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ASYNCHRONOUS MOTOR SPEED CONTROL BY PRO VIEW OPEN SOURCE SOFTWARE WITHIN A SCADA INTERFACE

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Abstract. This paper presents the modeling and implementation of an installation designed to control an asynchronous motor within a SCADA interface by a frequency converter. The installation is software controlled by using open source systems. From this perspective the achievement is cheap, yet stable and reliable, ensuring protection of the equipment when leaving the working regime. The surveillance of equipment parameters is done locally through measuring equipment (indicators with precision and digital display) and remotely on a PC with software for monitoring and recording data.

The adoption of Pro View as an open source software solution brings the costs down while maintaining a high level of robustness in installations controlling.

I. INTRODUCTION

The issue of management of industrial processes with software tools is not recent. Attempts in this direction were first made in the functioning surveillance of technological processes. The development of technology has allowed the transition from surveillance to effective conduction by computer, in real time. Of course, this transition was a staged process: the initial stage involved the continuous management, implemented using continuous functions in time. Within the latter stages evolution of specific computer tools allowed the implementation of discrete functions, examples being computer numerical controlled machines. Currently it is inconceivable to conduct any kind of industrial technological process without a proper automatic driving equipment.

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Online real-time control is one of the most advanced management method being nowadays the most complex process possible [2]. An important component of the control in real-time is its adaptive character, which is strongly linked to the software component used for control. The software component ensures flexibility of the system and also provides it with an important feature - its peripheral interchangeability [3, 4, 6]. When seeking automatic control in real-time of some process it must be taken into account a number of related features [4]: i) process complexity represented by the number of parameters to be monitored and controlled, and the ways they interact; ii) the nature of the parameters and the way the commands are made (synchronous, in time) for choosing the appropriate interfaces to maintain a proper connection between the process and the control management; iii) ensuring process stability and maximum efficiency; iv) ensuring the continuity of command and control regardless of the nature of the process; v) establishing the significance of the human operator tasks depending on the degree of computerization and automation of the process, etc.

II.GENERAL SYSTEM FOR PROCESS MANAGING

The command and control of any process is performed according to a closed-loop principle scheme (command circuit and reaction circuit), as shown in figure 1.

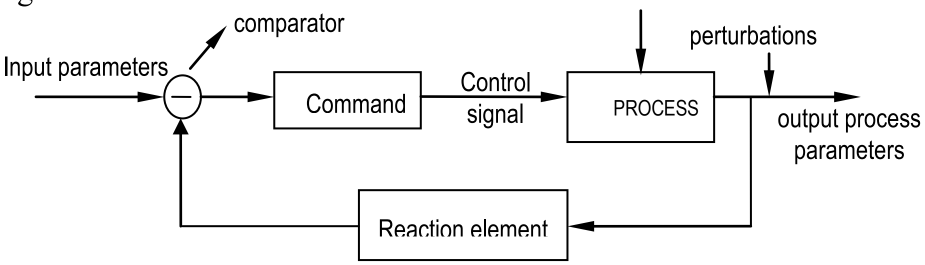

Figure 1. Command circuit and reaction circuit (adapted from [4]).

The control circuit consists of complex control elements that ensures the management of the process based on a the control model. Within this model, on the basis of the input parameters, decisions are taken based on the reaction parameters values read from process [5]. From mathematical perspective, the functions of the two circuits (direct circuit and reaction circuit) are presented in figure 2.

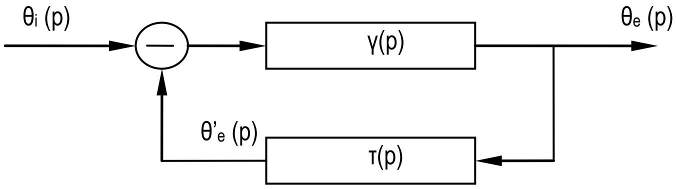

Figure 2. Mathematical model

The mathematical model is characterized by the transfer function of the direct circuit *γ(p)*, the transfer function of the response circuit *τ(p)*, reference parameters (input) for the command $\theta_i(p)$, output parameters of the process *θe(p)* and reaction parameters *θ'e(p)*.

The transfer function for the system described in figure 2 is:

$$\frac{\theta_e(p)}{\theta_i(p)} = \frac{\gamma(p)}{1-\gamma(p)\cdot\tau(p)} \tag{1}$$

The elements of interest for controlling process in accordance with the scheme from figure 1 are the control element and the reaction element. The quality of the command and control system depends directly on the quality of these elements. The structure of these elements is numeric and disturbances are modeled synthetic by the transfer function of the reaction circuit *τ(p)*.

II.1. **The data acquisition system**

The data acquisition system is located on the reaction circuit of command - control system and it has the following functions:

a) analog to digital conversion of signal inputs.
b) processing of numerical data resulting from the conversion.
c) storing numerical data in files or in specialized databases.
d) formation and transmission of output data.

The block diagram of the data acquisition system is shown in figure 3.

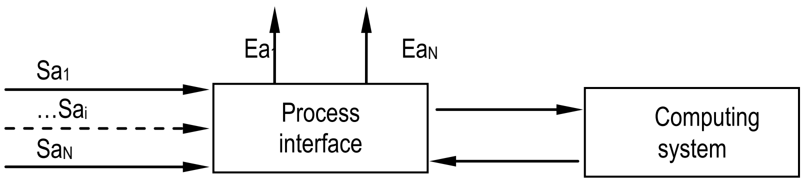

Figure 3. The data acquisition system

Acquisition interface functions are: analog to numeric conversion of the input signals (Sa_1, ..., Sa_N), communication with the computer system and digital to analog conversion for the output channels (Ea_1, ..., Ea_N);

The conversion parameters are: form and level of analog signals (continuous with standard amplitudes of 0, +5 V, 0 to +10 V, ± 5V, ± 10V) and converted digital word size (8, 10, 12, 14, 16, 20, 24 bits).

The standard structure for the process interface is shown in figure 4.

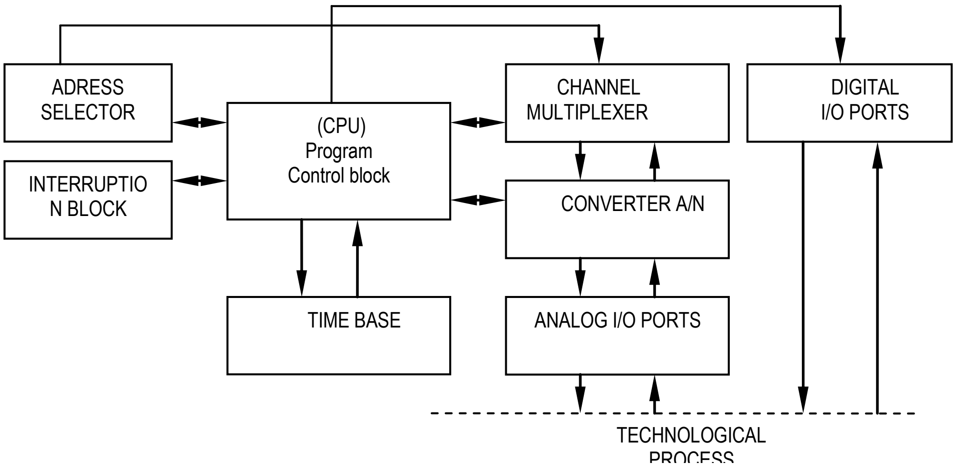

Figure 4. – Standard structure for the process interface

II.2. **The command system**

The command part is designed to generate the appropriate signals and data according to the selected control laws for controlling the operation process. The block diagram of the control loop is described in figure 5.

The interface input receives signals or data that results from the comparison (decrease) between the desired parameters of the system and the real ones, process, form, interpret, and send them to the computing element. The relationship between the input interface and computing element is in closed-loop.

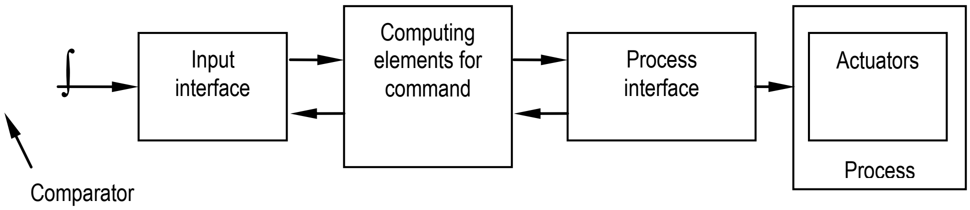

Figure 5. – Loop control

III. EXPERIMENTAL PART

III.1. **Pro View programming details**

ProView is a modern, powerful, and complex control system for industrial processes. It contains all necessary functions for sequential control, adjustment and data acquisition, communication, surveillance, etc. Pro View concept is based on a soft-PLC solution that runs on standard computers with Linux operating system. The programming is done either via a GUI editor PLC or by a high level programming language as C, C+ +, Java, or FORTRAN.

For the experimental part the implemented SCADA system consists on the following subsystems:

i. user interface through the whole process can be viewed and controlled;
ii. computerized system that collects data through Ethernet interfaces;
iii. interface units that are connected to equipment in the process, convert signals in digital, and sends them after via the communication network to the computer system;
iv. communication network connects the sensors in the field (in our case the frequency converter, electronic counter and the computerized system);
v. programmable controller. Pro View incorporates the programmable controller function that performs speed control, displays parameters and graphics, stores values, etc.;
vi. function to convert the data received via serial communication ports, as shown in figure 7.

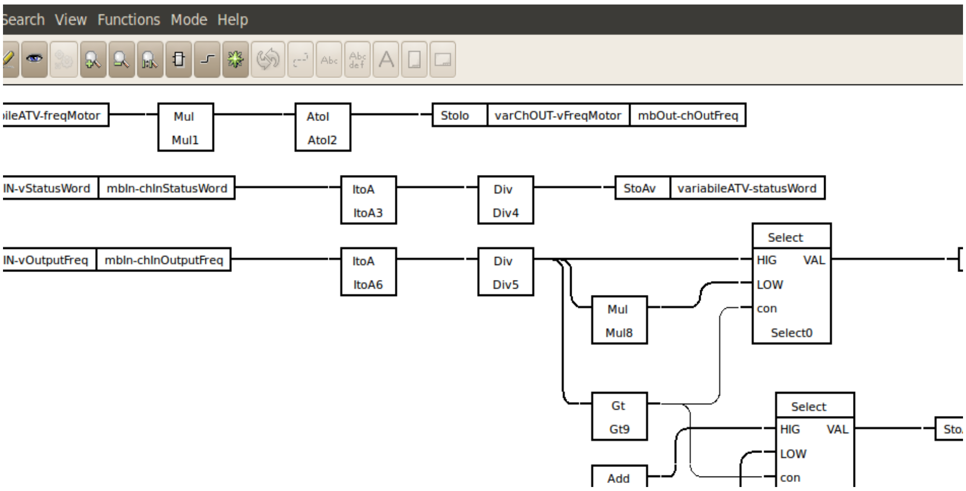

Figure 7. Achieving the communication with the programmable controller function (detail)

The algorithm starts by setting the starting conditions and command the engine. Frequencies are read and, finally, after a communication stage corrections in conveyor speed are made according to frequencies values which are compared to a reference frequency. The simplified logical schema for the implemented algorithm is described in figure 8.

The input and output variables are read and updated with PLC scanning frequency of approx. 100 ms. The interface unit is an ATV 71 frequency converter which is also the element of command and control and monitoring of the conveyor motor parameters. The communication network is type RS 485, an EIA standard that defines the electrical characteristics for multipoint communication systems; the protocol used is Modbus.

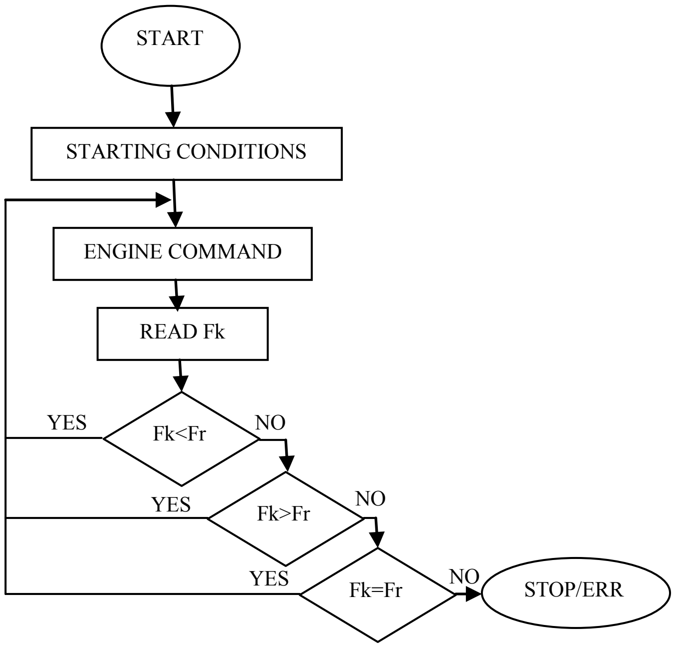

Fig. 8. The algorithm (simplified logical schema)

A detail of the algorithm is shown in figure 9. ATV-freqMotor variable reads the motor frequency and assures the starting conditions. Similarly varChin – vstatusWord transmits the read input in 8 bits format. Last four variables are used to monitor the output frequency, reference frequency, the current, and the torque.

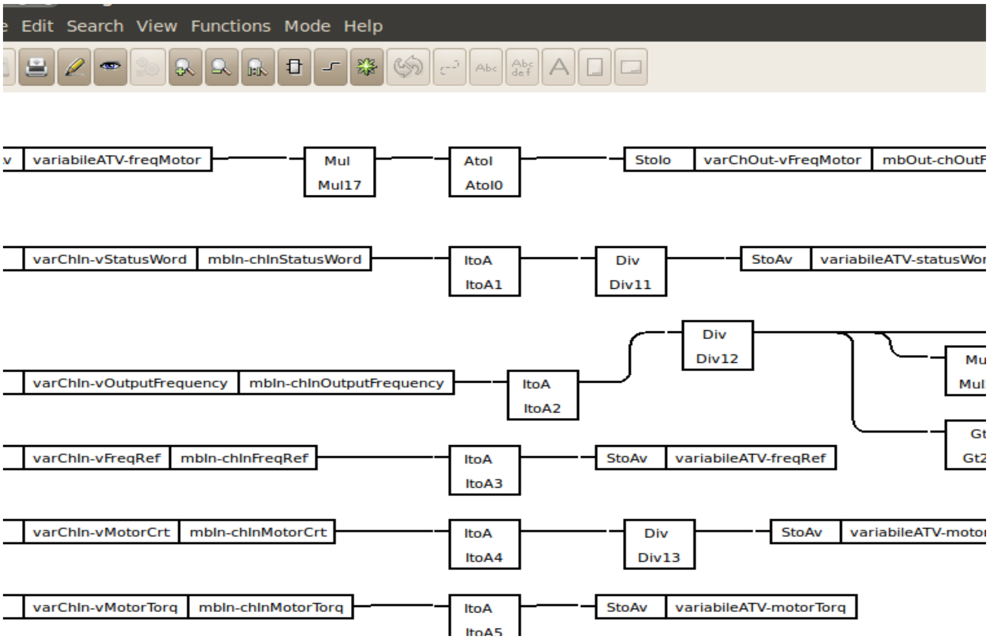

Figure 9. Pro View algorithm (GUI editor) for automatically adjust the conveyor speed.

IV. Conclusions

The application is designed to control the speed of an induction motor in a SCADA interface, with a frequency converter by using Pro View open source software.

The installation command is implemented with open source systems which is a great advantage in stability and reliability [6]. The parameters surveillance is done both locally on the measurement equipment and remotely on a PC computer that has installed the monitoring and data recording software.

Communication between measurement devices and computer is made using a Modbus RTU communication protocol type within an Ethernet network. Monitoring operations tested have provided the ability to set and manage actions like operative tracking, alarm the operator, event management [1], drapers analysis, and viewing the functioning times of the aggregates.

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