CONTROL SYSTEM IN INDUSTRY BASED ON WIRELESS COMPUTER NETWORK

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ABSTRACT
Possibilities and realization of system for control of more entry doors and ventilation in industry based on using wireless computer network technology are considered and described in the paper. Described solution has possibility to monitor, control and perform diagnostic of system using wireless computer network. The system is consisted of set of sensors, actuators and control devices (PLCs). Structure and characteristics of system are described first. Then the practically realized example of such system is given and described. It is used SIEMENS PLC equipment from series SIMATIC S7-200 for realization of the system. For creation and development of complete user software it was used software package WinSPS-S7.
Keywords: Control, Industry, Wireless computer network, Programmable logic controller

1. INTRODUCTION
Different types of PLC (Programmable Logic Controller) devices are used in many practically realized control systems [1-6]. Practical application of one concret PLC (Programmable Logic Controller) device in industry control system based on wireless computer network is shown and described in this paper. It is control of electromechanic system with two movements used for automatic entry doors and ventilation in production workshop. For realization of control it is used SIEMENS PLC equipment from series SIMATIC S7-200. SIEMENS PLC S7-200 (CPU 222) used for direct control of system is expanded with expansion module EM 235 and communication network module CP 243-1. Expansion module is used for connection with sensors and actuators (input and output elements) in system. Network module is used for connection on standard computer network via TCP/IP protocol and over it for connection with radio equipment for wireless networking over IEEE 802.11 standard. In industry plant and industry applications it is necessary to have as better as possible quality of radio signal because of equipment that can cause interferences in wireless network. Therefore for our system it is used infrastructural way of network implementation.

2. PLC DEVICES
Computers used for systems with programme control in industry environment have been formed one particular group called Programmable Logic Controllers or PLC devices [1-4]. Its rapid development and application starts with appearance of cheap and powerful microprocessors and microcontrollers. PLC is digital electronic device that uses programmable memory for storage of instructions with what execution are realized specific control functions of all control system with aim to control different

types of machines, objects and processes over digital and analog input-output modules. Also, PLCs should work in unfavourable conditions that are existing in industrial surrounding and should be flexible enough for adaptation to different modifications on control process [1-6]. So, PLC is designed as a very reliable modular device that is easy for maintenance and programming. In its basic form PLC is used for realization of functions that transform signals from sensors into signals transfeded to actuators. So, it is required ftom the PLC to periodically read (input) signals from sensors and perform some arithmetic-logic operations (according to function of control) which results are transfered onto actuators or indication elements and devices. Also, PLC should perform communication with other computer systems or devices in the network.

Practically there are two types of PLC programming languages:
1. Textual – Instructions list (IL), Structural text (ST).
2. Grafical – Sequential functions chart (SFC), Function block diagram (FBD), Ladder diagram (LAD).

PLC devices are mainly programmed using ladder diagram what is a way of simbolic representation of electric circuits and what was facilitating transfer to programming of PLC devices.

3. DESCRIPTION OF PRACTICAL PLC APPLICATION
3.1. Automatic doors
The object of control are automatic entry doors with two slide movable wings. Wings of the door are moving between completely closed and completely open position. Thise two extreme positions of the door are registered by appropriate switches for extreme positions registration (S1 and S2). The door is driven by electric motor. Change of door movement direction is accomplished by change of motor rotor rotation direction. Presence of persons in door surroundings and registration of movements near the door is performed by movement sensors placed above the door (B1 and B2). Principle presentation of construction of automatic entry door that is controled is shown in Fig.1.
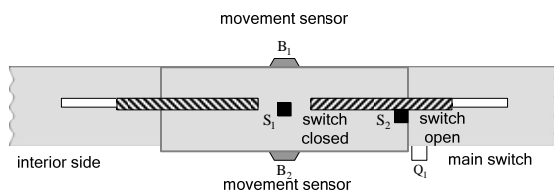
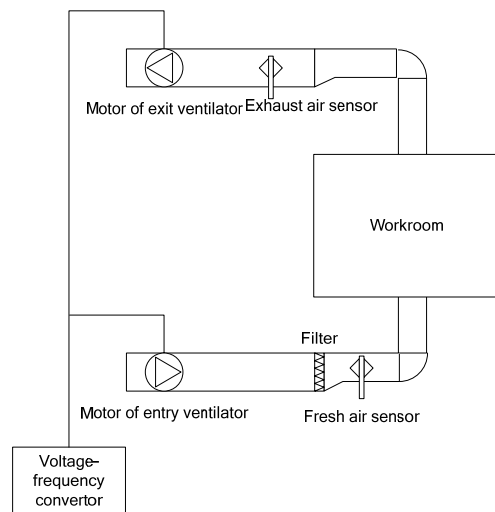

Figure 1. Principle presentation of automatic entry door.

Figure 2. Scheme of ventilation system.

For automatic door control are put next requirements:
– when any person appears the door should completely open,
– door stay open as long as there are passing persons,
– the door is closing some time (so called waiting time) after passing of last person.

3.2. Ventilation system
Practically realized ventilation system is functioning such that at the entry part of ventilation tube there is ventilator for fresh air introduction. It is provided next:
- needed speed of motor rotation and
- automatic turn on and turn off depending on need for fresh air in industry workrooms.

Further along the tube there is air filter that is filtering introduced air before it enters the production plant, i.e. workroom. In tubes after the filter it is placed sensor of fresh air that gives analog signal, i.e.

information about freshness of air before introduction of air into room. At exit part of tube it is located sensor and ventilator for throwing out "old used or exhaust" air from the workroom. With aim to obtain good air circulation through the workrooms motors of entry and exit ventilators are synchronised in such a way that both motors are connected to the same voltage-frequency convertor. Scheme of the ventilation system is shown in Fig.2.

Control model of described system for application in industry represents monitoring and control of components, i.e. input and output elements of the system. According to description of system functioning all devices are connected into one system and synchronized in such a way that realize control system.

3.2. Selection of hardware PLC configuration

For realization of control of described system it is selected SIEMENS PLC equipment from series SIMATIC S7-200 that completely satisfies all important requirements of this application. Practically there are used next units-modules.

Central module CPU 222: More powerful version of PLC SIMATIC S7-200 with 14 inputs/outputs and possibility to be added up to 2 expansion modules.

Expansion module EM 235: Since the basic modul does not support enough number of analog inputs and outputs needed for realization of the concrete control, additional expansion analog module EM 235 is used. It modele is used for support of control and possibility of monitoring and generating needed analog signals inside the system that is controled. The module makes conversion of analog input signals geting from the system into digital signals for processing in central module. Also, it makes conversion of digital signals from central modul into analog output signals taken to control system.

Network communication module CP 243-1: To relize networking of PLC with rest of SCADA system it is needed to accomplish wireless comunnication, i.e. wireless network. For that purpouse it is used network module CP 243-1 for networking. It module enables connection to standard network over TCP/IP protocol, and over it is connected with radio equipment standardised for wireless networking by IEEE 802.11 protocol.

4. REALIZATION OF WIRELESS NETWORKING

Communication between mobile personal computer and remaining network of SCADA systema is accomplished over wireless network by IEEE 802.11 protocol. The protocol IEEE 802.11 has more defined standards that differ in physical layer by working frequencies and modulations. Link layer is the same for all IEEE 802.11 protocols and consists of MAC (Medium Access Control) and LLC (Logical Link Control) layers. Access control layer (MAC) in the protocols 802.11 uses CSMA/CA (Carrier Sence Multiple Access/Collision Avoidance) protocol. From market available standards 802.11a, 802.11b and 802.11g, for the described and realized system choosen was standard 802.11b because of the largest support in mobile personal computers. Used protocol IEEE 802.11b has next characteristics: frequency band of 2.4–2.5GHz, transfer speed up to 11Mbit/s, distance up to 300m. It is practically most often used IEEE 802.11 standard. In IEEE 802.11 standard are defined two methods of wireless networks realizations:

- **Ad hoc** – Connection is established directly between two or more computers. Because of small power of transmitters in wireless network adapters networked computers have to be in a small area, on smaller distances.
- **Infrastructural** – More often way to accomplish network, and network realization is by using access points.

In industry plant and industry applications it is necessary to have as possible as quality signal because of equipment that can cause interferences during usage of wireless network. Because of that it is used infrastructural way of wireless network realization in described control system.

5. CREATION OF USER CONTROL SOFTWARE

For creation and development of complete user control software for described system control it is used software WinSPS-S7. It is complete program system for programming of PLCs from series SIMATIC S7-200 and PLCs compatible with that one. Software WinSPS-S7 is intended for creation

of programs for PLCs using simple graphic and structural programming languages: LAD (Ladder Logic Diagram), FBD (Function Block Diagram) and STL (Statement List).

At starting the software WinSPS-S7 it is obtained window for starting of next options: *Open last project*, *Go to Open Project dialog*, *Create new project*. When the option *Create new project* is selected window for entering creating project name is open. After confirmation of project name entering main menu is appeared. After opening of program main window it is necessary to start Symbol table. When the Symbol table is started it is obtained empty table where it is needed to enter next data:

- *Symbol* - Name for certain input or output that will be used in the program when its address is used.
- *Address* – Address of an input and output, for input from I 0.0 and for output from Q 0.0 up to address of last input or output used in concrete application.
- *Type* – Type of input or output.
- *Commentary* – Optional data in last column of table as a commentary for certain input or output.

The complete user control program is realized using LAD programming language, i.e. LAD diagram, on personal computer. In Fig.3 it is shown execution of program of block OB1. In the simulator mode it is used graphic representation of S7-200 for control of outputs and monitoring of inputs. To start that it is needed to go to *Quick start* button: PLC Mask Simulation. As the result in the window will be shown CPU modul, what can be seen in Fig.4.
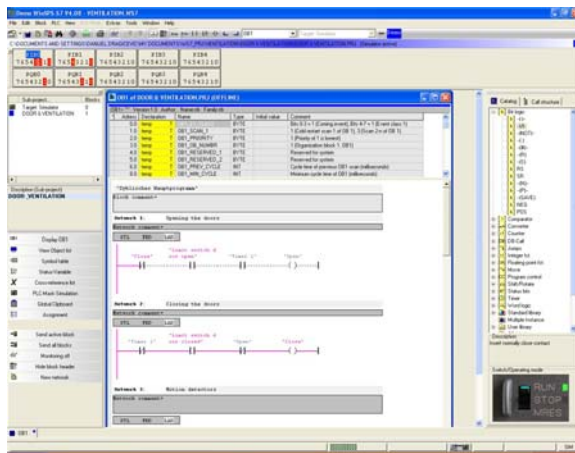

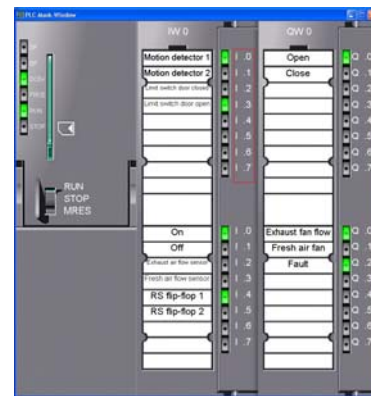*Figure 3. Window of WinPLC simulator in moment of program execution..*

Figure 4. Simulation using mask of S7 simulator.

6. CONCLUSIONS

Solution that is described shows relative simplicity of practical design and realization of systems for control in industry by application of PLC equipment, personal computers and wireless communication. Although here is case of relatively simple system, described principles and solutions can be in the same way and very easily applied also on much complicated and demanding applications in different areas of use, especially for similar applications in industry plants and industry systems. Similar hardware principles and similar software solutions can be easily adapted or simply developed according to concrete use.

7. REFERENCES

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