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EXPERIMENTAL LABORATORY COMPUTER SYSTEM FOR HYDRAULIC SYSTEMS CONTROL

The main issue of this research was to create a laboratory computer system for hydraulic control system capable to perform all necessary tests and measurements included in a research program. The program applies to all hydraulic and control elements (units) of a laboratory test stand, designed for research on computer-aided control of hydraulic systems. A detailed specification of actuators, sensors and other relevant units involved, as well as the whole project of the test stand and Mr. Jarosław Kuśmierczyk has prepared research program.

The following requirements for the system have been met:

- the system should be built basing on industry equipment and technologies,
- the system should fulfil all requirements imposed by the research program of the test stand, i.e.:
- at least 5 analogue input signals,
- at least 4 analogue output signals,
- registration of data collected during the entire measurement cycle,
- possible co-existence of manual and computer aided control on separate signals,
- further enlargement of the system should be possibly easy (because automatic control have been planned).

Considering all these points the project of the system has been proposed. The proposed system has been created basing on a PLC controller SMART I/O delivered by Pep Modular Computers. It is a well-known modular controller, based on a Motorola 68302 processor, used and verified in many industrial applications. This unit works under control of a real-time operating system, OS-9. These features guaranty that all tasks regarding control of the test stand (generating signals for actuators and scanning sensors) and data transmission, which are assigned to the controller, will be performed in a predictable order and time period. The PC has an auxiliary function in this system and provides a User Interface, necessary for interaction between a user (operator) and the controller, and data storage for the data collected from the sensors.

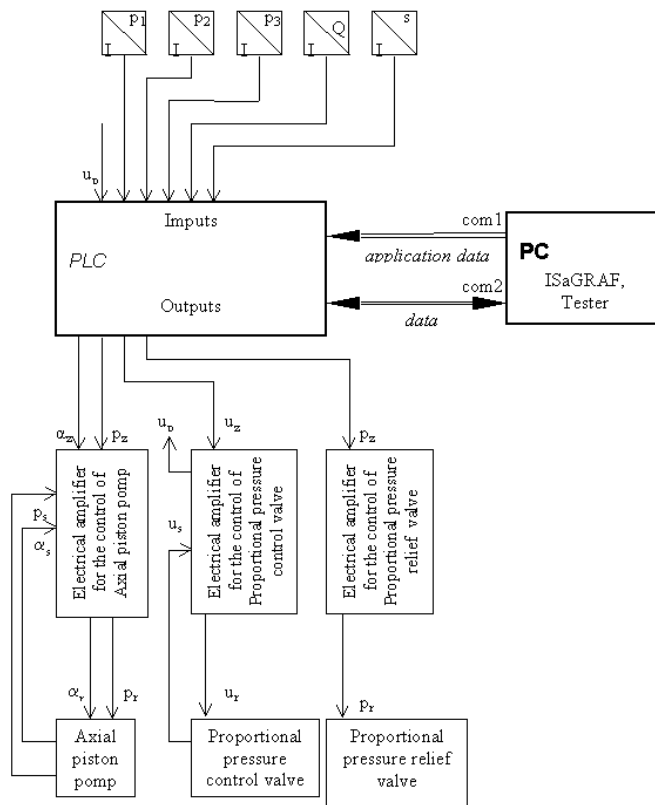


Fig. 1. Block diagram of control system

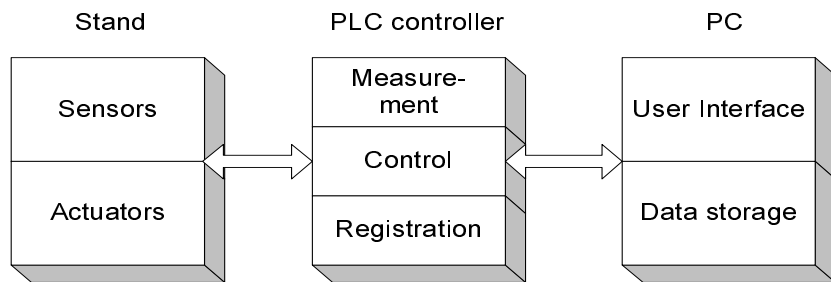


Fig. 2. System structure

In compliance with the requirements of needed I/O signals and data transmission to the PC the controller has been equipped with following modules:

- SM-DAC1 digital-analogue converter (6 voltage outputs),
- SM-ADC1 analogue-digital converter (6 current inputs),
- SM-RS232 serial data transmission module.

Communication between PLC controller and PC has been established through a serial link, based on RS232 standard. A simple and flexible protocol has been invented and implemented for communication purposes, capable to transfer data in frames of different length and providing a basic redundancy check.

All programmes for the PLC controller were written using ISaGRAF by CJ International, a professional engineering tool kit providing all symbolic languages for PLC controllers (SFC, LD, IL, ST, FBD). It is a complete environment for writing, generating and debugging a code for PLC controllers. To meet the requirements for possibly highest speed of the control by different number of required inputs/outputs depending on the particular test, a wide set of programmes has been created for the controller, where each programme was dedicated to a single measurement. On the other hand, for PC there has been created one universal program - SPCH-Serwer - capable to send required settings to the controller and retrieve the measurement results.

Because of high complexity of the test stand a need to verify each unit separately appeared. For this purposes were developed two additional programmes, one for the PLC controller - test_com, and one for PC - Tester.

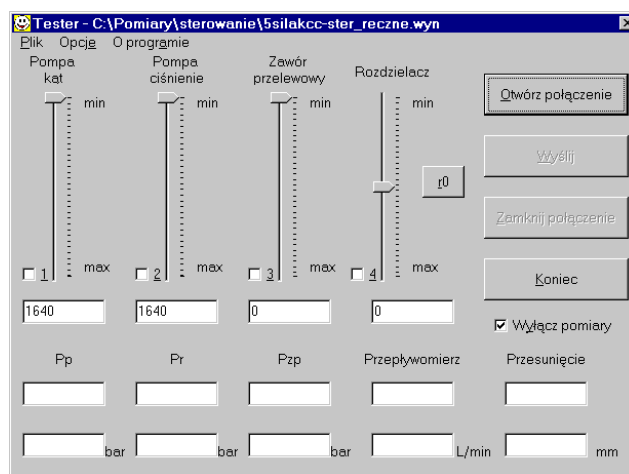


Fig. 3. User interface

The Tester is a universal and easy to use User Interface providing a complete control of the basic units of the test stand and registration of measured signals. The Tester programme, exactly like SPCH- Serwer, has been created using the Visual Basic 5 compiler, giving a user all graphical benefits of Windows operating system and to a programmer a quick result because of an easy access to the wide range of Windows' standard controls.

The User Interface has been designed to provide easy and self-explanatory set of controls for each of maintained signals:

- command value of the proportional pressure control valve,
- command value of the proportional pressure relief valve,
- command value of the swivel angel,
- command value of the maximal pressure on the pump output.

Therefore, to each of them there are assigned the following controls:

- a slider, scaled to the applicable range of the signal,
- a text box, showing current or taking a new value of the signal,
- check box, determining if value of this signal should be sent to the controller.

Thanks to the check boxes, while controlling each signal separately the operator can easily switch between manual and computer aided control for each of them. Additionally, the programme provides a visualisation of momentary values of measured signals in digital (discrete) values and recalculated to the analogue units.

Generally, the built system turned out to be useful during the test program. Although, measurements could be performed with cycle time around 20 ms. Except testing of the hydraulic elements - the system can be used as a laboratory subject for students.