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To cite this article: V S Kuzmin and D V Elenev 2021 *IOP Conf. Ser.: Mater. Sci. Eng.* **1060** 012017

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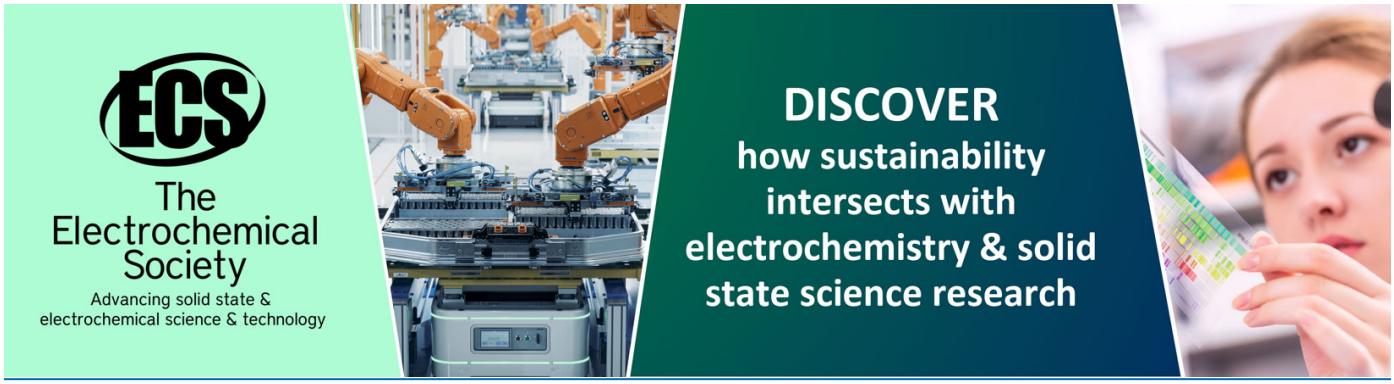

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Modelling the work of the transport complex

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Abstract. The modelling of the transport complex is made using an automated system and an example of the enterprise that uses the dangerous materials. The example of such enterprise is a nuclear power station. The automated system used for modelling is a web-based intranet application that realizes monitoring and control functions. The automated system uses a system of objects included into the model of the enterprise, namely: gates, roads, transportation devices and controllers, airtight zone, describing the reactor building, gateway which allows to move cargo into and out from the building, non-airtight zone, which describes the outside area, and the zone of loading and unloading the cargo. The system receives input signals of discrete or analogue origin. Basing on the results of data collection, the algorithms of forecasting the crucial changes in states of main elements of the transport complex were developed. The automated system models the workflow of elements and the whole transport complex.

1. Introduction

The transportation of cargo between different sites of the territory of an organization should meet the requirements of logistics process and safety of the cargo. Some cargos being transported can be dangerous for the environment and staff. In order to obtain safe transportation, special conditions may be used. For example, the transport complex of the nuclear plant or chemical station provides transportation of containers with fuel and radio- or chemical-active elements through the sealed enclosure of the building [1].

The aim of the work is to create cross-platform software (designer) allowing an engineer without special programming skills to develop a complete software tool for operator panels that meets requirements for the functionality and safety of technological processes in production. In order to reduce the repair time when breakage occurs, it is necessary to minimize the time spent on diagnostics of individual elements at their installation sites. This can be done by standard software procedures aimed to monitoring and forecasting procedures for the operations of the transport complex.

In contrast to commonly used software like TIA Portal by Siemens AG and ABB Panel Builder, the automated system described below offers a novel fast user interface based on web application that can be used on different desktop and mobile devices.

2. Literature review

The transportation of cargo is a complex process that has peculiar properties basing on the nature of the cargo. The automation of the transport is necessary to reduce the decision-making time by providing operators and other staff with actual information about current state of the transportation process. The transportation process can be described by a number of process variables including temperature, pressure, distance, liquid levels, etc., and these variables can be received with delays or simultaneously [2]. The connection between people, services and things can be made using the Internet of things (IoT) concept [3] instead of traditional automaton of the manufacturing process [4,5].

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Some researchers use their own software modules for simulation testing systems, for example, testing for train-borne controller [6]. Usually these applications are desktop, but for better mobility, it is possible to use web-based technologies [7].

The transportation where dangerous cargo is being transferred, like atomic energetics, should always have the risk management [8-10]. The transportation of the cargo can be consistent, aimed to transport one cargo at a time, while wide number of transport complexes use multi-vehicle transportations in both civil and military areas [11,12]. The cargo itself can be solid, liquid, bulk [13] or may have special properties.

The automation of the transportation process allows to reduce the reaction time and to forecast possible failures in the elements of the complex basing on the history of usage.

3. Architecture

The model of the transport complex is based on a number of typical objects used in software designer. These objects include airtight and non-airtight zones, gateway between them, zones of loading and unloading etc. The automated system receives input signals of discrete and/or analogue origin.

The automated process control system (APCS) during its workflow realizes the data transfer from the field level sensors that performs discrete and analogue signals, to the panel PC level where the web application works (figure 1).

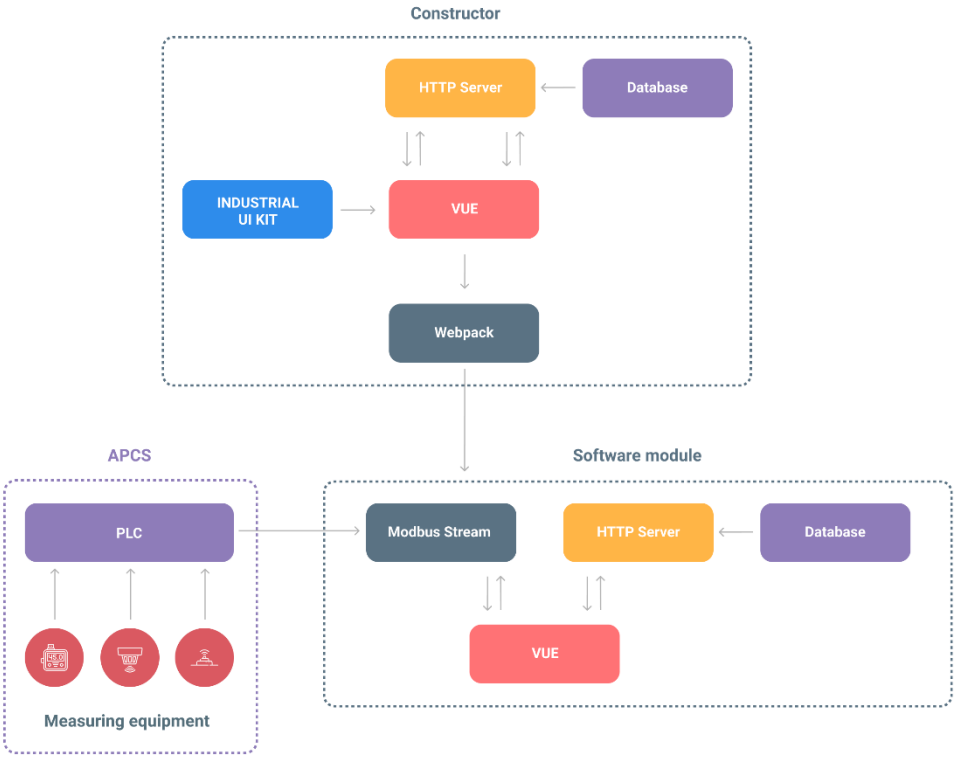

Figure 1. Model of the automated system

As a result of exchange of states between the server and client sides at the Panel PC level, the subsequent visualization of the data in made on the operator panel. The event log with warning and alarm conditions is sent to the Database block.

The software project for modelling the work of the transport complex uses the technological stack where the components work in a single eco-system that does not consume excessive hardware resources. This technological stack consists of the following components:

- Vue.js - a framework for implementing the client part of the constructor

- Vuex.js - a library with a centralized state repository for the Vue.js framework
- Chart.js – a library for converting data into charts
- HTTP server for collecting and transmitting data between the PLC and the operator panel
- Modbus TCP js library – a library for working with the ModbusTCP protocol
- MongoDB – database
- IndustrialUIKIT – author's library of components for implementing user interfaces

This software solution is cross-platform, allowing to use any desktop or mobile device.

4. Modelling and forecasting

The software made for allows to the model the work of the transport complex as a web-based application. This application uses the database of states of the element of the transport complex and helps to predict possible faults of elements. As a result, the application automates the work process of the transport complex.

An example of a constructor web application user interface is shown in figures 2 and 3. The constructor provides the following functions: creating a parameter, collecting statistics from an object, import/export data, filtering, sorting parameters on the screen, warning dialogues.

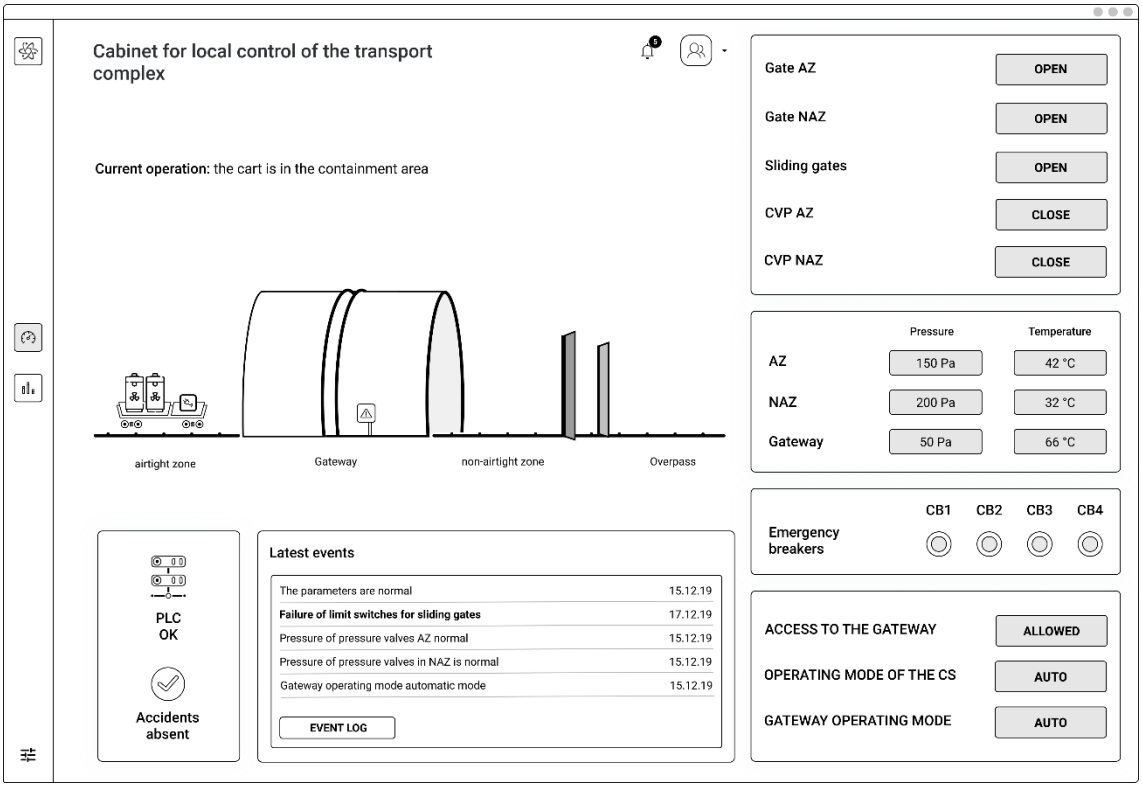

Figure 2. User interface

The software system collects data about elements of the transport complex, and this database allows to forecast the crucial changes in states of main elements. The forecasting algorithms allows to provide emergency messages for operators. The base of the algorithm is the statistics on duration and intensity of usage of every element of the transport complex. The algorithm uses the information about the properties of the elements given by their manufacturers. The software allows to complement this information by user-defined parameters.

Therefore, the upcoming end of lifetime of the elements can be forecasted using the data stored in the database of the system, thus reducing the frequency of failures in the lifetime of the transport complex.

Figure 3. Constructor

5. Discussion

The algorithms of forecasting the important changes use the base of knowledge of lifetime of single elements. This knowledge and logging all events allows to predict the failure of elements due to end of their life cycle thus reducing time while replacement of element. At the same time, the conditions of the surrounding medium like overheating, high humidity, electromagnetic radiation *etc.* lead to the reduce in lifecycle of element, and this factors should be taken into consideration to minimize the events of replacement of single elements thus reducing the cost of ownership.

6. Conclusions

The automated system that models of the work of the transport complex provides operators with actual information about state of the cargo and elements of the complex. The sources of this information are field level sensors, and the analysis of the collected data allows to reduce the number of unplanned repairs.

The software made for the automation uses fast user interface base on web application, thus offering platform independency for the end-user device.

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