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REMOTE CONTROL OF REAL EQUIPMENT MODELS THROUGH PROGRAMMABLE CONTROLLER

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Abstract: The paper is focused on description of remote control of laboratory models that are used in the process of education at our faculty. The models are connected to programmable logical controller (PLC) and through this equipment the models are controlled. There is explained process of building one of the models. As the first step the students have to connect the model to a PLC. The PLC Saia is used, the product of Saia Burgess Company. With that they have to make a program to control the model and they must verify its functionality. The last step is the visualization of the process control in some commercial SCADA/HMI systems. There are also described possibilities of remote control in the paper. It is possible to control the model through serial interface RS232, RS485, Internet or Intranet interface or through GSM mobile net. Examples of all these cases are presented in this contribution.

Keywords: real control, PLC, remote control.

1 INTRODUCTION

Curriculums at our faculty are specialized on applied informatics and control of technological processes. Our students attend several different mainly theoretical courses specialized on the control theory like the Automatic Control Theory, System simulation, System identification, Measurement and control of technological processes.

With that they pass through mainly application courses like Microcomputers and their applications, Programmable Logical Controllers and others in which they apply its knowledge from preceding courses. In this application courses students have to know the measurement method, they must know types of sensors for temperature measuring and for pressure, speed, power and liquid level measuring. (Sysala *at al.* 2005), (Sysala *at al.* 2006).

In PLC course the teacher determinates a model to control and a control method. Students must make the controller design and then they can implement it into control software of a PLC. For this they must can its programming system and its programming language. If the application appears functional the student must do project in some visualization SCADA/HMI software.

The main tasks for students are:

- to analyze number and category of inputs and outputs (digital I/O, analog I/O, etc.),
- to connect model to PLC, if it is not connected.
- to propose a control algorithm and to implement it into PLC memory,
- to make an project in some SCADA system (InTouch, Control WEB, WizCon).

2 REAL MODELS

There are several models in our laboratory for programming PLC education. There are models of real equipments and models based of microcontroller. The models from both groups are connected to PLC and optionally from PLC to PC.

2.1 Models based on microcontroller

All models from this group look very similar. They consist from the board with microcontroller where is stored a program (Figure 1), board with LED diodes (Figure 2) and a connector and cable to PLC connection. A program simulates a behavior of some real equipment. It reads inputs (outputs from PLC) and sets outputs (inputs to PLC), so the PLC doesn't detect if the signals send model or real equipment.

There is the second board above the board with microcontroller.

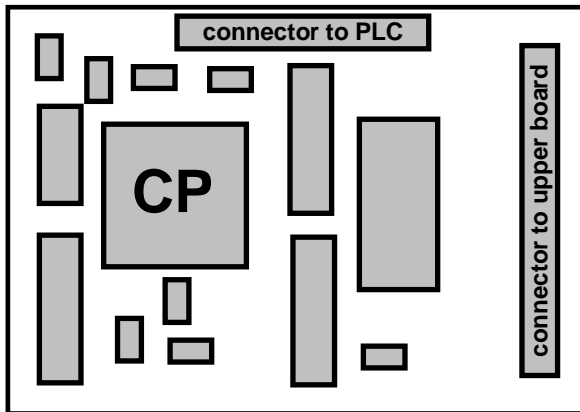


Fig. 1. The lower board with microcontroller

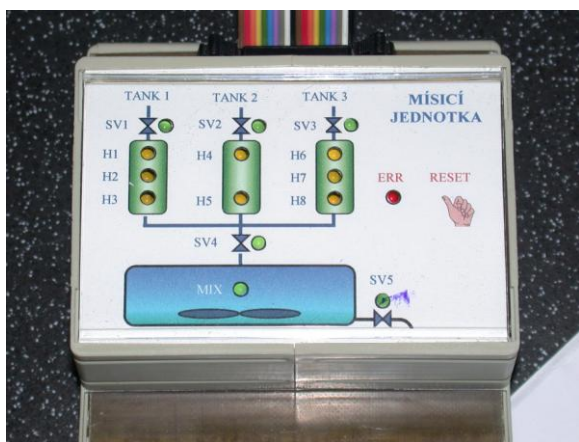


Fig. 2. Interfluent unit model based on microcontroller

For example: A model of a washing machine – PLC send a signal “heating”, “rotation left or right”, “wring”, etc. The model sends back water temperature and water level.

There are on the upper board several LED diodes and these diodes indicate all inputs and outputs and schematically represented simulated device (Figure 3).



Fig. 3. Washing machine model based on microcontroller.

There are these models at our laboratory:

- washing machine,
- interfluent unit,
- cross-roads,
- moveable conveyer,
- display with seven LED segments for number representation.

2.2. Real equipment models

The second group is group of real equipment models. Each model is connected to PLC and we can control all inputs and measure all outputs of the model.

There are these models at the laboratory:

- elevator model,
- railway model,
- small fountain,
- family house model.



Fig. 4. Small fountain

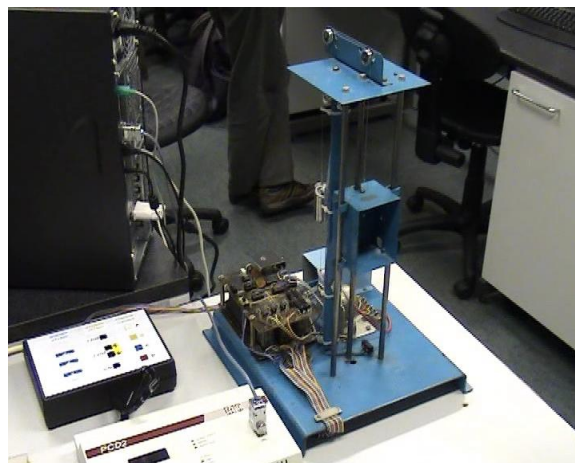


Fig. 5. Elevator model

3 PROGRAMMABLE CONTROLLER SAIA DESCRIPTION

All models are controlled by PLC SAIA, the product of Saia Burgess company. It looks like modular PLC and it is suitable for smaller task from the



Fig. 6. Railway model



Fig. 7. Family house model

technological process control sphere, but it can be complement up to eight different modules (binary inputs, binary outputs, analog inputs, analog outputs, communicating modules, etc.). (Saia 2005). In the laboratory we use PLCs Saia – model family – PCS1 (model PCS1.C622), PCD2 (model PCD2.M140), PCD3 (model PCD3.M5540).

Main properties and parameters of the SAIA PCD2 model:

- Central inputs/outputs - fit with any 8 I/O modules for up to 128 I/Os, additional 4/8 I/O module socket via expansion housing for up to 255 I/Os,
- User memory for programs, texts and data blocks - 1 MByte RAM in basic assembly,
- Flash-card - 1 MByte for backup the user program,
- Fast counters and interrupt inputs - 2, for interrupts or counting up to 1 kHz,
- Serial data port (PGU connector) - 1× RS 232 with RTS/CTS or RS 485 electrically connected,
- Serial data ports - 1× RS 232 (suitable for modem connection)/RS 422/RS 485 or 2× RS 232,
- Field bus connection - PROFIBUS FMS, PRO FI BUS DP as master or slave, LONWORKS®,
- Ethernet-TCP/IP network connection - 2 × PROFIBUS DP as slave or 2 × LONWORKS®.

This were properties and parameters of the SAIA PCD2 model family. The PCD3 model family offers more possibilities. The model family PCS1 is simpler, but we have got a model, where is implemented a module MC35. This module offers receiving and sending of Short Messages (SMS).

It is a recommended programming tool PG5 for making a programs for SAIA®PCD. Whole system is organizing by files (containing several program blocks) simplifies the shared use of program files between several SAIA®PCD controllers.

Each file and each part of program can be made via various techniques:

- FUPLA (function block diagram),
- S-Edit (instruction list IL),
- GRAFTEC (sequential function chart).

The Fupla editor is the simplest, fastest introduction to programming PCD controllers. The name "Fupla" means "FUncion PLAn", a graphical programming environment in which the user raws programs with the aid of hundreds of functions. GRAFTEC environments better for sequential programming. The program in GRAFTEC is created by transition conditions and steps what each other change and the program runs step by step on defined conditions (Saia Burgess 2005).

4. REMOTE CONTROL

There are several possibilities how to change some parameters to process control stored in PLC memory. Some of them are described hereafter.

4.1 HMI Panel

HMI panel – Human Machine Interface panel is the easiest way to change parameters in the PLC. But this way has a disadvantage – we have to be close to control PLC, so it is not a remote control.

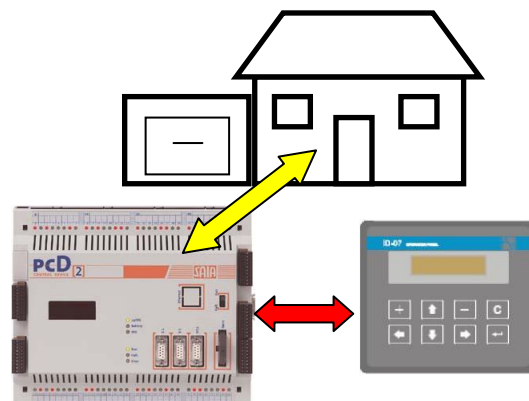


Fig. 8. Remote control through HMI panel

4.1 RS232, RS485

The other way is to use classic communication through RS232 or RS485. This way is used if PLC

has only these types of communication ports. We use this way if we have got some older PLC. A PLC is connected to a personal computer or to some other recent PLC type. Through this device we have access to all inputs and outputs of the first PLC.

4.2 Internet, Intranet access

Current data PLC enables to create distributed industry nets. All devices in this net have dedicated address, so we can send data to arbitrary PLC in this net. If our net is a industry net we use communication through a bus. It is a Profi-Bus, S-Bus, ModBus or more other protocol used. If we have a PLC connected to Internet we mostly use a TCP/IP protocol.

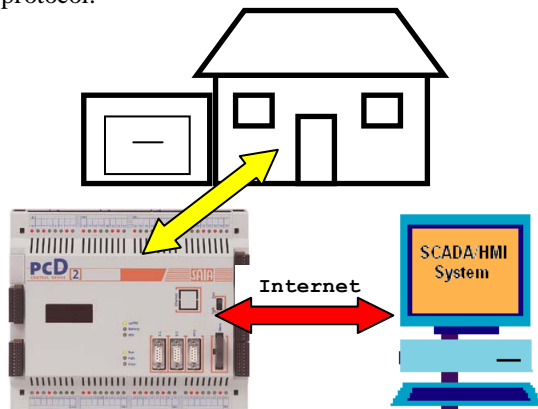


Fig. 9. Remote control through Internet

4.3 GSM Communication

If we don't have connection to Intranet or Internet and we have no possibilities to connect the controlled process to control room via wire, we can use a GSM module set in PLC. Through this device we can send or received "Short Messages" (SMS). It is possible to get a temperature or water level and other parameters of the control system and we can send SMS with control commands to the heating, water pump or other outputs in the PLC (Sobolík 2007).

In our laboratory we have all of these described methods of communication between technological process and control room.

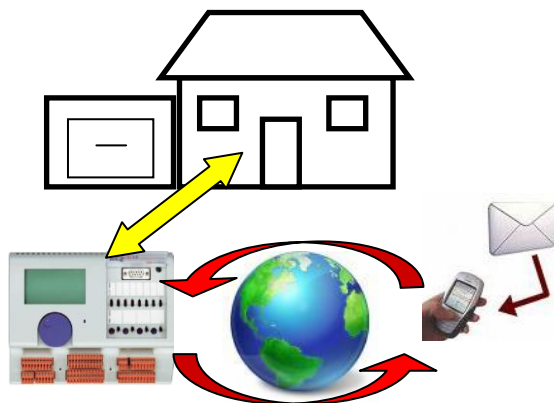


Fig. 9. Remote control through GSM communication

5 CONCLUSION

It was description our laboratory for education PLC programming. The students learn to program and to control real equipment models. They can use possibilities of remote control through personal computer or PLC or control through local computer. The students are very interested in this course because:

- The models are very similar like real equipments.
- Students apply theoretical knowledge in real application.
- It is easy to see if application is working correct.
- They are prepared for working with programmable controllers and SCADA/HMI systems in the factories, in industry, in their new job in the future.

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7 REFERENCES

- Saia Burgess (2005). Saia-Burgess Electronics: *Hardware – Řady PCD1 a PCD2*. Edition 26/803 M2.
- Sysala, T. and Dostál, P. (2005). Monitoring and Control Systems for Real Equipment Controlled by PLC in Education, In: *Proceedings of the 8th IASTED Control Conference COMPUTERS AND ADVANCED TECHNOLOGY IN EDUCATION – CATE 2005*, August 29-31, 2005, Oranjestad, Aruba, p. 248-253, ISBN 0-88986-522-1, 2005.
- Sysala, T., Dostál, P., and Adánek, M. (2006). Monitoring, Measuring and Control Systems for Real Equipment Controlled by PLC in Education, IN: *XVIII IMEKO WORLD CONGRESS - Metrology for a Sustainable Development*, September, 17 – 22, 2006, Rio de Janeiro, Brazil, p. 9, section TC1.
- Sobolík, M. (2007): *Nové laboratorní úlohy pro předmět Programovatelné automaty*, diploma work (in czech), Tomas Bata University in Zlin, Faculty of Applied Informatics, 2007.