Visualization techniques for production processes using the communication TCP/IP protocol

Techniki wizualizacji procesów produkcyjnych z wykorzystaniem protokołu komunikacyjnego TCP/IP

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Visualization of production processes allows you to monitor, diagnose and process control. In addition, it enables rapid assessment of state of the production machines. The basis of modern technology of data communication is protocol TCP/IP. This article presents example solutions based on modern methods of data transfer, which make it possible to visualize production processes in real time.
SŁOWA KLUCZOWE: production processes, visualization techniques, TCP/IP, PLC, SCADA, HMI

Wizualizacja procesów produkcyjnych umożliwia monitorowanie, diagnozowanie i sterowanie procesem. Ponadto daje możliwość szybkiej oceny stanu maszyn produkcyjnych. Podstawę współczesnych technologii przesyłu danych stanowi protokół komunikacyjny TCP/IP. Artykuł przedstawia przykładowe rozwiązania bazujące na nowoczesne metodach przesyłania danych, umożliwiające dokonanie wizualizacji procesów produkcyjnych w czasie rzeczywistym.
SŁOWA KLUCZOWE: procesy produkcyjne, techniki wizualizacji, TCP/IP, PLC, SCADA, HMI

The dynamic development of industry observed in the recent years has resulted in the increased complexity of technological processes and tightening requirements for quality, efficiency and timeliness of production. The huge competition prevailing in the market forces the use of more and more modern, safer and more reliable control and production management systems [9]. As a consequence, the management of a contemporary company is a very complex process. This is due to a great number of streams of goods and information, which intersect and complement each other. More and more often, systems supporting management in companies are insufficient. Therefore, techniques and tools based on the visualization of processes are used in companies, which enable better understanding of phenomena, which translates into a better production management [5, 7].

The current technological level enables acquisition and processing of production data directly from a production line in a way independent the process itself. The visualization of production processes is a graphical presentation of the data acquired in this way. It is designed to provide information supporting the process of proper decision making related to manufacturing processes in a simple an intuitive way. Visualization techniques for production processes may be separate applications to be run on a PC or they may be based on the use of web servers.The aim of this paper is to present solutions enabling visualization of production processes using the communication TCP/IP protocol and to present a selected system based on SCADA.

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Data acquisition from processes

It is in the industrial practice that the management and control of manufacturing processes is usually executed using PLC drivers. PLC drivers are industrial computers, whose task is to collect and process information and control of machines, equipment and complete production lines, in an open system and/or closed. Moreover the tasks performed by the PLC is the realization of diagnostic functions controlled devices and processes and communication with systems of management production and HMI devices. The PLC drivers executing of programmed control algorithms on the basis of an analysis of input signals from controlled processes in real time. As a result of a response to changes in input signals, a driver generates appropriate output signals and transmits them to external executive elements so as to obtain a desired action. The modern PLC drivers are very universal. The modular design of such drivers enables flexible hardware configuration, which allows for fitting them to work together with external signals with specific physical characteristics and for using them to work in different environmental conditions [8, 9]. PLC drivers are currently an essential element of the modern control of modern techno-logical processes used in almost every industry.

Data Transfer using the communication TCP/IP protocol

Modern technologies of data transmission in industrial automation amongst modules of automation systems are based on the concept of a computer network. They use standard protocols or devices participating in the data exchange. The functioning of the network is possible due to the transfer of data between devices. Transfer of data is enabled by sets of data transmission rules, called protocols. Different protocols are used in various types of networks, however, the Transmission Control Protocol/Internet Protocol (TCP/IP) is the most popular. TCP/IP is based on a number of layers working together. The assumptions of the TCP/IP model are similar to the assumptions of the OSI model in terms of the organization of layers, but the number of the layers is smaller and reflects the true structure of the Internet much better [1, 2]. The architecture of the TCP/IP stack is shown in fig. 1.

The TCP/IP protocol provides methods for transmitting information between different machines on the network, providing a reliable data transfer, supporting emerging errors and generating additional information associated with the transmission. TCP/IP allows for examining issues concerning communication regardless of network equipment [4].

These are PLC drivers which are the core of the automation devices in industry. It can be stated objectively that most popular drivers used by the domestic industry

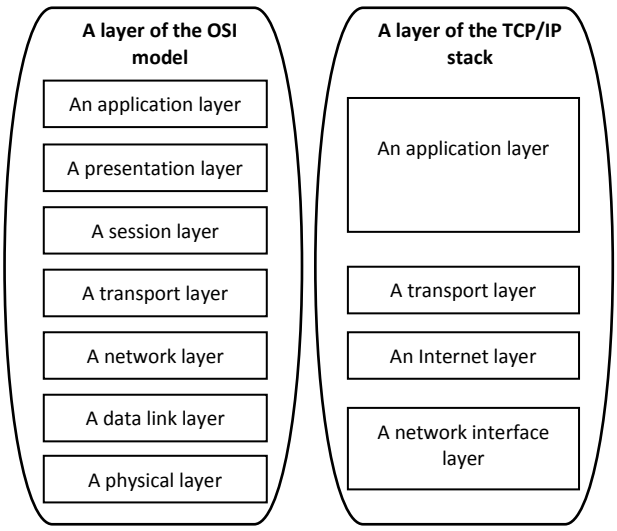

Fig. 1. The architecture of the TCP/IP stack [3]

are the SIMATIC S7 drivers of the Siemens company. In order to ensure the possibility of monitoring and controlling of industrial processes supported by such drivers, it is necessary to provide effective and continuous communication between the drivers and the master unit.

It is in practice that the information on controlled processes is continuously collected by the drivers. It may be stored by the PLC driver in special files in the memory (DB) or with markers (M). The data collected in this way may be used to decide on the process or (and) for visualization of the progress [8].

Visualization of production processes

Industrial technological processes require a reliable control system. The complexity of the processes themselves and of control systems entails the need to ensure a fast and reliable exchange of information between machines and an operator. It is as a consequence that safety of people, processes and objects depend on clear and functional software. For this reason, these are distributed control and visualization systems called SCADA (Supervisory Control and Data Acquisition) which are used universally in automation and which allow for viewing and analyzing data from controlled objects, devices or machines using a PC. The modern SCADA software enables full visualization of the state of processes [7]. An operator can both observe and change technological parameters. The system automatically generates information about alarms and emergency situations. The SCADA acts as an expert very often, making it easier for a user to make decisions in emergency situations. Generally, it can be said that the use of SCADA systems enables improving working comfort of the stuff working directly at production lines and of the management. Indirectly, it affects increasing economic efficiency and improving the quality of offered products.

There are many SCADA systems available on the market. Review of selected type systems SCADA shown in Table 1. In this study was decided to present the operation of the SCADA system on the example of the mySCADA software [6]. It was decided because the service mySCADA system is very intuitive and similar to WinCC. Moreover, the system mySCADA is much cheaper than WinCC, has a much lower hardware requirements and is available on multiple operating systems. An exemplary screen of a controlled process visualized in the mySCADA environment is shown in the fig. 2.

The mySCADA software enables viewing statistics of the data exchange in real time, a graphical presentation of value changes of a variable, a visualization of current and archival data (so-called trends); moreover, the system also allows for defining critical values of the monitored variables.

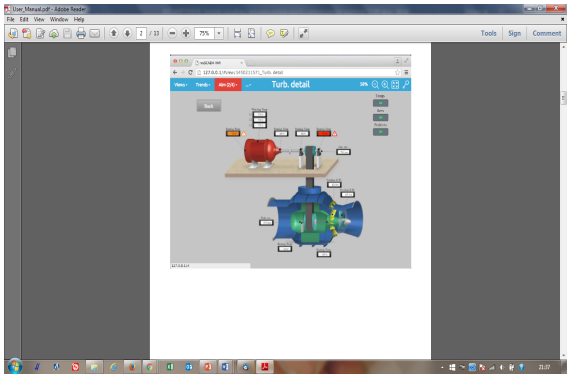

Fig. 2. An exemplary dialog box of the mSCADA [6]

After exceeding these critical values, the system generates an alarm. The information on an alarm can be displayed on a monitor, sent by email to a specified address or by SMS to a specified phone number [6].

Summary

The aim of this paper was to present solutions enabling visualization of production processes using the TCP/IP protocol and to present a selected system based on SCADA.

The systems of the SCADA type work closely together with PLC drivers, the communication amongst them is executed using an existing network infrastructure, so that the implementation of a SCADA system does not generate additional costs.

The techniques for visualization of production processes provide valuable information on processes in a clear and understandable way for an operator. Thanks to the access to archive data and possibility of their visualization in the form of a trend line, they are a valuable tool for supporting management of technological processes.

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