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MONITORING AND CONTROLLING AGENT OF MICROGRID CLUSTER

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Annotation

Abstract*.The article is devoted to the research of multiagent systems and methods of their usage in monitoring and controlling Microgrid clusters. Such systems must be able to adapt to changes in energy demand from the user side and respond to changes in environmental parameters, taking into account environmental constraints and the dynamics of energy costs. It allows to easily integrate different energy sources of distributed generation, especially renewable resources. This article is reviewing in detail Multiagent systems and their possible implementation in Microgrid clusters and describes as an example created agent for small energetic system.*

Key words*: distributed systems, multi-agent systems, microgrid systems, remote control*

I. Introduction

With the rapid development of modern technologies, it becomes more and more important to create a reliable network of permanent stable energy supply. Not only important the efficiently divided load distribution on the network, but also the possibility of integration various sources of distributed generation into such systems, especially renewable ones, characterized by the variability of the generation parameters. The system must be able to adapt to changes in energy demand from the user side and respond to changes in environmental parameters, taking into account environmental constraints and the dynamics of energy prices.

One of the most promising solutions is a way to organize energy communications using Microgrid. Microgrid systems are localized group of sources of energy resources and loads that can work both autonomously and can be part of a larger system. The idea behind such an organization is to make local systems (city, village, etc.) more autonomous and resilient and able to communicate efficiently with other systems. The simplest Microgrid system can consist of distributed generators, renewable energy resources, energy-efficient clusters with flexible load.

The existence of such a system is impossible without the right approach in its management. There are two ways to manage such systems: a more conventional centralized way where all systems are subordinate to one main element (center); or in a decentralized way where each system controls its function or system and is able to regulate its work, adapt to external changes, and share requests and information with other systems.

The centralized approach of managing such systems loses its effectiveness due to the constant complication of systems - constant dynamic modes of operation and the need for constant adaptation to rapid changes of parameters of nonlinear solvable problems of the system.

The decentralized system is based on the idea of dividing it into independent systems, which are able not only to perform all the necessary functions to regulate the internal state, but also to adjust their work relative to the external situation and the operation of other systems. This method of control makes the system flexible to external changes and allows you to effectively adapt the system to the current situation without stopping it.

II. Multiagent systems

Microgrid systems can be a promising energy system for renewable energy technologies that accompany the necessary expansion of distributed energy resources, especially small-scale thermal and electrical and small-scale renewable energy. Such systems typically include: microturbines, fuel cells, photoelectric cells, solar thermal arrays and wind turbine installations, as well as accumulation regulation, load regulation, power and voltage regulation, and heat recovery must be grouped into a Microgrid system. Micro-grids can meet the costs, efficiency and environmental benefits; and the requirements for the safety, quality, reliability and affordability of on-site production are achieved by incorporating state-of-the-art controls and functioning with some autonomy [1].

For even more efficient use of such systems, the principle of multiagent systems can be used in their management [2].

The most relevant approach to creating highly adaptive distributed systems is the Multi-Agent Approach. Multi-agent system is an automated distributed control system consisting of independent (or partially independent) intellectual agents who control their own restricted branch of the system. Agents should be able to respond to external and internal changes, as well as share information with other agents to solve a common problem or problem.

The main principles of intellectual agents are:

- Activity - the ability to organize and execute actions

- Reactivity - the ability to perceive the state of your environment
- Communication - the ability to solve problems together with other agents of the system using advanced communication protocols
- Autonomy - the ability to work in relative independence from one's environment and the presence of some freedom of will in one's actions
- Purposefulness - the presence of clearly stated tasks and the mechanism for setting tasks and the scenario for solving them.

Agents can exchange information using any agreed language, within the constraints of system communication protocol, the approach can lead to overall improvement. Examples of implemented agent communication languages are Knowledge Query Manipulation Language (KQML) or Agent Communication Language (ACL).

This management approach not only automates the process of managing the system, but also allows you to accurately and quickly diagnose the causes of system failure, optimize the work to solve them. Therefore, applying a multi-agent approach to energy systems is a rather interesting and promising approach, as it has few implementations and requires further investigation of its main issues:

- Decision-making: what decision-making mechanisms are available to the agent? What is the relationship between their perceptions, ideas and actions?
- Control: what hierarchical relationships exist between agents? How do they sync?
- Communication: what messages do they send to each other? What is the syntax of these messages?

Fundamental research is currently underway on the challenges involved in implementing multi-agent systems and communication protocols. This system is usually used in telecommunications, the Internet and physical agents such as robots.

The study of multiagent systems has made progress in artificial intelligence, hardware and sensor technologies, which has led to agents' technologies being successfully used to solve real-world industrial problems. For example, the VOLTTRON project, which employs a multi-agent approach to managing network devices, was supported by the US Department of Energy to transmit the VOLTTRONTM software platform to Tranformative Wave. In addition, the department provides Tranformative Wave with technical support for the development of products and services that increase the efficiency of buildings and the resilience of power grids. This project indicates that the industry adopts agent technology.

III. Monitoring and controlling agent

The purpose of my research is to create a prototype of a system for monitoring the technical condition and control the modes of operation of the energy infrastructure using a multi-agent approach. Such a system must harmonize the processes of generation, transmission, distribution, transformation, accumulation and use of energy in real time, taking into account environmental, technical, physical, meteorological, social, economic factors and ensuring the most comfortable conditions for the energy consumer.

The first step in creating such system was to develop a software agent to monitor the technical state and control the operation mode of the energy system branch, with the end consumer (Fig. 1).

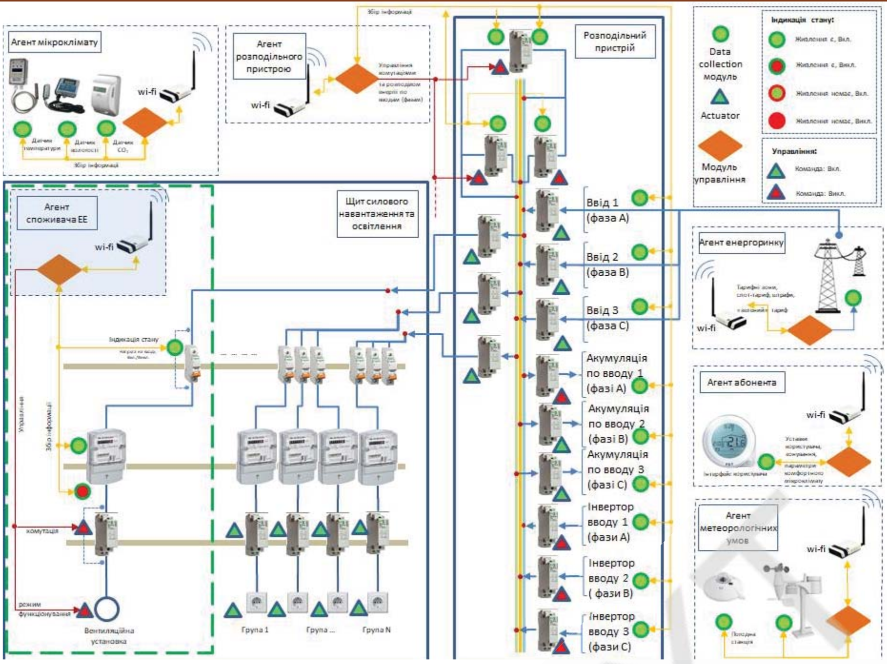

Figure 1. Multiagent system for monitoring and controlling energy system

The software agent monitors the availability of power on each individual link of the branch, the mode of operation of the means of protection and power switching (circuit breaker, starter), keeps a record of the consumed energy, diagnoses the technical condition of the consumer. In the event of an emergency or before an emergency, the agent fulfills the response in accordance with the developed scenario. If the deviation in the mode of operation "in the opinion of the agent" can be adjusted, then it makes such correction by making management actions. If the deviation does not lead to the development of the accident, but allows the use of the equipment is not at full capacity, then the agent translates the equipment into energy-saving mode - the mode of partial use of resources - and requests a service department to restore the technical condition of the equipment. If agents are unable to resume branch operations on their own, they request a service and repair service. Today, a hardware and software complex has been created in which all of the above functionality is implemented (Fig. 2).

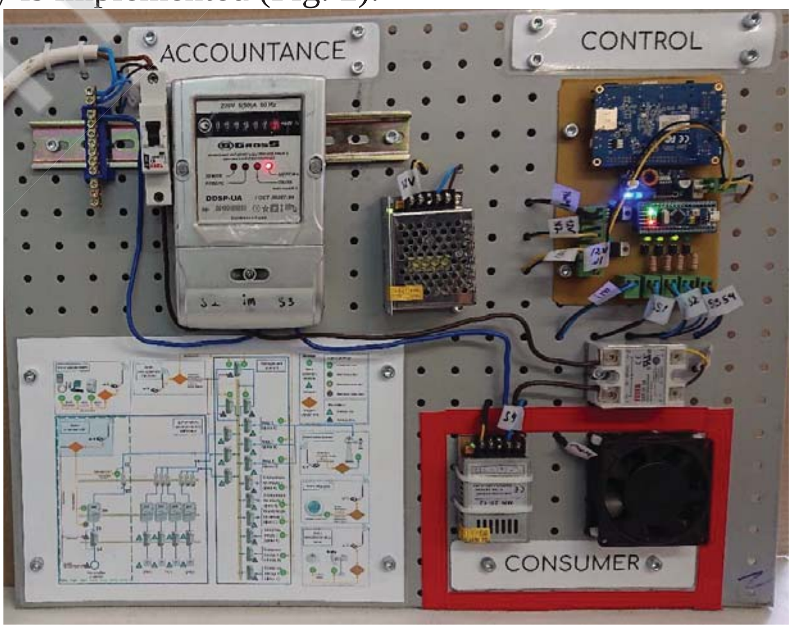

Figure 2. Created stand for testing and displaying agent’s work process.

The creation of the agent consisted of two parts: the development of the physical part of the agent - a hardware complex connected to the monitoring and control of the branch, and the software for it - the intelligent agent. The hardware complex is based on the STM32f103c8t6 controller for sensor data collection and actuator control, and a single-board OrangePi PC that houses the main agent code. C, C ++, and C # languages were used for the development of different system modules.

IV. Research result

As a result of research, I was able to create an agent that can be connected via TCP / IP and monitor its mode of operation, give it commands to change the mode of operation, edit the behavior script through the developed remote user interface. By constantly monitoring the sensors on the network, the agent can detect the part of the branch that is experiencing problems and keep constant monitoring of electricity use. The agent also archives all events on the system into a log file and can generate reports on requests from external agents of the system.

The user interface includes 3 tabs, each of which is responsible for its function. The tab entitled "Stats" (Fig. 3) shows the current status of the power grid. In the scheme of the system, near the points where the current sensors should be, there are quadrilaterals that reflect the current value of the sensors: if the quadrilateral has a red frame, the sensor shows no current in this area. If the quadrilateral turns bright green, the sensor captures current in this area.

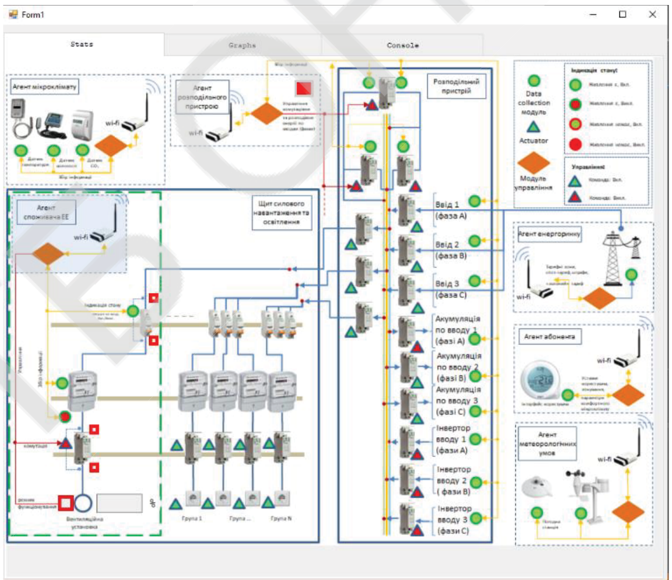

Figure 3. Tab “Stats”

The circle of the ventilation unit mark also includes a quadrilateral indicator that indicates whether the installation is currently on. On the other side of the label there is a text box that shows the current value (in percent) that is supplied to the ventilation system.

The following tab - "Graph" - contains a graph of the load of the grid. The chart changes in real time and displays the meter every second.

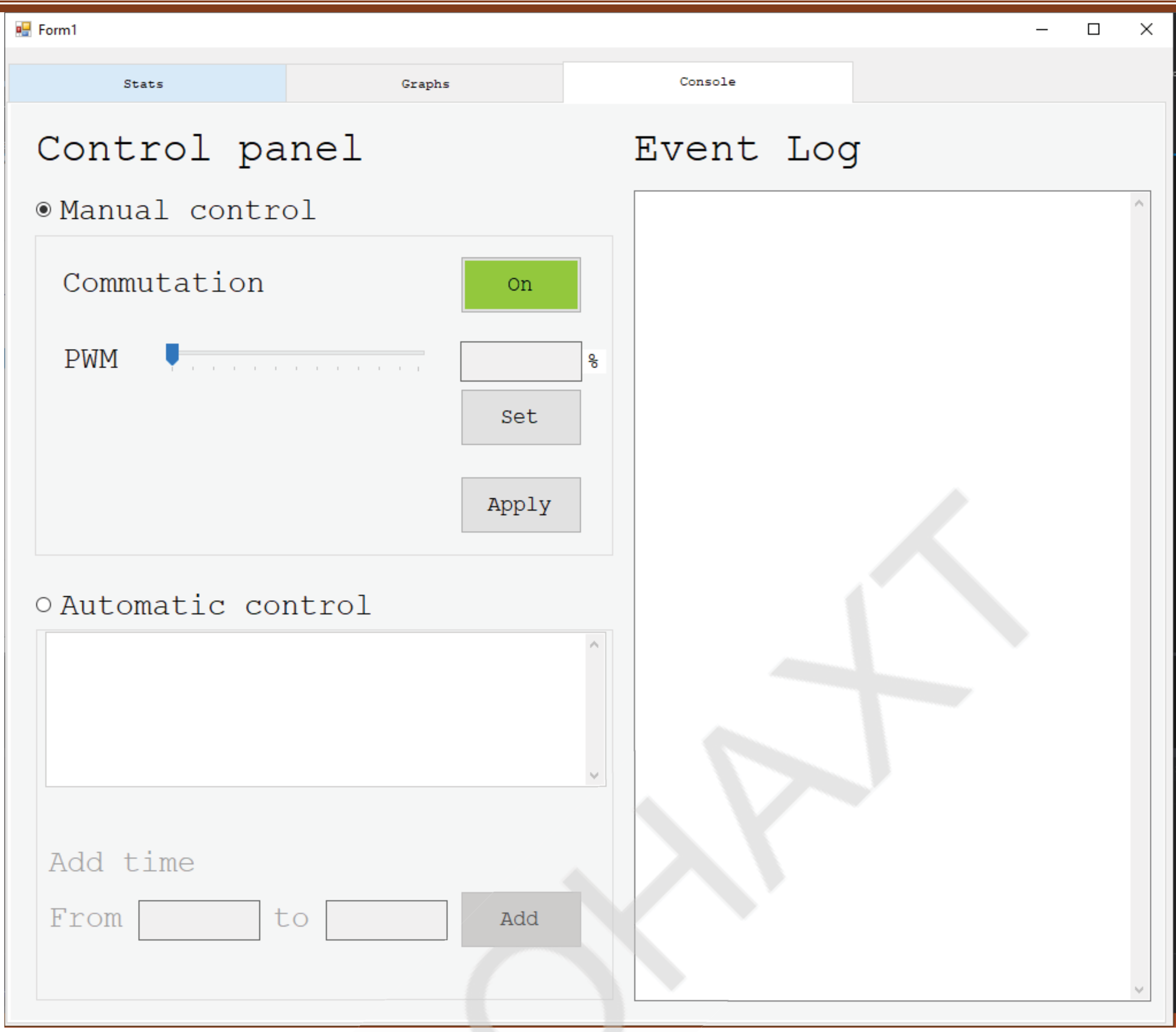

Figure 4. Tab “Console”

The Event log records all system changes and fixes errors. It can be used to conveniently track system events and detect bugs.

The automatic and manual control units cannot operate at the same time, so when selecting one or the other unit, the elements of the second are automatically locked until the unit is selected.

In the manual control unit, you can switch the installation on and off and set the signal strength of the installation. To send the command to the agent, press the button. The program will capture the values it will pass to the agent and send them to TCP / IP.

In the future, it is planned to create several agents that need communication with each other. This step is aimed at solving one of the most important issues of a multi-agent system - creating a convenient and easy-to-speak agent language. The developed system can be useful for both large industrial systems and small user systems.

V. Conclusion

The result of conducted research is the creation of a multi-agent distributed power and energy systems. It allows you to monitor systems’ technical state, integrate different devices and manage their work, overall management of power usage and its control.

This agent allows the multi-agent system to track electricity usage and manage system work according to that. This development has the greatest potential in facilities with high stable power requirement.

The introduction of such a control system will allow to effective usage of power resources, easy maintenance of PowerGrid nodes and gives complete control over all devices in system.

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HEAT LOSS MONITORING OF MULTI-STORY BUILDINGS USING MULTI-AGENT APPROACH

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Abstract. *In this paper, the problem of developing a multi-agent method for detecting the places of heat energy leaks on the multi-story buildings using machine learning is solved. Efficient data processing of scanning areas for the heat energy leak monitoring was achieved using the multi-agent monitoring system (MAMS) that can perform calculations in the cloud conditionally. Features of the monitoring system with the integration of an analytical model for presenting a heat loss map with an account of multiple autonomous separated UAV's for temperature measurements were contained. The MAMS reliability of the synchronization model between simultaneous localization and mapping method and generated heat loss map based on temperature measurements was confirmed. It has been experimentally proven that theoretical assumptions and accuracy for experimental usage during the multi-story building leaks analysis are sufficient.The recognition time of markers of the front of the building is in the range from 0 to 27 s. In this case, with the proposed model CNN, the CPU load during the execution of tasks did not exceed 26%.*

Keywords: *heat loss mapping, heat leak detection, machine learning, multi-agent system, GPS, pyrometer, UAV, MAMS.*