммерциализации/ практического применения

The results of the Project can be used to predict the temperature regime of various materials, soils. Perhaps there is a possibility to commercialize the developed software product

Функционал



Коэффициент



[illegible]

NOTES



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