LABORATORY MODELS FOR PLC PROGRAMMING EDUCATION

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ABSTRACT
The paper is focused on description of two laboratory models which are used in the process of education at our faculty. Both models are connected to programmable logical controllers (PLC) and through these equipments all models are controlled. The first model is a model of rail yard, the second one is a small fountain. As the first step the students have to connect the models to a PLC. It is used PLC Saia, the product Saia Burgess Company. With that they have to make a program to control of the model and they must to verify its functionality. The last step is the visualization of the process control in some commercial SCADA/HMI systems
Keywords: laboratory model, PLC, real time, visualisation, real equipment.

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 Automation Control Theory, System simulation, System identification, Measurement and control of technological processes.

With that they pass trough mainly application courses like Microcomputers and their applications, Programmable Logical Controllers (PLC) 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. [6].

The teacher determinates the control method and the students must make the controller proposal. At first in Matlab environment and then they can to implement it into control software of real equipment. For this he must to choose device for control system. It can be microcomputer, personal computer, PLC and so one. He must can its programming system and its programming language. If the application appears functional the student must to do project in some visualisation software. Thank this software it is better to see process of a model control and it is possible to monitor all inputs and outputs of a control device as well as parameters of controller in each sample period.

The main tasks for students are:
- to analyse number and category of inputs and outputs,
- to connect model to chosen device,
- to propose a control algorithm and to implement it into device memory,
- to make an project in some SCADA system (InTouch, Control WEB, WizCon).

2. REAL MODELS
There are several models in our laboratory for real process control education. Some of them are described in this contribution.

2.1. Rail yard model
The first model is a model of rail yard in scale HO. See figure 1. There are three rail circuits in this model and the main task is to control ride or movement of trains on all circuits. The model contains

more then 70 measuring and controlling point. We get the position of trains and we can control train velocity and direction, switches, traffic lights, crossing lights, rail way station lights, etc. Proportions are approximately 2 m (length) and 1 m (width).

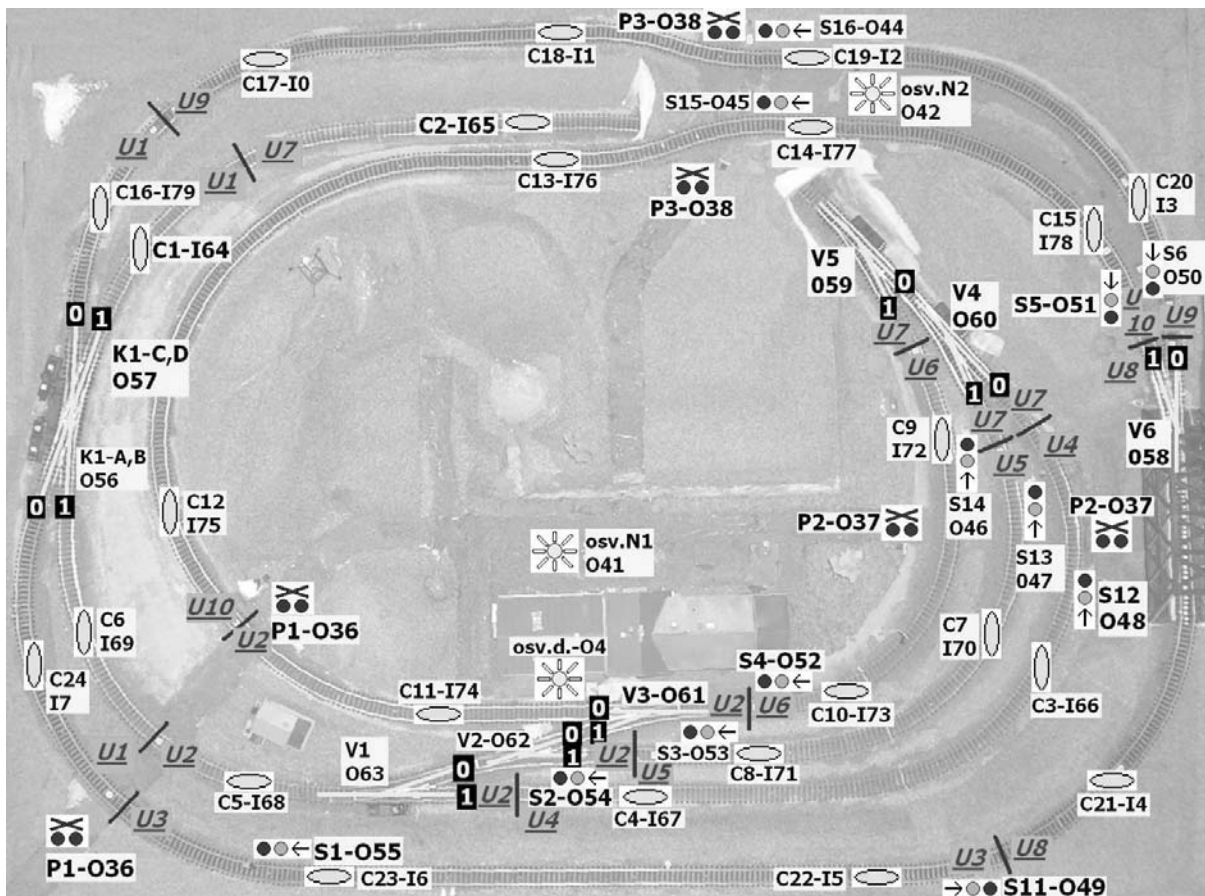*Figure 1. Rail yard model*

Figure 2. List of model elements (Label – input/output address)

Trackage is divided in ten sections. In each section we can control direction and velocity of the train separately.

The train position we get by means of dry-reed relay. There are 24 sensors on the trackage. On the train undercarriage is placed magnet and if the train is coming through position sensor the magnet generates logical signal. As a signal is used voltage 0/5 V (TTL logic). This signal is converted to 0/24 V and it is used as input into PLC. These voltages are the same for all inputs and outputs.

The train route is controlled through switches. Logical signal High means "directly" and logical signal Low means "turn". Control of other model elements is easy and it is very similar. There are 17 semaphores, 8 switches, 3 railway crossing and 1 gate on the model. [3]

List of active model elements:

Track section	U1 – U10	Low = "stop"	High = "go!"
Switches	V1 – V6, K1	Low = "directly"	High = "turn"
Rail way station lights	N1, N2, OD	Low = "turn off"	High = "turn on"
Semaphores	S1 – S16	Low = "red light"	High = "green light"
Railway crossing	P1 – P3	Low = "off"	High = "blink"
Gate	O39	Low = "up"	High = "down"

2.2. Fountain model

The second model is a model of fountain. It is not exactly model; it is real small fountain controlled by PLC. See Figure 3.
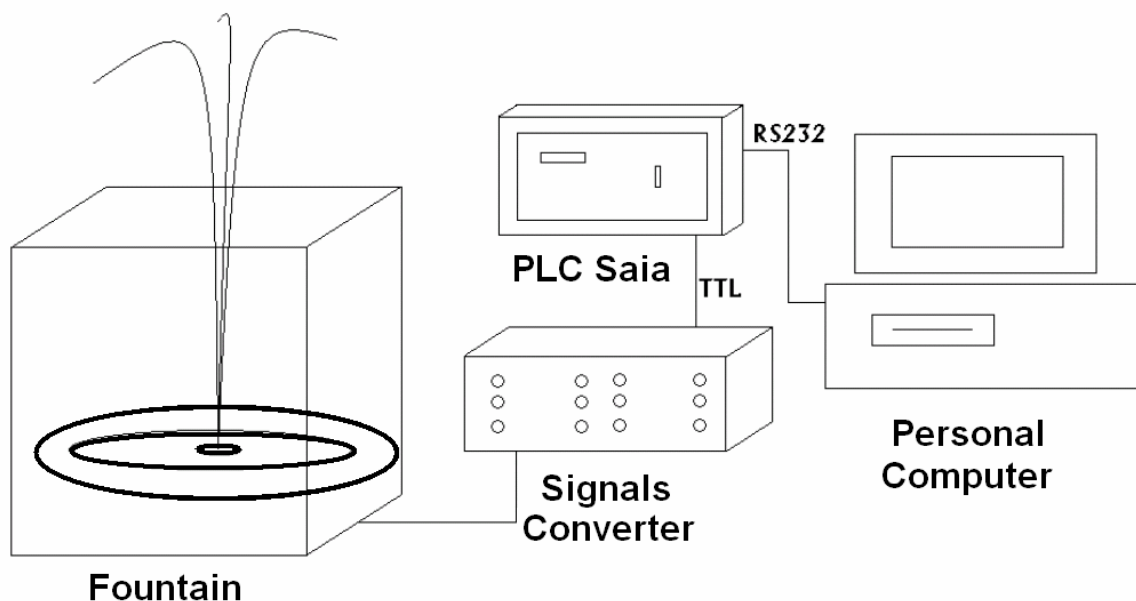

Figure 3. Scheme of a small fountain system

Whole system contains a fountain, a signals converter, a PLC Saia and computer. The computer is used for PLC programming only and for visualization of the process.

The fountain is created by glass cubical aquarium (1 x 1 x 1 m) and there are three water pumps and three circuits of pipe with different numbers of nozzles on tangential bottom. The main task is to control in real time the elevation of water column above nozzles in each circuit. The signal converter changes voltage for pump power from 5 V (TTT logical signals) to 230 V (voltage for pump control). There is one nozzle on the first – central circuit, four nozzles on the second-middle circuit and eight nozzles on the third – outer circuit. [4].

3. PROGRAMMABLE CONTROLLER SAIA PCD2 DESCRIPTION

Both models are controlled by PLC SAIA PCD2, the product of Saia Burgess company. It looks like modular PLC and it is suitable for smaller task from the 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.) [5].

It is recommended a programming tool PG5 for making new 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 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 "*FUnction PLAn*", a graphical programming environment in which the user raws programs with the aid of hundreds of functions. These functions are organized into libraries covering the basic applications, with more specialized functions added for certain professional domains. The special libraries include: a HEAVAC library for heating, ventilation and air conditioning, a modem library for networking PLCs to exchange data via telephone line (analog, ISDN, GSM, GPRS), the messages SMS, Pager and DTMF. Other libraries for communications networks LON, EIB or Belimo products are available too.

For fountain control program was used the FUPLA environment only, for rail yard control were used the FUPLA and GRAFTEC environments. GRAFTEC is 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. The control of a train on the rail it is a typical task from this area.

4. CONCLUSION

It was description of two from some models in our laboratory for education PLC programming. The students are very interested in this course because:

- They 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.

5. ACKNOWLEDGMENT

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