Theoretical aspects of the implementation of remote monitoring and control of technological processes controlled using SoftPLC

P A Nikishechkin and A A Akimov*
MSUT “STANKIN”, Moscow, Russian Federation

*E-mail: akimov2804@gmail.com

Abstract. The presented article discusses the theoretical aspects of the implementation of remote monitoring and control of technological processes controlled using the SoftPLC. The developed software environment must meet the requirements for visualization systems: speed, ease of understanding the control process, reliability and information content.

1. Introduction

The introduction of new techniques and information technologies in the management of technological processes, as well as the tasks of increasing the information content and providing opportunities for remote monitoring of technological processes, are currently relevant in the management of heterogeneous technological processes [1-3]. When building systems for monitoring and visualizing technological processes, the main tasks are:

• data exchange with “devices for communication with the object” in real time through drivers, information processing in real time;
• logical control;
• displaying information on the monitor screen in a convenient and human-readable form;
• maintaining a real-time database with technological information;
• alarm management;
• preparation and generation of reports on the progress of the technological process;
• implementation of network interaction between SCADA-stations (computers);
• providing communication with external applications (DBMS, spreadsheets, word processors, etc.);
• the ability to develop an automated process control system in a client-server or in a distributed architecture.

The requirements for visualization systems include: speed, ease of understanding the control process, reliability and information content.

The article proposes a solution to the problem of increasing the information content and providing opportunities for remote monitoring of technological processes by developing an interactive environment for visualization and control of heterogeneous technological processes controlled by the SoftPLC [2,4-7].

2. Structure of SoftPLC with a built-in development environment and visualization of interfaces

SoftPLC developed at the department of CNC MSUT "STANKIN" is a consequence of the development of technologies in the field of PLC: the core of the SoftPLC is implemented in software,
and the input / output of control signals is carried out through hardware expansion modules. The computational module of the controller is fully integrated into the core of the CNC system. The terminal editor is implemented as an external application, which allows the PLC to be used both as part of a CNC system and as a stand-alone product. The PLC program editor is intended for creating, editing, configuring, debugging, starting / stopping an electroautomatic program, as well as its verification [8-10]. PLC development is implemented in the Functional Block Diagram (FBD) language of the IEC 61131 standard. SoftPLC have a number of advantages over classical PLCs, which lead to the emergence of this direction in the development of intelligent automation tools:

- no need for additional equipment;
- low cost compared to PLC;
- the ability to quickly upgrade by installing updates, since SoftPLC is a software implementation;
- the ability to remotely diagnose and resolve error situations on the Internet.

The structure of the SoftPLC client application consists of:

- PLC programming environment;
- configurator of hardware input / output devices;
- PLC variable manager.

Variables can be bound to either hardware I / O modules or be part of the internal variables of the PLC program.

Figure 1 shows the developed structure of SoftPLC with a built-in development environment and visualization of user interfaces.

**Figure 1.** Structure of SoftPLC with a built-in development environment and visualization of user interfaces.
The organization of communication between the terminal part and the kernel based on the TCP/IP protocol stack allows separating the main data streams of the control system and the data streams of the logical task. The SoftPLC core can be divided into: a component that implements the SoftPLC operation logic and a configuration component [11-15].

State machine SoftPLC is an automaton graph with a finite number of states, the set of which is determined at the design stage. The transition from one state to another occurs when the values of the set of system variables that characterize the system as a whole change.

Shared I/O memory defines the underlying I/O mechanism. The shared memory area is located in the system area of the core - the area of control drivers and allows you to synchronize work with the SoftPLC hardware and its software implementation.

The level of control and data transmission contains computing resources with installed software and mathematical software SoftPLC, which are located in the control cabinets of electrical equipment of the production system, and carry out centralized control of production processes. To interact with remote I/O modules, specialized boards are used that implement work based on the selected industrial protocol. The control and diagnostic terminals implement the possibilities of visualizing the technological process of the production line and their parameters [2,6].

SoftPLC client application has a component architecture and is used for:

- design, development (programming), debugging, testing and maintenance of software products created for the implementation of algorithms for the operation of SoftPLC, which is part of the CNC systems;
- for setting up, checking and supervising monitoring and control systems;
- configuring the user interface, client and server applications;
- to visualize the work of SoftPLC, both target and WEB-visualization.

To implement the above functions, the architecture of the SoftPLC client application consists of the following components:

- PLC programming environment, responsible for the implementation and maintenance of programs that implement the algorithms of SoftPLC;
- monitoring and control tools are built into the programming environment, they can also be implemented using custom applications using open programming interfaces.

The developed software environment consists of a designer of interfaces, consisting of visual components with the ability to bind them to the PLC with variables defined in the PLC program. Also, the software environment includes interface launcher, which allows you to emulate a controlled process, providing ample opportunities for debugging PLC programs, as well as monitoring and controlling a real technological process [15-17].

3. Conclusions
This work presents a solution to the actual problem associated with the possibility of remote monitoring of technological processes controlled by the SoftPLC [3,18].

Developed a structure model for building interface designer to visualize and control heterogeneous technological processes, characterized by the communication with the controller core using the mechanism of shared memory.

A method of interaction between the interface launcher and the SoftPLC core has been implemented, allowing you to display up-to-date information about the technological process and manage it.
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