Using of the modified approach “hardware-in-the-loop” while developing an process control system for belt conveyor

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Abstract. The method to test application software of a process control system for belt conveyor on the base of the modified approach “hardware-in-the-loop” is proposed. The description and example of using of specialized software-hardware complex for testing of application software of process control systems is given.

1. Introduction
Alterations of software and hardware of the process control systems during commissioning and start up slows down the process of implementation and can cause emergency conditions.

Such alterations can be required as the need arises to integrate the new or modified software and hardware into existing process control systems. In this connection not only adjustment and testing is required but checking of compatibility of the new system components with the components of previous versions working on the operating enterprise. It is possible to solve the problem with the help of adjustment and testing of application software for process control systems with the help of specialized software-hardware complex adapted to checking of compatibility of the tested system with previous versions.

2. Specialized software-hardware complex
The complexity of complex debugging and testing of process control systems resides on laboriousness of artificial shaping the complete set of agreed concurrent signals of the real technological equipment.

In order to develop, debug and test the application software of process control systems such facilities as software and hardware simulators of signals and interfaces are used. But specialized systems with the problem oriented models of automated technological processes are more effective. They ensure the agreed generation of sensor and control signals.

To solve the problem of debugging and testing of application software for process control systems there exist different specialized systems with the problem oriented models, for example [1, 2] and others. The specialized software-hardware complex for testing the application software for process control systems in mines is developed in the Institute of Computational Technologies of Siberian Branch of the Russian Academy of Sciences [3].

This specialized software-hardware complex tests the application software by substituting the actual signals from sensors of operating technological equipment and controller commands to virtual signals formed on the base of values of simulated parameters of the technological equipment.

The complex has two level structure containing software and hardware levels. The software level contains the SCADA system, the simulation environment MTSS [4], a communication dispatcher,
input/output modules of process control system, simulation models of technological processes, simulation models of technological equipment, control programs for the upper and the lower levels of process control system.

The hardware level contains a workstation of the model operator, a workstation of the SCADA operator, data transmission environment, a unit for forming actual signals, and equipment of process control system (controllers, input and output equipment, sensors, etc.). The unit for forming actual signals generates corresponding analogous and discrete signals basing on model data.

The simulation model takes into account the peculiarities of the hardware, i.e. parameters of technological equipment (pumps, engines, etc.), the project data on the technological equipment configuration, and the parameters of the actual technological processes.

The complex is used in the Institute of Computational Technologies of Siberian Branch of the Russian Academy of Sciences while testing the application software for mine process control systems.

3. Process control system for coal mining
The Institute of Computational Technologies of Siberian Branch of the Russian Academy of Sciences is developing process control systems of dangerous industrial projects including technological processes of coal mining and transportation.

According to functions the process control systems which is develop in the Institute can be divided into two parts – underground (lower) level and surface (upper) level. Lower level provides control and data collection from different technological equipment of the mine. Upper level performs the functions of central calculating processor and dispatcher’s workplace.

As the process control systems develop more and more complex algorithmic tasks and functional requirements were entrusted on them. Moreover different teams of developers participated while developing versions of the process control systems and there can be cases of interaction of different versions or implementations in the frame of integrated automation system. In this connection there exists the necessity to check the compatibility of components of the developed process control system with the previously developed ones.

4. Modified approach “hardware-in-the-loop”
In the frames of the existing software-hardware complex the task the checking the compatibility of components of the developed process control system with the previously developed versions or implementations was solved by modifying the approach “hardware-in-the-loop”. The approach “hardware-in-the-loop” involves automatic testing of process control system (controllers) with signals which numerical value are formed with the usage of mathematical model and transformation of model signals into virtual is done by corresponding transformers.

The approach is modified in such a way that in order to test the controller together with the model the connected in parallel controller of previously version or implementation (the reference controller) is used. This allows carrying out the test and obtaining identical functioning of the test and the reference controllers on the identical sets of input signals.

Figure 1 depicts the diagram of implementation of the modified approach. The simulation model of the technological process generates virtual signals and the unit of generation of the actual signals transforms them into their electric analogues. The parallelization of discrete and analogous signals is carried out in the unit of duplication of actual signals. After that the signals go simultaneously to the test controller and the reference controller. The control commands of the upper level of the process control system pass to the controllers through the interface RS-485. The signals formed by the controllers go to the unit of generation of actual signals and after transforming into digital form go to the technological process model where in the specialized unit the comparison of signals from the test controller and the reference controller is performed. The model of technological process simulates control commands from the test controller.
5. Conclusion
The software-hardware complex with the modified structure was applied to develop one of process control system designed to automate the process of coal mining and transportation. The controllers tested on the software-hardware complex were successfully introduced on the mine Gramoteynskaya (Kuzbass) to control of belt conveyers.

The peculiarity of the software-hardware complex is the existence of the mode of operation when several controllers work concurrently on the identical sets of test signals. The simulation model works as the source of signals and analyses responses of control system. It allows to test the compatibility of input signals of the test controller and the reference controller, to accelerate the verification of the developed applied software.

The developed software-hardware complex can be applied to debugging and testing of the applied software for perspective control process systems for other industrial branches for example while developing the process control system for movement of roof supports when the coal mining is produced by longwall.

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