THE TECHNOLOGICAL PROCESS CONTROL THROUGH THE USE OF VIRTUAL CONTROLLERS.

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В статье рассматривается использование виртуальных регуляторов для управления технологическими процессами. Было реализовано два типа виртуальных регуляторов, которые используются в учебном процессе. К технологическому процессу регуляторы подключаются с помощью платы PCI-1711S.

In 2005 we have started deal with idea of development of industrial controllers virtual laboratory for technological process control.

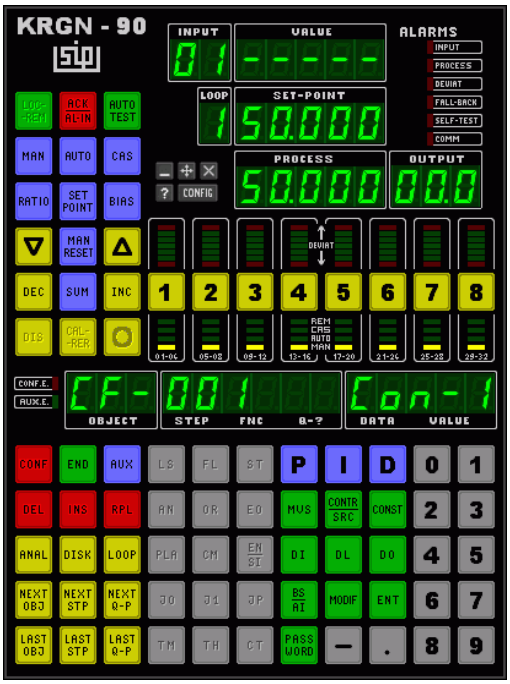
In the first phase of realization of virtual lab was done an analysis of functionality of several industrial controllers types, which could be a candidate for virtual form in the education process.

During the realization of analysis we have utilized many years of experiences with real industrial programmable controllers that are used at Institute of Information Technology Automation and Mathematics, Faculty of Material Science and Technology in Trnava, Slovakia.

The analysis result has been recommendation to realize two types of industrial controllers – in the sense of activities plan.

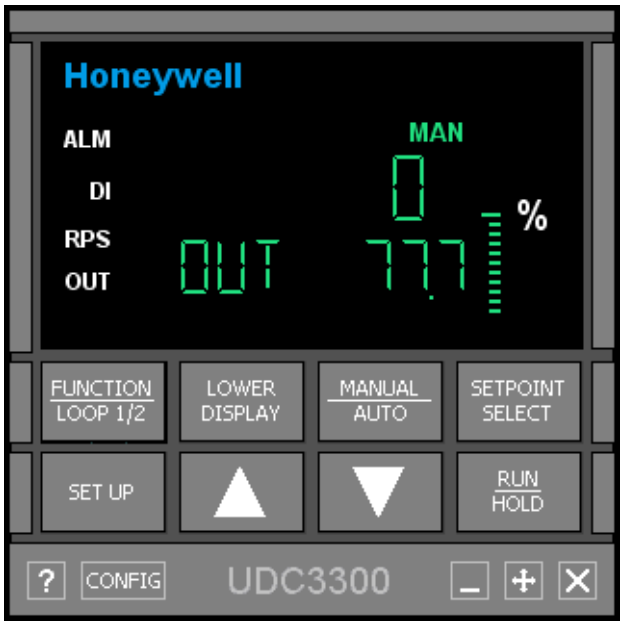
The first type of controller is eight loops controller KRGN 90 that is given for automated systems of control construction small and medium sized (tenths till hundreds IO signals).

In terms of subjects teaching utilization is the big advantage the using of the library with almost 40 preprogrammed modules that are aimed for configuration of various control circuits, starting with simple control loop and finishing with adaptive circuits. (1)



Pic.1: Implemented operator panel board for controller KRGN-90

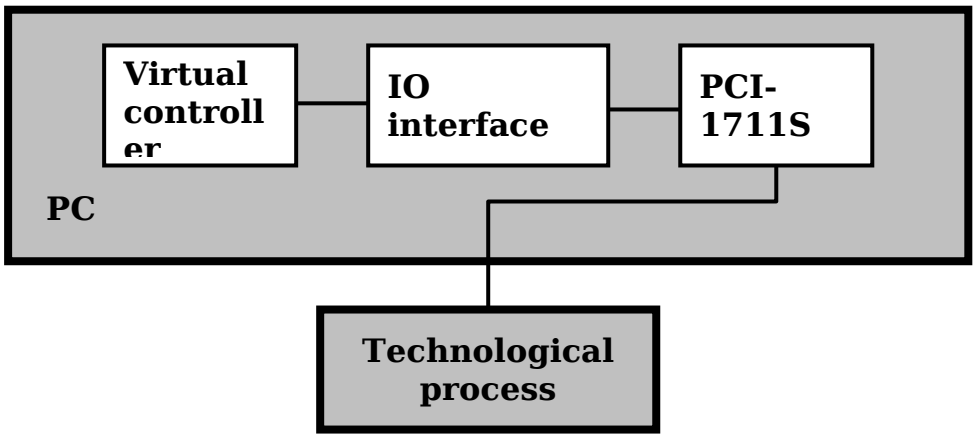
The second type of controller has been chosen controller UDC 3300/3000. This controller is representative of the compact two-loops controllers aimed for realization one/two-loops control circuits. UDC 3300/3000 has relatively designed structure of control circuit – either one/two simple control loops or one cascade control circuit.
This type of controller is suitable for primary education based on using of industrial controllers thanks to simplicity of handling. (1, 2)



Pic.2: Implemented operator panel board for controller UDC 3300

In the next phase we have done for both controllers analysis of functions efficiency in term of subject's request.

The resulting specification of chosen functions of both controllers utilized also results of student's graduation thesis of our Institute.
Having finished the analysis and exploitation its results was realized the proposal of operator panel board and application program of virtual controllers and their implementation in development tools Delphi and C++. (3)
In the verification and validation's phase have been realized base types of testing and also testing of virtual industrial controllers functions. This testing procedure was realized in term of using of program modules for control algorithms configuring.
Having finished the phases of implementation, testing and deploying of both types of controllers we have been concerned with possibility of utilization of controllers for technological process control.
The best solution to connect the virtual controller and technological process has been the utilization of data acquisition card Advantech PCI-1711S.
During the programming of IO interface have been utilized functions that are offered by DLL library of card driver. Thereafter we have joined booth controllers to Advantech PCI-1711S card by using IO interface.
The analog model of exothermic chemical flow reactor that serve as one of technological process has been connected into card input. (Pic. 3.)



Pic. 3: The connection of tg process with virtual controller

The DAQ card Advantech PCI-1711S, which we used, provides users with the most requested measurement and control functions as seen below:

- PCI-bus mastering for data transfer
- 16-channel Single-Ended or 8-channel Differential A/D Input
- 12-bit A/D conversion with up to 100 kHz sampling rate
- Programmable gain for each input channel
- On board samples FIFO buffer
- 2-channel D/A Output
- 16-channel Digital Input
- 16-channel Digital Output
- Programmable Counter/Timer
- Automatic Channel/Gain scanning

The Advantech PCI-1711S card is supplied with DLL drivers, configuration software (for setting up and controlling the device) and testing software to test various functions (Analog/Digital Inputs/Outputs, Counter etc.).

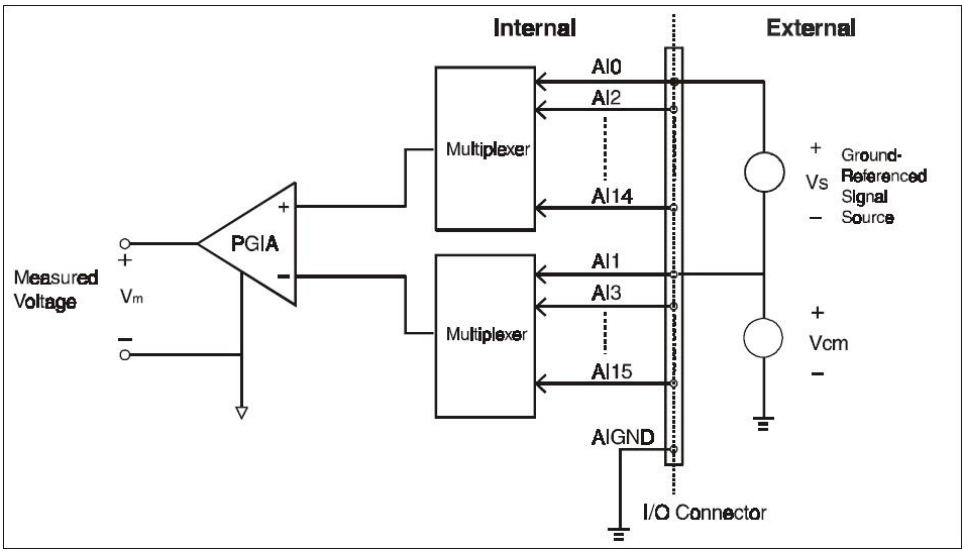


Fig. 4: Differential input channel connection

Advantech DLL driver offers a rich function library to be utilized in various application programs. This function library consists of numerous APIs that support many development tools, such as Visual C++, Visual Basic, Delphi and C++ Builder. According to their specific functions or services, those APIs can be categorized into several function groups:

- Analog Input function group
- Analog Output function group
- Digital Input/Output function group
- Counter function group
- Temperature measurement function group
- Alarm function group
- Port function group
- Communication function group
- Event function group

Programming by itself is simplified by tutorial chapter in the DLL drivers Manual. You can also take a look at the example source codes provided for each programming tool.

We can place into expectant self-contribution of implemented solution the realization those virtual application resources, which considerably truly represent environment of processional level of control systems Virtual representation of the front panel of the industrial programmable controller, which is realized on the base of industrial programmable controllers, which are used for controlling of continuous technological processes. The main contributions are summarized below:

- provides to obtain wide range operator skills and configuration engineering skills for using it
- Implemented software modules of application kit provides the same possibilities and methods of the control loops configuration, technological values processing and alarming as real industrial programmable controllers

- Two types of controllers realization – one provides realization of simple control loop or double control loop and the second one is eight-loops controller, which provides configuration of compound control loops
- Implemented technological process models include models of common processes such as hot supply water preparation, central heating, nonlinear models of chemical processes (eg. exothermic chemical reactor) and of course several complicated models with more than one control loop (eg. Administration buildings with air conditioning and protective security systems)
- The possibility of education in industrial controller conditions, when every theoretical solution concept of control loops is necessary to adjust and implement within provided possibilities of given industrial controller type and so verify the solution in conditions very close to the real environment
- The economic assets are spared costs of real industrial controllers, physical technological process models and costs of technical resources maintenance
- Submitted project solution could be used for creation of multimedia books, distant education and e-learning

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