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DEVELOPMENT OF INFORMATION SUPPLY AND CONTROL SYSTEM OF HIGHER EDUCATIONAL INSTITUTION AT TECHNOLOGICAL PARK (ON THE EXAMPLE OF SUMGAIT STATE UNIVERSITY)

Specialty: 3337.01 Information - measuring and control systems
(education system)

Field of science: Technical sciences

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ABSTRACT

on the presented dissertation to get an academic degree of philosophy doctor of technical science

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GENERAL CHARACTERISTICS OF WORK

Relevance of the topic and the degree of development . According to the Azerbaijan 2020 Future Development Concept, in order to develop the non-oil sector, the issues of building an innovation-oriented and knowledge-based economy have been set. One of the main pillars of such development is the creation of modern innovation structures aimed at the development and application of high technologies. At present, in order to form a competitive and high export potential, innovative product or service, in other words, to develop an innovative economy, industrial and chemical technology parks in Sumgayit, the State Fund for Information Technology Development under the Ministry of Communications and High Technologies, Baku - Pirallahi "High technology park", agro-park on agricultural technologies in Shamkir, industrial park on waste processing in Balakhani, High Technology Park in Mingachevir have been established. Such new institutions will provide financial and organizational support for strengthening the Azerbaijani economy, attracting foreign investment, expanding the production of quality industrial products in the country, as well as organizing the activities of other emerging socio-economic and public institutions.

It is necessary to bring the higher education system of the Republic of Azerbaijan to the international level of education, to bring it into line with standards, to widely apply innovative methods, high technologies and automated information systems in the principles of higher education. In order to increase the potential of Azerbaijani science, recognition of our scientists in the international scientific world, it is necessary to organize and conduct modern scientific research, production, training centers in higher education institutions, to involve bachelors, masters and doctoral students in production. By integrating research and production centers created in the field of high technologies with the economic institutions of higher education institutions, we have achieved the formation of a complex innovation infrastructure - technoparks, and thus have given a great impetus to the development of the country's economy.

Thus, the organization of science and technology parks in the field of high technology of the higher education system in Azerbaijan, distinguished by its scientific relevance, and the automation of processes using modern

computer technology, raising management issues and research by intellectual information methods is a scientifically relevant problem.

The purpose of the research: Development of algorithms and models to improve the metrological and reliability characteristics of the information-measuring and management system of research and production areas of technology parks created in higher education institutions .

In order to achieve this goal, the following key issues are addressed:

- Exchange of electronic documents for information-measurement and automated management of scientific-research and production areas of the technological park of the higher education institution, information-search and development of information provision on the basis of data, knowledge base;
- Selection of layout scheme and modeling of functions of research and flexible production areas, which are the object of research of the technopark of the higher education institution;
- Selection of means of technical support of the information-measuring and management system of the scientific-research and flexible production area of the technopark of the higher education institution, layout and modeling of equipment and industrial robots;
- Development of mathematical and algorithmic support of means of designing information-measuring and automated control system of scientific-research and production areas of the technopark of the higher education institution;
- Development of models of structural and functional analysis of the information-measuring and automated management system of the research department of the technopark of the higher education institution and the flexible production area;
- Development of mathematical software and logic algorithm for the selection of information-measuring and control elements of the flexible mechanical assembly production area of the Technopark;
- Establishment of SCADA-based automated control system architecture of the flexible production area of the higher education institution 's technopark;
- Algorithmic development for the planning of management procedures of the production area of the Technopark;
- Development of a control algorithm and a semantic-network model of the Technopark's mechanical assembly plant ;

- Development of an algorithm for planning the address areas of the industrial network of the information-measuring and management system of production of the technopark of the higher education institution .

Object of research. These are research and flexible production areas for the establishment of a technology park at Sumgayit State University.

Subject of research. Planning, functional and structural analysis, development of technical and software tools for the design of intelligent management system of research and flexible production areas of the technology park in higher education.

Research methods. Modern modeling methods, the concept and methods of artificial intelligence , automated control methods were used to solve the problems .

The main provisions of the defense:

- Organization of information provision of the information-measurement and automated management system of scientific-research and production areas of the technological park of the higher education institution on the basis of data and knowledge ;
- Development of algorithmic and mathematical support tools for automated design of information-measurement and management system of scientific-research and production areas of the technological park of the higher education institution ;
- Structural, functional modeling and research by computer experiments of information-measurement and automated control system of production areas of the technological park of the higher education institution ;
- Research of technological operations of active elements of the flexible production area of the Technopark with logical planning and control algorithms;
- Construction and experimental study of the industrial network of SCADA-based automated control system of the production area of the technological park of the higher education institution.

Scientific innovations of research. The scientific innovations of the dissertation work are as follows:

-Models and algorithms of information provision on the basis of data and knowledge base of information-measuring and automated management

system of scientific-research and production areas of the technological park of the higher education institution have been developed;

-Structural and functional analysis models of the complex automation scheme of the flexible production area of the technopark of the higher education institution have been developed;

-Algorithms and models have been developed for the selection and design of technical and software tools for the information-measurement and management system of the flexible production area of the technopark of the higher education institution;

-SCADA-based automated control system architecture of the flexible production area has been developed in the technopark of the higher education institution ;

-control algorithm and semantic-network model of the mechanical assembly production of the technopark of the higher education institution have been developed;

-An industrial network planning algorithm has been developed for information-measurement, control and management of the active elements of the flexible production area of the Technopark .

Practical significance of the research and application of the results. Management models and algorithms have been developed to meet the requirements for automated design, development of its tools by more efficient methods of research of the activity of the automated control system of scientific-research and production areas of the technological park of the higher education institution . The issue of establishing a technology park management system on the basis of Sumgayit State University with the application of automated design, software, information and mathematical tools has been resolved . Based on the principles of building a corporate network, the effective planning and management system of the IP addressing area of the management system of the technology park on the basis of Sumgayit State University was studied with a wireless computer network. Dissertation The scientific results obtained were tested in the field of training, research and agile production of Sumgayit State University. The obtained theoretical and practical results can be used in other higher education institutions of the Republic of Azerbaijan.

Approval of the dissertation. The main results of the work at the XX Scientific Conference of Doctoral Students and Young Researchers (Baku, May 24-25, 2016); Mathematical application issues and new information technologies at the III Republican Scientific Conference

(Sumgayit, December 15-16, 2016); International scientific-technical conference dedicated to the 40th anniversary of the Department of Chemistry and Technological Processes of the Ufa branch of the Ufa State Petroleum Technical University (Ufa, Salavat, May 26, 2017); 18-th İFAC conference on technology, culture and international stability (Baku, 13th-15th September 2018); At the International scientific-practical conference on the possibilities and prospects of application of information technologies and systems in construction (Baku, July 5-7, 2018); Information Technologies for Intelligent Decision Making Support + Models and Algorithms of Applied Optimization the 6th All Russian Scientific Conference (Ufa State Aviation Technical University, May 28-31, 2018); Information systems and technologies: achievements and prospects. Proceedings of the International Scientific Conference, SSU, Sumgayit November 15-16, 2018, Information systems and technologies: achievements and prospects. Materials of the International Scientific Conference, SSU, Sumgayit, 2020, July 09-10, were reported and discussed.

Name of the organization where the dissertation work is carried out. The dissertation work was carried out at the Department of Information and Computer Engineering of Sumgayit State University.

The structure and scope of the dissertation. The dissertation consists of an introduction, four chapters, a conclusion, a list of references and appendices. The main content of the work consists of 139 pages, 20 figures and 3 tables. The bibliography lists 164 sources. The dissertation consists of 185913 characters without tables, figures and bibliography.

CONTENT OF THE CASE

Introduction , the relevance of the topic of the dissertation is substantiated, the purpose of the research is formed, the main issues that need to be addressed are identified, the main provisions for defense are indicated, the scientific novelties and practical significance of the obtained results are indicated.

First chapter, a comparative analysis of existing design methods, technical, information, mathematical, algorithmic and software tools of information-measurement and management systems of scientific and production areas of technological parks applied in higher education

institution, scientific problems in this field were identified and the general purpose of the dissertation key research issues have been identified.

Second chapter, the creation of equipment, industrial robots, automatic transport lines and its control system architecture in the flexible production area of the technopark, based on the application of industrial infrastructure, meeting the modern innovative technologies of these areas for efficient placement, planning, information-measurement and management of the main structures of the HEI technopark. is a topical issue from a scientific and engineering point of view.

One of the important design issues is to justify and equip the selection of infrastructure facilities for the effective organization of research and production of the technology park created on the basis of Sumgayit State University (SSU). Information on agreed project solutions, approval of compliance of design estimates with state standards, rules and norms are carried out at the stage of sketch design of the technological park of SSU.

The process of repairing all departments of science and production of SSU's technopark, providing them with basic inventory, equipping them with special technical means in accordance with the profile directions, installation, adjustment and financing of innovative projects is planned.

In order to ensure the automation of the mechanical assembly production area, which is considered to be a flexible manufacture area of the technopark, it is required at the initial stage to design its assembly scheme. Selection of appropriate layout scheme based on the profiles of the technology park Intellectual information - search, comparative analysis of scientific materials, existing project technologies, options, identification of deficiencies, implementation of procedures, long-term computer time, purposeful research by the designer, large number of designers and specialists, requires automated workplaces with large information capacity, technical resources. In this regard, the goal is to create an effective layout, functional, kinematic, selection of structural schemes, sketch design and creation and verification of the working design for the design design of the mechanical assembly flexible production area.

The following issues need to be addressed to achieve the goal:

1. Development of information-searching, selection and database management system of machines for mechanical assembly flexible production area.

2. 2 and 3 dimensional design of the assembly scheme of the mechanical assembly flexible production area.

3. Functional and structural analysis of the assembly scheme of the mechanically assembled flexible production area.

The issues of design and technological design in accordance with the issues of substantiation and arrangement of the selection of infrastructure facilities for the effective organization of research and production of the technological park of Sumgayit State University were considered.

In order to ensure the automation of the mechanical assembly production area, which is considered to be a flexible production area of the Technopark , it is necessary to design its assembly scheme at the initial stage. In this regard, the aim is to create an effective layout, functional, kinematic, selection of structural schemes, sketch design and creation and verification of the working design for the design design of the mechanical assembly flexible production area. Due to the complex design issues of information retrieval, selection and database creation of mechanical machines in the flexible production area, a flexible control panel is offered to automate all project operations based on a single interface. The flexibility of the proposed control interface is that by selecting mechanical machines and devices with different functions, it is possible to build and analyze different configurations, functional circuits from these technical units. With the help of the control interface, an algorithm for the construction of an efficient layout scheme from mechanical machines of the flexible production area is gradually built.

In order to select and study the configuration scheme of mechanical machines and manipulated overhead cranes, the initial search of mechanical machines on the social network, the organization of the database is carried out. The following basic operations are performed in the process of selecting mechanical machines:

1. The subsystem of the project assignment procedure is activated. Based on the initial data of the project, the search, intuitive selection and structuring of similar project options (SPO) in the global network system is carried out according to the priority of similarity. The basis of this procedure is the initial data of the project (project area of application (PAA), project name (PN) and project purpose (PP)).

First similarity priority (SP):

SP1: If $PO\ \{\ PAA_i\ \}$, then $SPO^1\ \&\ SPO^2\ \&\ ....\ \&\ SPO^n$;

SP2: If $PO\ \{\ PN_i\ \}$, then $SPO^1\ \&\ SPO^2\ \&\ ....\ \&\ SPO^m$;

SP3: If $PO\ \{\ PP_i\ \}$, then $SPO^1\ \&\ SPO^2\ \&\ ....\ \&\ SPO^k$.

At this stage, the technical parameters of the selected project options (constructive dimensions (CD), type of material (TM), working principle (WP)) are checked.

The second similarity priority:

SP4: If $PO\{PN_i: DD_1, DD_2, ..., DD_n\}$, then $SPO^1 \& SPO^2 \& .... \& SPO^n$;

SP5: If $PO\{PN_i: TM_1, TM_2, ..., TM_m\}$, then $SPO^1 \& SPO^2 \& .... \& SPO^m$;

SP6: If $\{PN_i: WP_1, WP_2, ..., WP_k\}$, then $SPO^1 \& SPO^2 \& .... \& SPO^k$.

2. In the second stage, the main engineering parameters of the proposed project, equipped with cost-effective, new information and computer technology, are studied, checked and economic evaluation is carried out. At this stage, the project options selected by the principle of artificial intelligence, provided with progressive automation systems of the selected project options, are stored in the newly organized database.

3. Technical parameters of the active elements of the base subsystem provided with the software tools of the operating system and database management system; AutoCAD 2D, 3D software system, their 2 and 3 dimensional engineering drawings; algorithmic reports of kinematic and dynamic parameters of active elements are included. Management operations of the library of standard active elements are provided in the menus of data collection, structuring, editing, search in the form of a query to the database and selection menu commands.

4. According to the conditions of selection of separate machines, the layout schemes of mechanical machines (serial, parallel, circular) are offered in several variants, and lines are created in the computer graphics system. Based on the type of product, productivity and product manufacturing technology and technological map reflected in the project assignment, the variant of the layout scheme is selected.

Functional analysis of functionally related scientific-experimental and production areas is required for designing the information-measuring and management system of scientific-research and production of the technopark of SSU.

Functional communication between the users of the research and flexible production of the Technopark is carried out within the corporate network by electronic addressing. Each user is assigned automatıon workıng place (AWP) and the appropriate e-mail address. Accordingly, the logical algorithm of functional analysis is expressed as follows:

P1: Designer_1 → [Applied Mechanics (tm_layiha@mail.ru) & AWP_1];

P2: Designer_2 → [Technological process automation

(tpa_layiha@mail.ru) & AIY $_2$];
P3: Designer_3 → [Electric power (ee_layiha@mail.ru) & AWP $_3$].
If ∃ "Designer_1_Technical task_1"∈ {tt $^1{}_j$ → indicators of the technical task are selected} ,
where, tt $^1{}_j \in$ {tt $^1{}_1$, tt $^1{}_2$, ..., tt $^1{}_n$ }
Then Designer_1
And (tm layiha@mail.ru).
If ∃ "Designer_2_Technical task_2"∈ {tt $^2{}_j$ → indicators of the technical task are selected} ,
where, tt $^2{}_j \in$ {tt $^2{}_1$, tt $^2{}_2$, ..., tt $^2{}_n$ }
Then Designer_2
And (tpa_layiha@mail.ru).
If ∃ "Designer_2_Technical task_3"∈ {tt $^3{}_j$ r → indicators of the technical task are selected} ,
where, tt $^3{}_j \in$ {tt $^3{}_1$, tt $^3{}_2$, ..., tt $^3{}_n$ }
Then Designer_3.

The programmer, designer and technologist builds algorithmic, constructor and technological software by accepting the relevant project tasks in the form of an electronic document. Couplings and plotters are used to make design documents more efficient. The functions of $_{the}$ local network between designers, programmers, constructors and technologists in the field of scientific research are provided.

P4: Programmer_1 → [Applied Mechanics (tm_program@mail.ru) & AWP$_4$];
P5: Programmer_2 → [Technological process automation
(tpa_proqram@mail.ru) & AWP $_5$];
P6: Programmer_3 → [Electric power (ee_proqram@mail.ru) & AWP $_6$].
P7: Konstruktor_1 → [Applied mechanics (tm_konstruktor@mail.ru)
& AWP $_7$];
P8: Konstruktor_2 → [Technological process automation
(tpa_ constructor @ mail.ru) & AWP $_8$];
P9: Technologist_1 → [Applied Mechanics (tm_texnoloq@mail.ru) & AWP $_9$];
P10: Technologist_2 → [Technological process automation
(tpa_texnoloq@mail.ru) & AWP $_{10}$];
P11: Texnoloq_3 → [Elektroenergetic (ee_texnoloq@mail.ru) & AWP$_{11}$].

Functional connection scheme is established to determine the control operations of the technological operations of the machines in the studied

production area . A functional scheme is proposed based on the machines, service vehicles, control and power supply units of the flexible mechanical assembly area (Fig. 1). The functional scheme provides technological (tracer, manipulator movement trajectories), control (according to the operations of the manipulator, hoist, machine) and electrical energy (provides hoist, machine and control node) interactions between each of the four modules and blocks of production.

In order to improve the layout of the automated control system (ACS) of the flexible mechanical assembly production area of the Technopark, the conditions of compactness, availability of minimum dimensions, minimum number of parts must be ensured:

Correction of technological process ACS → New project (NP);

NP: NP mechanical part; Part of NP electronics.

NP mechanical part: NP_mech_1, NP_mech2,. . . , NP_mech_n, yes

$n \rightarrow \min$

NP_mech_ $i \rightarrow min \{R_i\}$ - *minimum dimensions of the i-th element.*

NP electronics part: NP_elect_1, NP_elect_2,. . . ,

NP_elect_n,

NP_elect_ $i \rightarrow max \{V_m$ *(productivity)};*

$$V_m = \frac{1}{\sum_{k=1}^{n} P_k t_k} \qquad (1)$$

where P_k - the frequency of the processing operation of the processor k during the solution of the control problem of the technical object ; t_k - the duration of the processing operation of the processor k .

NP_elect_ $i \rightarrow max \{V_y$ *(memory. Volume)}.*

The continuous operation of the selected electronics Δmust be ensured for a period of max ($T_{к\_i}$ (ΔP_k)). *The* coefficient of increasing the probability of continuous operation of electronics varies k_i = *1.2-1.6* .

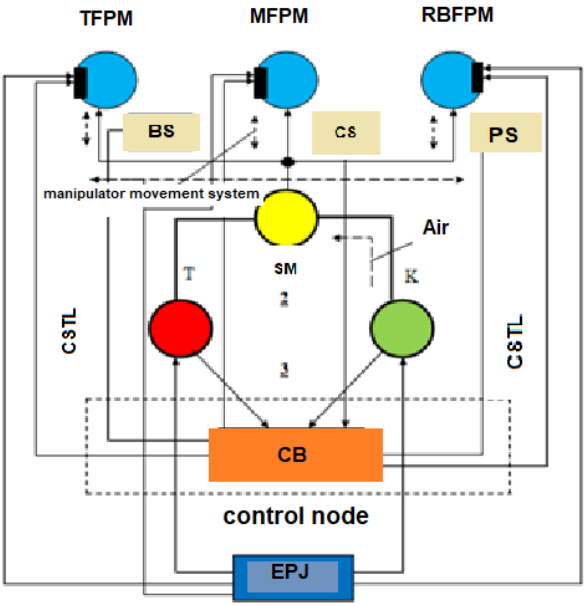

Fig. 1. Functional scheme of agile mechanical assembly production area

$$\Delta P_k \leq k_i e^{-\frac{\Delta T_{k\_i}}{T_{k\_i}}} \quad (2)$$

The type and number of programmable logical controllers (PLC) of the control system of the projected technical facility are selected according to the condition.

PCL creates a scheme of selection of electronic parts of transmitters and actuators that provide information input and output execution signals and ACS of the flexible mechanical assembly production area of the technopark.

The line of the crane-manipulator serving each machine for complex automation of the technological process in the field of flexible mechanical assembly production of the technopark of SSU depends on the positioning errors of back and forth, up and down movements, opening and closing of its handle. Depending on the positioning errors, the position transmitters of the crane-manipulator are selected. Due to the linear displacements and loading and unloading operations in the process of crane-manipulator technological service in this production area , the total error is calculated as follows:

$$\Delta_{\sum} = \sum_{j=1}^{m} \Delta h^j + \sum_{i=1}^{n} \Delta l^i \le [\Delta], \quad (3)$$

where Δh^j are the errors arising from the up-and-down linear displacement movements; Δl^i - forward-reverse linear displacement errors; $[\Delta] = \frac{\Delta_{\Sigma}}{K_{\Delta}}$, K_{Δ}= 1,2 - is the reserve factor.

Δl_i Depending on the displacements, the positioning error is determined according to the X and Y coordinates (Fig. 2).

For the service of a lathe parallel to the Y coordinate, the positioning error due to linear displacement is determined as follows:

$$\Delta y^1 = \frac{\Delta h^1 \sin\varphi K_{\Delta}}{D_n} + \frac{\Delta h^1 K_{\Delta}}{D_n}, \quad (4)$$

where D_n is the number of pulses in the discrete conversion of the transmitter; Δh^1- is the displacement distance of the crane manipulator for the service of the lathe.

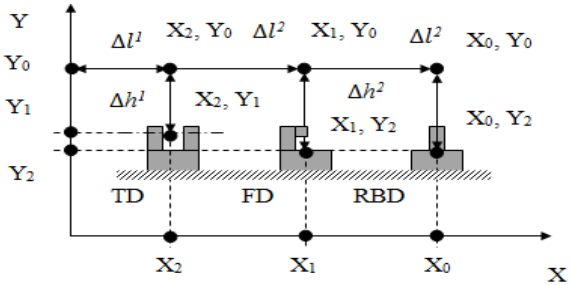

Fig. 2. Positioning coordinates of the crane-manipulator in the field of flexible mechanical assembly production

If we take into account that the service height of milling and radial turning machines is the same, then the distance of service for these machines - Δh^2. In this case, the positioning error for linear displacement for the service of milling and radial turning machines parallel to the Y coordinate is determined as follows:

$$\Delta y^2 = \frac{\Delta h^2 \sin\varphi K_{\Delta}}{D_n} + \frac{\Delta h^2 K_{\Delta}}{D_n} \quad (5)$$

X coordinate are carried out in the service process of lathes, milling and radial turning machines, respectively. Then the positioning errors that occur during the service of lathes, milling and radial turning machines are defined as follows:

$$\Delta x^1 = \frac{\Delta l^1 cos\varphi K_\Delta}{D_n} + \frac{\Delta l^1 K_\Delta}{D_n} \quad (6)$$

$$\Delta x^2 = \frac{\Delta l^2 cos\varphi K_\Delta}{D_n} + \frac{\Delta l^2 K_\Delta}{D_n} \quad (7)$$

where Δl^1, Δl^2 - are the displacement distances of the crane manipulator for the service of milling and radial turning machines, respectively.

In the third chapter development of a conceptual model for the automated design of the management system of research and production modules of the technology park in a higher education institution The question is posed. In this regard, in accordance with the requirements for the establishment of technology parks in higher education institutions , a block diagram of the process of phased design of the management system of research and flexible production areas of the technology park is proposed on the example of SSU . The following management units are established to ensure the integration of the research and flexible production modules of the Technopark: the Expert Council of the Technopark, which performs the functions of expert evaluation and project selection; Management company for the effective solution of the goals and objectives of the technopark.

Of the control units of the FPA in the Technopark of SSU are defined by setting the issues of algorithmic and software development to automate the process of developing an innovative project in the FPA applied in the technological park of SSU:

1. The topics of the ideas created by the residents of the SSU technopark are initially registered on the website of the technology park as “ *Teacher_registration* ” or “ *Student_registration* ”. The summary of the project formed on the basis of the idea is stored in the " *Annotation* " database in the form of an annotation (standard form AnF1) .

2. After the registration of the project in the research department and production of the SSU technopark, a database management system is formed from all the information of these projects included in the terms of reference. Thus, a database of innovative projects of the scientific-technological park of SSU is being created.

3. Experts on scientific profiles, considering the purpose, main idea, working principle, constructive changes and economic efficiency of innovative projects in the annotation, keep the initial opinions in the " *Expert opinion* " section. The evaluation process is carried out in accordance with the innovative requirements of the project, new design and technological indicators, the availability of opportunities for the application of automation

technology and standard requirements developed in accordance with high economic criteria.

In addition, the prototype of the proposed project, its descriptions, technical and economic indicators and working principle are prepared in the form of electronic information and sent to the e-mail address of a qualified expert. A special software page has been created to automate the expert evaluation process of the innovative project, with the help of which an expert in the field of science selects an innovative project related to the specialty and records its grade point time. Grading is carried out on 1 ÷ 5 points. The coefficients of the criteria for the objective assessment of the expert vary in the wall $A_m = 0 \div 1$. Then the coefficients in accordance with the accepted criteria (C) of the proposed innovative project are as follows:

C1: Degree of preference over prototype design by design →
(very low / 0; low / 0.25; similar / 0.5; superior / 0.75; very superior / 1);
C2: Economic efficiency →
(very low / 0; low / 0.25; same / 0.5; high / 0.75; very high / 1);
C3: Power consumption →
(very high / 0; high / 0.25; same / 0.5; low / 0.75; very low / 1);
C4: Demand →
(none / 0; low / 0.25; same / 0.5; high / 0.75; very high / 1);
C5: Use of modern electronics →
(none / 0; less / 0.25; sufficient / 0.5; high / 0.75; very high / 1);
C6: Application of intellectual information system →
(none / 0; less / 0.25; sufficient / 0.5; high / 0.75; very high / 1).

By calculating the algebraic sum of the coefficients in accordance with the above Ci criteria, a decision is made on whether or not to adopt an innovative project based on the maximum value of the result obtained. Thus, by selecting the maximum coefficients and their preferred degrees according to the Ci criteria, it is written in the following expression:

$$\ni_{Mi} = \left\{ \begin{array}{c} C1 \rightarrow (\frac{\text{superior}}{0,75} \wedge \text{ more} \frac{\text{superior}}{1}) \\ C2 \rightarrow \left(\frac{\text{above}}{0,75} \wedge \text{ more} \frac{\text{above}}{1}\right) \\ C3 \rightarrow \left(\frac{\text{low}}{0,75} \wedge \text{ more} \frac{\text{low}}{1}\right) \\ C4 \rightarrow \left(\frac{\text{up}}{0,75} \wedge \text{ more} \frac{\text{up}}{1}\right) \\ C5 \rightarrow \left(\frac{higer}{0,75} \wedge \text{ more } \frac{\text{higer}}{1}\right) \\ C6 \rightarrow (\frac{\text{higer}}{0,75} \wedge \text{ more } \frac{\text{higer}}{1}) \end{array} \right\} \quad (8)$$

Algebraic sum of the coefficients of *Ci* selected in expression (8) is calculated on the basis of technical, structural and economic indicators of the proposed innovative project and the prototype project submitted by the designer .

$$C_{gen} = \sum_{i=1}^{6} Ci \quad (9)$$

Ci are intuitively selected by the expert and included in expression (9). Then the following result is obtained:

$$C_{gen} = \sum_{i=1}^{6} (0,75 + 1 + 0,75 + 0,75 + 1 + 1) = 5,25$$

The following logical expression is written to make a choice based on the result:

C $_{gen}$ = 0 ÷ 1,24 → the project is rejected by the expert (*unsatisfactoriali*);

C $_{gen}$ = 1,25 ÷ 3,24 → the expert decides to change the design of the project, add modern electronics, adapt to the needs of the region and increase economic efficiency (*satisfactori*);

C $_{gen}$ = 3,25 ÷ 4,224 → the expert decides on some improvement of the project design, addition of intelligent information system and reduction of electricity consumption (*good*);

C $_{gen}$ = 4,25 ÷ 5,24 → the project is accepted as a whole, but the decision on carrying out certain technical changes is made by the expert (*very good*);

C gen = 5,25 ÷ 6 → the project is accepted unconditionally (*exelent*).

Based on the price close to the maximum value of the value (*max* ($_{value}$) = *6*), it is decided to choose an innovative project. Fig. As shown in 3.4, the

project is given an excellent grade (*exelent*) and the author is notified (a message is sent to his e-mail).

On the basis of SSU the issues of development of functional and system-technical design tools for modeling of information-measuring and management system of production of technopark are set. For the development of the functional scheme of the research-production-commercial system of the Technopark, the priority specialties and scientific directions of the departments of “Engineering” and “Economics” faculties of SSU are determined and the scientific research-production functional scheme of the technopark of SSU is proposed (Fig. 3).

Management modeling of the technopark at the stage of system-technical design to ensure reliable operation of the automation scheme of the information-measuring and control system of the technopark's FPA issues are addressed. In order to study the functional interactions between the research and flexible production units of the technological park of SSU, at the initial stage, the structure scheme of the management system of the technopark is established.

The subsystems of the automation scheme of technopark production are defined by the following set: $P \in \{ P_1, P_2, \ldots, P_n \}$, where P_i is the control system of the technopark's FPA is divided into the following subsystems: P_1 is the control subsystem of the technopark's FPA; P_2 - general purpose and management program subsystem; P_3 - subsystem for registration of data of production units of the technopark in corporative information system (CIS); P_4 - technopark subsystem; P_5 - sensor subsystem of technopark equipment; P_6 - quality control subsystem of products produced in the technopark; P_7 - executive subsystem of technopark equipment; P_8 - technopark operational management subsystem; P_9 - technopark management program launch subsystem.

Taking into account the information-functional connections between the subsystems of the control system of the SSU Technopark, the relationship matrix is built which allows to determine the quantitative characteristics of the system by matrix calculation.

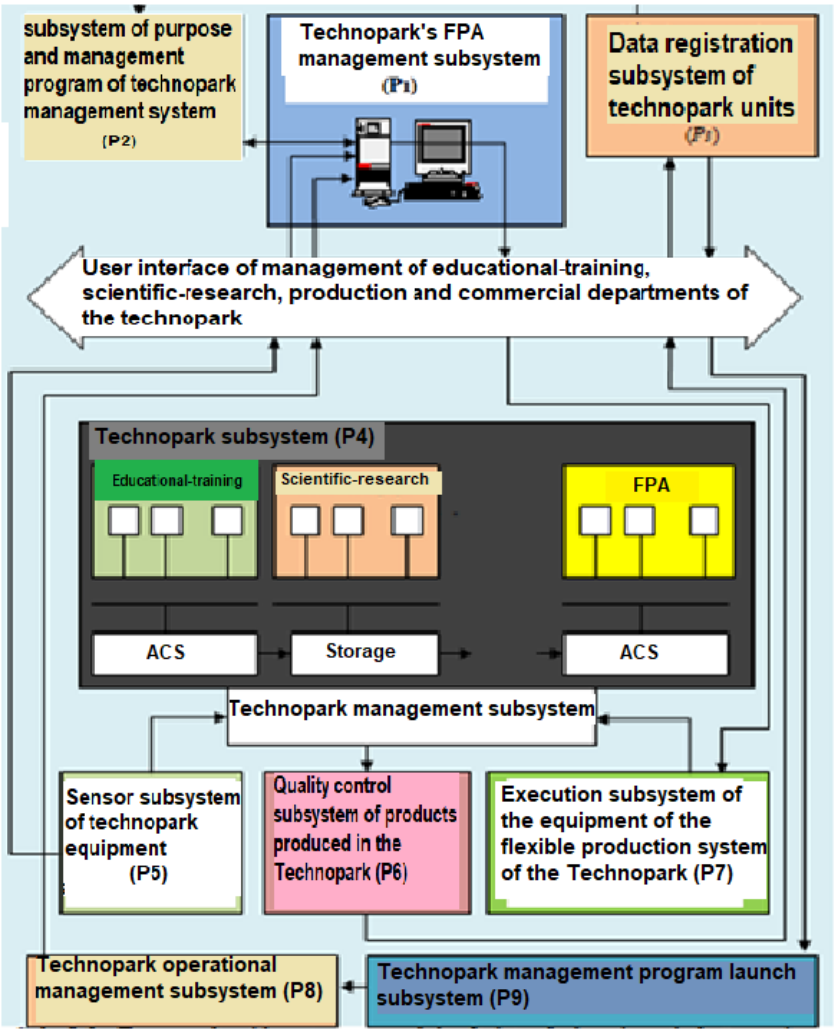

Fig. 3. Schematic diagram of the control system of the SSU Technopark

Matrix include the values of the input connections, and the columns include the values of the output connections. If there is a connection, then the value of the cell of the matrix is 1, otherwise the cell of the matrix is 0:

$$a_{ij} = \begin{cases} 1, \ if \ \ P_i \in P_j \\ 0, \ if \ \ P_i \notin P_j \end{cases} \tag{10}$$

Thus, the relationship matrix of the system can be described as follows:

$$\left\| a_{ij} \right\|_1 =$$

P_1	P_2	P_3	P_4	P_5	P_6	P_7	P_8	P_9	
0	1	0	0	1	0	1	0	0	P_1
1	0	0	0	0	0	0	0	0	P_2
0	1	0	0	0	0	0	0	1	P_3
0	0	0	0	0	1	0	0	0	P_4
1	0	0	1	0	0	0	0	0	P_5
0	0	1	0	0	0	0	0	0	P_6
0	0	0	1	0	0	0	0	0	P_7
1	0	0	0	0	0	0	0	0	P_8
0	0	0	0	0	0	0	1	0	P_9

(11)

At the initial stage of the process of designing an automated control system for FPA, it consists of multi-stage procedures and operations, such as search and selection of active elements of information-measurement and management, database creation, modeling of control algorithms.

As can be seen from Figure 4, one of the important design issues for the effective management of the active elements of the ACS is the selection of ACS information-measurement and management tools (transmitters, implementation mechanisms, regulators, technical control, programmable logic controllers and communication systems). is the creation of a database management system of ACS. For this purpose, the specifics of the production under study, the types of technological operations of its active elements, the principles of product quality control are analyzed and a relational database is established (Table 1).

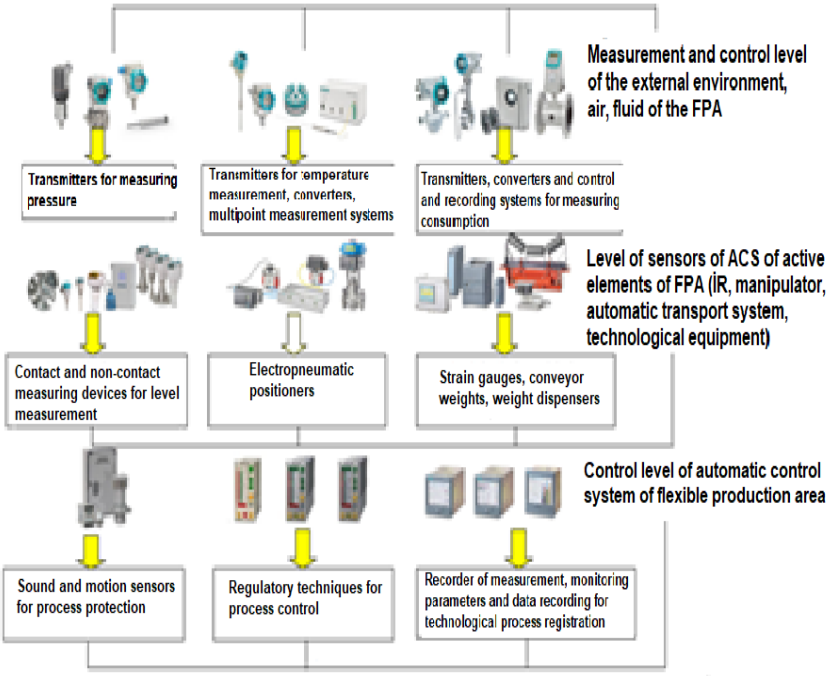

Fig. 4. Hierarchical structure of information-measuring, control elements with automated control system of FPA

Relational database

Table 1.

Code	Active element of the FPA	Information measurement element of ACS	Control element of ACS	Regulatory element of ACS	Technical control element of ACS
A111	Technological equipment	Transmitter recording the beginning and end of operations (2 units)	PLC		Equipment technical control system
A112	İndustry robot	Linear angle displacement transmitter (4, 2 units)			Technical vision system
A113	Automatic transport lines	Positioning transmitter (2 units)		Speed regulator (1)	Design quality control system
A114	Oven	Thermocouple		Thermo regulator (1)	
A115	Compressor	Air pressure gauge			
A116	Temperature regime of production			Thermo regulator (1)	
A117	Production voltage mode			Voltage regulator (1)	

Precise configuration of information-measuring and control elements in industrial robots (İRi), technological equipment (TEi), automatic transport lines (ATLi) and furnace, providing automation of technological processes for the development of a reliable control system of the flexible production area (FPA) operating under the University Technopark and modeling based

on technological operations. The İRi operating in the FPA provide for the removal, transportation, relocation and loading of standard-sized aluminum plates.In this case, the initial position coordinates and geometric dimensions of the İRs and serviced furnaces, ATLi and polishing machine (PMi), IOSs are given:

1. Geometric dimensions of the active elements of the production area:

Length $L_i = z[s_L, x_i]$; Width $B_i = z[s_B, x_i]$; Height $H_i = z[s_H, x_i]$. Here s_L - Values of geometric properties of active elements of IMCS; x_i is the name of the active element.

2. IMCS position parameters :

x in the direction of reading $P_{x,i} = z[s_x, x_i]$; y in the direction of reading $P_{y,i} = z[s_y, x_i]$;

z in the direction of reading $P_{z,i} = z[s_z, x_i]$; α rotation angle $P_{\alpha i} = z[s_\alpha, x_i]$.

$P_l = \{<x_{l,i}, y_{l,i}, z_{l,i}>\}$, $l = 1, N_l$, $i = 1, N_{пов,i}$, variable directions for determination of spatial positions of technological operations of industrial robot (IRi) coordinate points are defined. Here $N_{pov,i}$ - i is the amount of change in the direction of the combination.

By determining the initial coordinates of each active element depending on the coordinates of the IRi for the production under study, the virtual working area of the total working area of the IPS can be described as follows:

$F_1() = z[s_1, x_{i1}] = x_1, y_1, z_1 \& (z[s_{11}, x_{i1}] =$ " Initial coordinates of the measuring elements of the furnace ATL1 ", $j_1 \in J$,

$F_2() = z[s_2, x_{i2}] = x_0, y_0, z_0 \& (z[s_{12}, x_{i2}] =$ " Initial coordinates of the measuring elements of IR1 ", $j_2 \in J$,

$F_3() = z[s_3, x_{i3}] = x_2, y_2, z_2 \& (z[s_{13}, x_{i3}] =$ " Initial coordinates of the measuring elements of ATL2 ", $j_3 \in J$,

$F_4() = z[s_4, x_{i4}] = x_3, y_3, z_3 \& (z[s_{14}, x_{i4}] =$ " Initial coordinates of the measuring elements of IR2 ", $j_4 \in J$,

$F_5() = z[s_5, x_{i5}] = x_4, y_4, z_4 \& (z[s_{15}, x_{i5}] =$ " Initial coordinates of the measuring elements of PM1 ", $j_5 \in J$,

$F_6() = z[s_6, x_{i6}] = x_5, y_5, z_5 \& (z[s_{16}, x_{i6}] =$ " Initial coordinates of the measuring elements of IR3 ", $j_6 \in J$,

$F_7() = z[s_7, x_{i7}] = x_6, y_6, z_6 \& (z[s_{17}, x_{i17}] =$ " Initial coordinates of the measuring elements of PM2 ", $j_7 \in J$.

Thus, by determining the initial coordinates of İRi and serviced active

elements in the FPA, to determine the safe trajectories of the working zones of IRi (IR1, IR2 and IR3) for IMCS and ensure reliable operation of the automated control and monitoring system of the production site allows you to do.

The production process is being studied on the basis of SSU's technopark in order to develop an algorithm for the management of a flexible mechanical assembly production area (FMAPA). The crane-manipulator of the FMAPA performs the following technological operations (Fig. 5): the crane-manipulator (CM) moves linearly to the table position with the help of a hoist to remove the shaft-type manipulation object (STMO) located on the working table; To catch the STMO, the CM line moves downwards, and in this position the CM pneumatic cylinder holds the STMO in the open position and closes the handle; CM loads the captured STMO onto the lathe (L) by moving it up and down in succession.

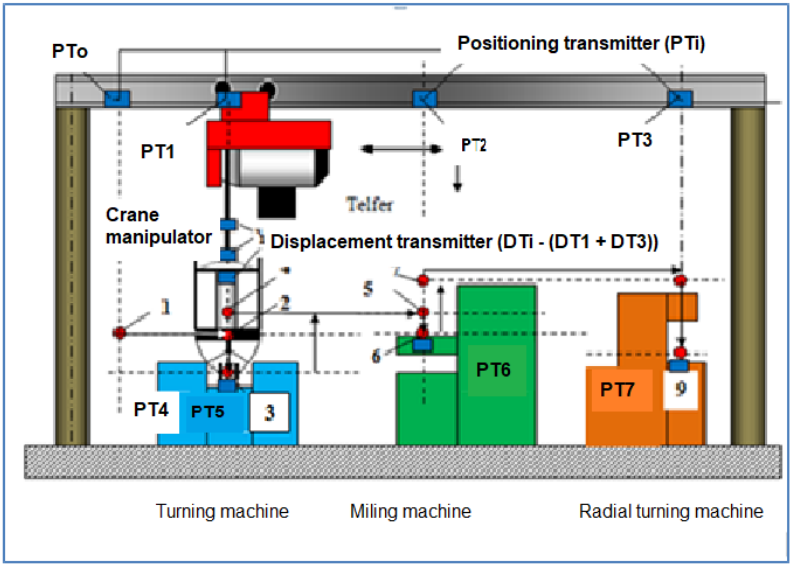

Fig. 5. Positioning scheme of control elements of FMAPA

P_i_ the sequence of events (technological operations) and the time of occurrence of events t_j logical predicate is described in the computational language as follows:

($\forall P_{ij} \in$ Technological operations of CM)
($\forall X_i \in$ Flexible mechanical assembly production site lathe module active elements)
[(P_{1j} = event_i) → [...
(type (operation j) = ...) ∧

$P_{i\ events}$ that take place in FMAPA are carried out in time t_i. This dependence can be described by a logical algorithm as follows:

($\forall P_{ij} \in$ {CM's technological operations} &
{CMT technological operations} &
{STMO Technological Operations})
[Forward movement of CM (P_{1i}) → (beginning (P_{1i}) + t_i = end (P_{1i})]
∧… ..

Based on the established control algorithm and the activity of the elements involved in the control process, a semantic network scheme of 1 ÷ 10 technological operations of the process of making a cylindrical axis on a lathe in the field of mechanical assembly production is created. Elements directly involved in the technological process are considered *active*, secondary elements are considered *inactive*, and the conditions for the application of Pi are the facts that occur, then

$Pi \rightarrow (F_i \in \{F_1, F_2, \dots, F_{10}\})$, F_i - *are* facts.

In the fourth chapter to ensure the automation of the management system of the ATM's technopark, remotely monitor all scientific and technological processes, analyze current technological indicators and make decisions by performing directions of integration of its research and flexible production areas without direct intervention. should be done. SCADA technology, one of the most advanced automated control systems, is widely used to manage the research and production process of the Technopark in real time. SCADA is a package program designed to develop systems for collecting, processing, describing and archiving information about control objects or to ensure their real-time operation.

The SCADA (Supervisory Control And Data Asquisition) system used in the HEİ's technopark performs the following functions (TRACE MODE):

1. Visualization of the management of the technological process of FPA.

2. Collection of data from information-measuring, control sources of technological equipment, industrial robots, automatic transport lines and

furnaces of FPA (using Dynamic Data Exchange (DDE), OPC (OLE for Press Control) protocols).

3. SQL language is used to modify, store, delete and read information in database tables.

4. Remote control of active elements of FPA, actively involved in the technological process.

5. Provide information on accidents and pre-accident situations (lighting or sounding).

6. Registration and archiving of emergency situations.

7. Graphically archive current data.

8. Provision of diagnostic procedures, their recording and automatic informing of the operator.

9. System protection.

The issue of designing a distributed CS GPS based on TRACE MODE for the implementation of software and hardware for the interface of the automated control and monitoring system of the Technopark's GIS is being considered. TRACE MODE based GPS management system uses all modern means of communication for data exchange: local area network; interface RS-232, RS-485, RS-422; radio channel; leased and replaced telephone lines; GSM networks; standard interfaces (OPC, DDE, NetDDE, ODBC) and vehicles. Using these tools, information is exchanged between all levels of the management system (Figure 6).

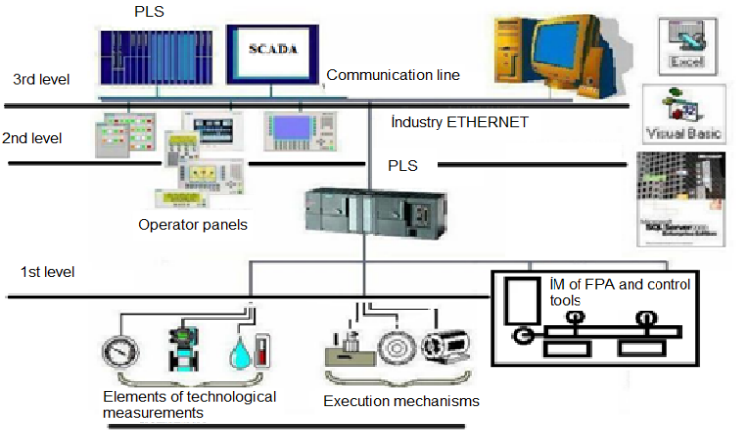

Fig. 6. ACS of the production area of the HEI technopark on the basis of SCADA

To describe the functional and technological connections between the modules of the production area of the SSU technopark, the routes of the industrial network are identified and the transitions of the relevant procedures are determined. Its control algorithm is developed on the basis of selected transmitters and execution mechanisms of the machines of the flexible mechanical assembly production area. The control algorithm built using the product model consists of elements of the application conditions (P_i) - i of the production core: $P_i = \{P_1, P_2, \ldots .., P_n\}$, where *n* - indicates the number of conditions.

The control algorithm is constructed by logical modeling in accordance with the production conditions:

1. $MV_{vtmo} \& MV_0 \& MV_4 \rightarrow IM_{tf1}$;
2. $MV_{vtmo} \& MV_4 \& MV_0 \rightarrow IM_{tf11}$;
3. $YDV_1 \& MV_4 \& MV_{vtmo} \rightarrow IM_{kmt}$;
4. $\urcorner MV_4 \rightarrow \urcorner İM_{tf11}$;
5. $\urcorner MV_4 \& \urcorner YDV_1 \rightarrow IM_{tf1}$;
6. $MW \& \urcorner MV_4 \& MV_1 \rightarrow \urcorner İM_{kmt}$;
7. $MW \& MV_4 \rightarrow IM_{51}$;
8. $MV_5 \& MV_t \rightarrow İM_{52}$;
9. $\urcorner MV_t \rightarrow İM_{so}$;
10. $MV_{tso} \& MV_4 \& YDV_1 \rightarrow İM_{kmt}$;
11. $MV_{tso} \& YDV_1 \rightarrow \urcorner İM_{tf11}$;
12. $\urcorner MV_4 \& \urcorner YDV_1 \rightarrow \urcorner_I tf\_tson$
13. $\urcorner MV_4 \& MV_{1son} \rightarrow \urcorner_I tf\_tson$
14. $MV_{1son} \& \urcorner MV_4 \rightarrow \urcorner_I kmt \& I_{sok}$

The planning algorithm is implemented recursively. A schedule has been established between the transitions to assess the status of the stages of preparation of the innovative project in production. Based on the transition facts given in the table, a planning algorithm was developed to determine the status of innovation project development in the flexible manufacturing modules of the technology park. Specifically, the production conditions of the innovation project are determined. Based on a recursive algorithm, a query algorithm is built to determine the status of an innovative project or product.

One of the important issues in the technopark is the creation of a corporate information system, its hardware and its software tools to ensure the production of IP. Given that the technopark operates as a complex technical system, the production of the technopark uses the hardware of the

local network, software and electronic database management tools that ensure the integration of the corporate information system (CIS) with the SCADA system.

In order to ensure the efficient operation of the corporate information system integrated with the Technopark's FPA, the selection of technical means of the wireless corporate network system (CNS), precise placement, adjustment and installation of relevant software in the required areas of the production area, security are carried out.

At the 3rd level of the SCADA automated control system of the FPA, technical means are selected to ensure the exchange of information between the modules of the corporate local area of production . Wireless information distribution with the switchboard center of the Technopark is installed in the UniFi database with the help of controllers, network switches, adapters. A network gateway (Internet Gateway) connects corporate local area network computers to the Internet.

Functional relationships are established on the basis of the units of the Technopark. Hardware and software of the corporate information system are created at the 3rd level of the automated management system of the FPA.

1. *The number of required access points of UniFi,* including external Wi-Fi, is used to expand the technopark inside and outside the FPA building;

2. *The required number of PoE adapters* (or PoE-based switches) must be provided. UniFi software controllers are installed on a computer or laptop;

3. *Router or switch* - connects to access points and computers installed with the controller;

4. *Uninterruptible power supply or mains filter* - designed to connect equipment.

A cable leading to the router or switch is connected to the UniFi LAN port, and a cable leading to the adapter is connected to the PoE port. A computer or laptop also connects to a router or switch. The sequence of activities of the technopark during the expansion of the administrative, research and UniFi network of the TIS is defined as follows

UniFi transmitters (Ubiquiti UniFi UAP, Ubiquiti UniFi UP-AC, Ubiquiti UniFi Outdoor AP) in the administrative building of the technopark - is installed, adjusted, tested, monitored in the laboratories of the research complex and in the field of flexible production, and the functions of the corporate network are managed in a complex way. To organize the general activities of the research and production facilities of the technopark and the corporate local network, the switch center is installed on the top floor of the

administrative building of the technopark and is provided with a local area network server.

The perimeter dimensions of the technopark area are determined by real prices. The placement positions of the production area of the Technopark are selected in a 2-dimensional coordinate system, and depending on these positions, the position coordinates of the distribution points of UniFi are determined. The distance between the coordinate positions varies from 100 to 150 m. UAP: UniFi based on 802.11n MIMO can provide -300 Mb / s. Wireless impact radius - 120 m is accepted.

At the 3rd level of the technopark's facilities and production management system, the address area of the corporate network consists of the addresses of the local network and the official addresses used by the telecommunication center (TC). A computer connected to a support network has a network serial number. With the help of TM, IP addresses are allocated, domain names are recorded, and network routes are selected and configured. By determining the address area, the reserve interest rates allocated to each technopark production modules are determined. The number of production modules must also be taken into account. According to the serial number, the algebraic sum of the number of production modules of the technopark is calculated:

$$S_8 = \sum_{cis=1}^{4} S_{cis}$$, *fpa* = head of flexible production area (1) +

number of production modules (number $m = \overline{1.4}$)

where *i* is the total number of production units of the technopark.

17 logical IP-networks are used to provide addressing with the production modules and the operator of the Technopark. At the 3rd level of the automated production management system, IP addresses used in the corporate industry network are considered private. Therefore , Internet addresses in the range of 192.168.1.0 ÷ 192.168.1.17 are used for Internet nodes of the industrial network.

THE MAIN RESULTS OF THE DISSERTATION WORK

1. As a result of comparative analysis of the current state of the problem, the purpose of the dissertation was formed and the issues that need to be addressed to achieve this goal were identified.

2. Algorithm for selection of scientific profiles of SSU technopark was proposed within the substantiation of creation of information provision for information-measurement and management of scientific-research and production areas of HEİ technological park [1, 11].

3. Information-search, selection and database management system of machines of flexible mechanical assembly production area, 2-dimensional design projects of layout scheme were developed for selection of set of production areas of HEİ technological park [7,8].

4. Functional analysis algorithms have been developed within the framework of the design of the complex structure scheme of the technopark, its research, production and management system [6].

5. Algorithm for selecting the active elements of technical support has been developed for the design of the management system of the flexible production area of the Technopark .

6. Conceptual model of automated design of the management system of research and production modules of the technological park in the higher education institution has been developed [14].

7. Algorithmic and software have been developed on the basis of SSU to automate the process of selecting an innovative project to be developed in the production of the technology park [3, 10].

8. Information-measuring and management system of science-research units and flexible production area of HEİ technological park Based on the general structure of the modeling tool, a structural analysis model and control algorithms have been developed [12, 13].

9. SCADA architecture was proposed to automate the management system of the Technopark's FPA, and an algorithm for planning information-measurement and management procedures of the active elements of the FPA was developed at each of its levels.

10. On the basis of SSU on the basis of the hierarchical architecture of the automated control system of the FPA of the technopark the selection of technical means of the corporate network and the IP addressing algorithm of deaths of active elements of the FPA were developed [9].

THE MAIN PROVISIONS OF THE DISSERTATION WORK ARE PUBLISHED IN THE FOLLOWING SCIENTIFIC WORKS:

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