Матеріали
XVI Міжнародної науково-практичної конференції
Materials of the 16th international scientific and practical conference

СУЧАСНІ ІНФОРМАЦІЙНІ ТА ІННОВАЦІЙНІ ТЕХНОЛОГІЇ НА ТРАНСПОРТІ

MODERN INFORMATION AND INNOVATION TECHNOLOGIES IN TRANSPORT

MINTT – 2024

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У збірнику представлено матеріали XVI Міжнародної науково-практичної конференції «Сучасні інформаційні та інноваційні технології на транспорті», яка відбулася у м. Одеса 29–31 травня 2024 р. і була присвячена актуальним питанням застосування сучасних інформаційних та інноваційних технологій у транспортній галузі.

Матеріали збірника розраховані на викладачів та студентів вищих навчальних закладів, фахівців науково-дослідних установ та підприємств.

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The collection presents the proceedings of the XVI International Scientific and Practical Conference «Modern Information and Innovation Technologies in Transport», which took place in Odesa on May 29–31, 2024 and was devoted to topical issues of modern information and innovation technologies in transport sector.

The materials of proceedings are designed for teachers and students of higher educational institutions, specialists of research institutions and enterprises.

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PECULIARITIES OF USAGE THE PHYSICAL MODELING OF SHIP ELECTRIC POWER SYSTEMS IN THE EDUCATIONAL PROCESS

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Introduction. The need to improve the quality and level of training of specialists for the marine electrical power industry in modern conditions is very important, since often the cause of accidents is the human factor. The paper [1] reflects the current state of the problem and outlines the main features of a systematic approach to human errors, taking into account psychological reasons. Various approaches to solving the problem of reducing the level of human errors in the operation of technical systems are considered. No less important is the visualization of parameters about the state of the power system using information display systems [2], the quality of which determines the speed and accuracy of obtaining information about the state of the ship's electrical power system (SEPS). One of the possible concepts for constructing operational and dispatch control systems for energy resources is considered in [3]. However, for the safe use of modern automated control systems (ACS), ship electromechanics must also have the appropriate professional knowledge and skills, providing maintenance of ship equipment and automation means. In the process of training specialists, the work with real equipment allows them to get the necessary competencies. In the context of university training, this can be achieved by creating a physical model of the SEPS and its ACS. This is also justified in work [4], which states that it is advisable to use the division of the training process into two stages – based on information and physical models of SEPS. In fact, such a physical model of the SEPS is a simulator that provides adequate reproduction of operational situations.

The aim of the research is to develop approaches to modeling control processes for ship electrical power systems using the physical model of the SEPS and its automated control system, the structure of which provides opportunities for training specialists in the operation and maintenance of ship electrical equipment and related software.

The educational and research laboratory of power electronics, electromagnetic compatibility and control problems in the electric power industry was created at the Admiral Makarov National University of Shipbuilding at the Department of Programmable Electronics, Electrical Engineering and Telecommunications. The basis of the laboratory is a physical model of the SEPS, consisting of two synchronous generators with a power of 2 kW and asynchronous drive motors, as well as an internal combustion engine. The stands are equipped with Altivar frequency electric drives, microprocessor systems for synchronizing generators and load sharing, microprocessor systems for excitation of synchronous generators, and digital devices for monitoring electricity parameters. All automation tools are integrated into a microprocessor network. The physical model of SEPS is controlled by an ACS, which includes microprocessor systems for acquisition and processing information, the main functions of which are:

– control of the SEPS physical model operating modes;
– switching of powerful electricity consumers;
– measurement of the generators active and reactive power;
– power factor control during parallel operation with the network;
– control of the synchronous generators excitation;
– control of generator voltage parameters and drive motors;
– statistical processing of power quality indicators;
– monitoring of vibration-acoustic indicators of equipment.

The parameters of the SEPS are controlled and monitored from the control panel, which is part of the automated control system and consists of three sections:

– section for monitoring the parameters of synchronous generators and monitoring the quality of electricity. It includes a sensor monitor that displays the values of voltage, current,

generator power, and displays the results of spectral analysis of voltage and current in the network;

– SEPS operating modes control section that provides control of the start/stop of engines, control of the excitation of synchronous generators and the process of their synchronization with the network, performs the functions of load sharing between generators;

– section for controlling and monitoring parameters of generator drive motors and load control. Provides monitoring of motor parameters, start and stop of induction motors, displaying of alarm signals, and allows to program the operating modes of drive motors.

The use of the physical model of the SEPS allows training to be carried out in accordance with the algorithm presented in Fig. 1.

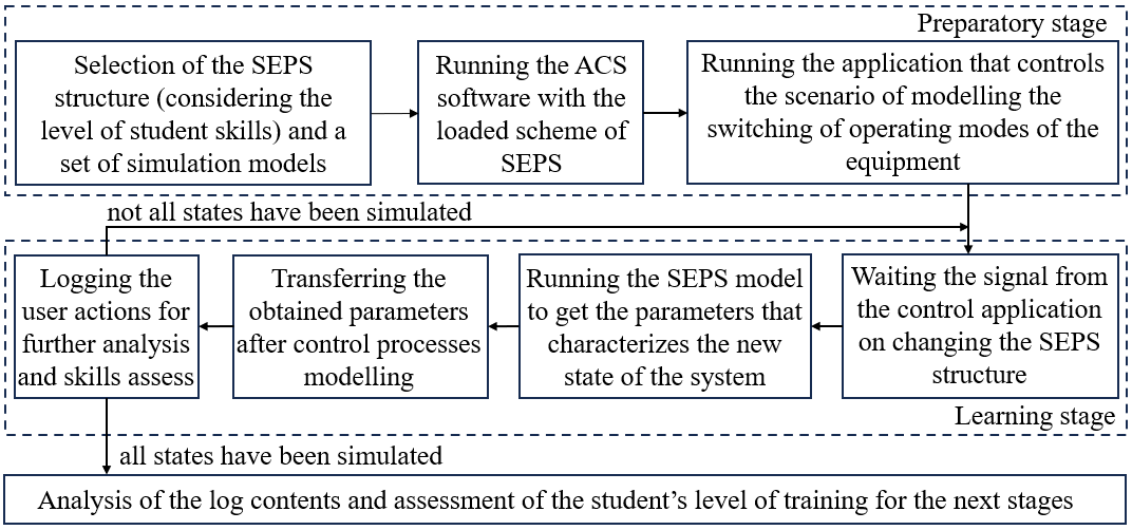

Figure 1 – The algorithm for training specialists in ship electrical equipment at the primary stage

In the laboratory a developed specialized SCADA system for controlling an electrical power plant is used, which performs the following functions:

– design of the ship power plant structural diagram;

– monitoring of diesel generator units parameters;

– management of electricity consumers and load sharing between parallel operating units;

– spectral analysis of current and voltage;

– displaying parameters of the current state of the ship electric power plant physical model and transmitting operator commands to automation controllers in real time;

– monitoring of communication channel congestion.

Software monitoring tools provide oscillograms of the voltage and current of each generator and perform a spectral analysis of voltage and current. Based on these data, the harmonic coefficient is calculated, which is an indicator of power quality. The values of active, reactive and full power of the generator, as well as power factor, are calculated. The use of stylized indicators allows to display parameters in a form convenient for the operator. The control panel, together with other stands, is used to conduct scientific research in the following areas:

– research of the process of automatic precise synchronization of generators;

– frequency control of induction motors;

– phase control of induction motors;

– active/reactive load sharing between generators operating in parallel;

– power quality control, voltages and currents spectral analysis;

– remote control of power converters;

– control of technological equipment via wireless channel;

– systems for acquisition and processing information about the state of power units;

– research and forecasting of ship power plants operating modes;

– research of predictive control systems of synchronous generator excitation;

– solving optimization problems which can occur in SEPS control;

– software development for ACS SEPS;

– research of microprocessor networks and optimization of information flows.

The use of the physical model of SEPS makes it possible to solve the following tasks of training specialists, in addition to ones described in [4]:

– studying of connection diagrams and adjustment algorithms for automatic frequency regulators of diesel engines and voltage regulators of synchronous generators; systems for synchronizing diesel-generators with the network and load sharing between generators that are operating in parallel;

– studying of soft start and braking systems, variable frequency electric drives of induction motors: study of the structure and operating principle, motor connection diagrams and control signals, features of system control using hardware and analog or discrete signals;

– studying of control and parameters monitoring systems for diesel engines: studying of block diagrams and operating principles, device circuitry and typical connection diagrams, features of setting up devices for operation in a unified information and control network of a distributed control system; studying of types and interfaces for connecting industrial sensors of physical parameters;

– studying the connection diagrams and operating principles of programmable logic controllers and expansion modules; studying PLC programming languages and the principles of combining devices into subsystems to implement complex local equipment control algorithms;

– use of knowledge and skills obtained as a result of studying the basics of operation of the above-mentioned automation systems, as well as specialized software for studying a distributed control system of a physical model of SEPS.

Conclusions. The described structure of the physical model of the SEPS provides wide opportunities for conducting research of SEPS automated control processes. This stage of training involves a step-by-step study of automation hardware at local stands and then as part of a distributed control system for the SEPS physical model. First of all, such a physical model opens up opportunities for undergraduates and graduate students to develop and research intelligent control systems based on neural networks and fuzzy logic, allows them to conduct research in the field of human-machine systems, and create training stands for certification and training of personnel. The SEPS physical model provides the ability to study the influence of power quality on information processes occurring in a distributed network of an automated control system. Software for managing the ship's electrical power system allows personnel to automate the process of generating electricity, managing the operating modes of the SEPS, etc.

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