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Marine Industry Automation Systems Simulation

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Abstract. In a competitive economy, regarding competition between companies that have the same field of activity, the growth of productivity, the fast solving of malfunctions, the quality of services, all of these are very important factors. To stand up in front of these challenges, many companies appeal to high technology, although expensive, which can lead to a spectacular growth of work efficiency, in the same time improving quality of services. This paper describes the interaction between PLC, SCADA and the software PICS Pro for the dredging system of a ship and the realization of a graphic interface which simulates the behaviour of the real system.

1. Introduction

Software industry has become more and more emphatic in the last years and it tends to solve all kind of problems in different domains of activity. Marine domain is one of the most demanding concerning the electric drive and automation complex systems[1], [2], [3], [4].

Safety on board is also a big issue in the scientific research [5] meaning that professional software is used by the specialists of the Ship Knowledge and Ship Design. As complexity of the ship is growing a combination of the specific skills in the mechanical, electrical, electronic, pneumatic, hydraulic, chemistry engineering is required. SCADA and PicsPro are two of the software needed to control and monitor engineering systems.

SCADA is the abbreviation of "Supervisory Control And Data Acquisition" systems, which were made to handle the safety and control requirements of complex systems. It contains different subsystems concerning:

- Measurement
- Automation
- Actuators
- Hardware
- Software
- Communication between the components

PICS Simulation software simulates real-world systems and machines controlled by DCS, PLC and PC control systems. The entire system (communications, sequencing/interlocking, HMI/SCADA, and alarms) can be tested, all emergency faults can be verified and operators trained, with minimal downtime.

2. System description

SCADA systems typically implement a distributed database, commonly referred to as a tag database, which contains data elements called tags or points [6], [7]. A point represents a single input or output value monitored or controlled by the system. Points can be either "hard" or "soft". A hard point represents an actual input or output within the system, while a soft point results from logic and math operations applied to other points. An example of SCADA system is shown in Fig. 1 which presents how the level of the fluid in a tank is controlled.

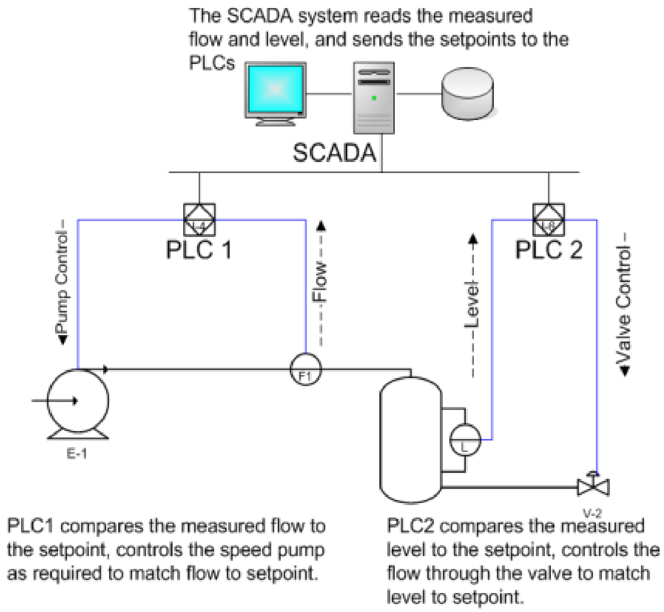

Fig. 1. SCADA system example.

PICS Simulation software enables you to identify and correct control system errors in the design stage, before implementation [6], [8]. This helps to implement the new processes quickly and accurately. Also it avoids the high cost of production downtime before “flipping the switch”. PICS Simulation software provides your project team with a realistic and versatile testing and training environment. PICS Simulation software allows you to create a dynamic model on a PC that duplicates the behaviour of the I/O devices, providing the control system with simulated device feedback (Fig.2).

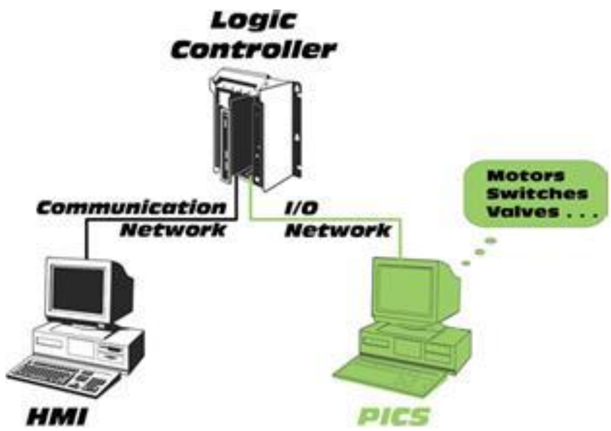

Fig. 2. PicsPro and SCADA system.

3. Automation system simulation

A program was made in Pics Pro which simulates the angles of pipes of a dredger ship, which is used for dredging the sand from the bottom of the ocean and also simulates the positions of the winches and those of the gantry cranes used for hoisting and lowering the pipes [6], [7], [8], [9].

The understanding of the behavior of the system is essential. First step is the analyzing of all the possibilities and also describing them:

- The pipes are on board in the saddle position (The Saddle and Inboard sensors are active).
- The three winches receive the command for hoisting. A sensor monitors the angle of the lower and upper pipe so it remains to zero. The hoisting command must be deactivated when the Highest sensors are activate.
- The gantries cannot be operated until the winches’ Highest signals are activated. When the Outboard command is received the pipes are moved out of the ship. After a certain time the Outboard switch is activated and the Inboard deactivates immediately.
- The lowering command for the winches is controlled from the PLC, so that the angles remain constantly zero. The command maybe manual or automatic. In the trunnion part the pipe is moving on a slider until it reaches the Pipe Pos position and the sensor activates the signal. The winches continue to lower the pipes until the Slack wire signal activates, signal that appears when the tension in the wire decreases below a certain value.
- From this moment only the intermediate dredger winches can be activated so that the pipes are positioned to reach the bottom of the sea. If the ropes of the winches reach the end during the lowering pipes action the Lowest signal activates.
- On hoisting the same principle is applied.

An important part of the control for the dredger is the positioning the pipe on the bottom of the sea independently of the currents of the sea, tide and inlet depth, Fig 3.

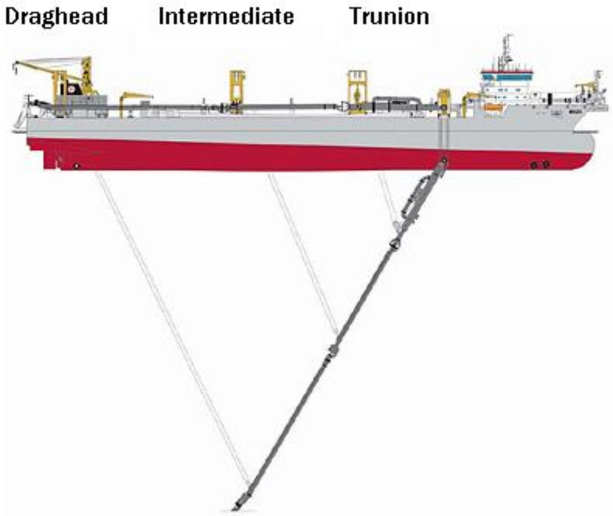

Fig. 3. Pics Dredger Ship.

To create de simulation interface the following steps are needed, Fig 4, 5:

- Create an I/O connection
- Import the variables
- Design the device templates if they are not predefined

For simulating the angles in manual mode sliders were used as predefined templates.

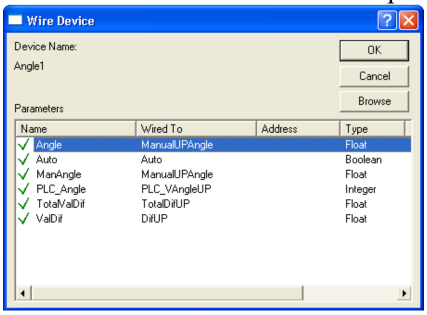

Fig. 4. Wiring the devices to PLC I/O.

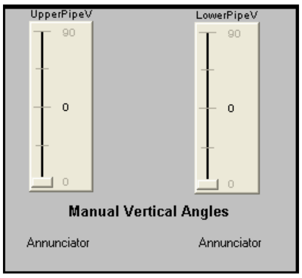

Fig. 5 Designing the device templates.

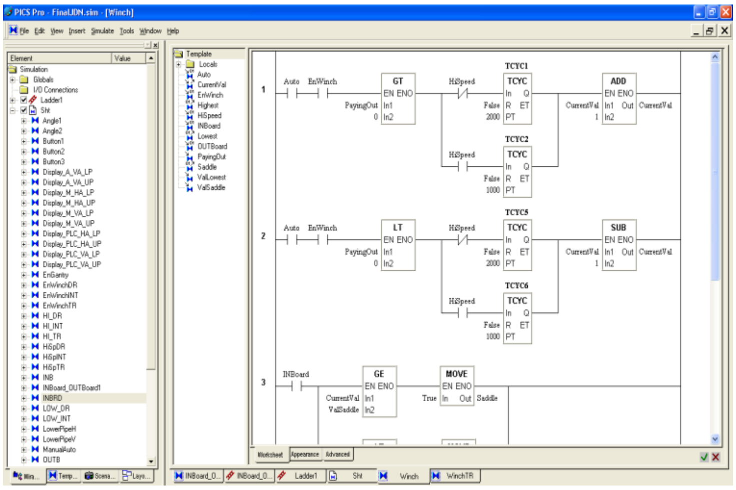

Fig. 6. PLC software programing.

For the upper and lower pipe a template simulated the angles in auto mode:

- Vertical from 0- 90º
- Horizontal from -45 - 45º

The PLC programming software in Fig 6 is helping to implement the system automation logical diagram. The control program gives the expected results of the automation system Fig 7. The winches movement takes into consideration the signals received from the PLC(enable winch, winch Hoisting/Lowering , the 2 speeds of the winch).The auto program actually calculates the length of the rope, value which was used for simulating the signals Lowest, Highest, Pipe Pos ,Slack Wire and Saddle. If the trunnion winch rope has a bigger value than the intermediate winch rope, than the angle of the upper pipe must remain 0º.

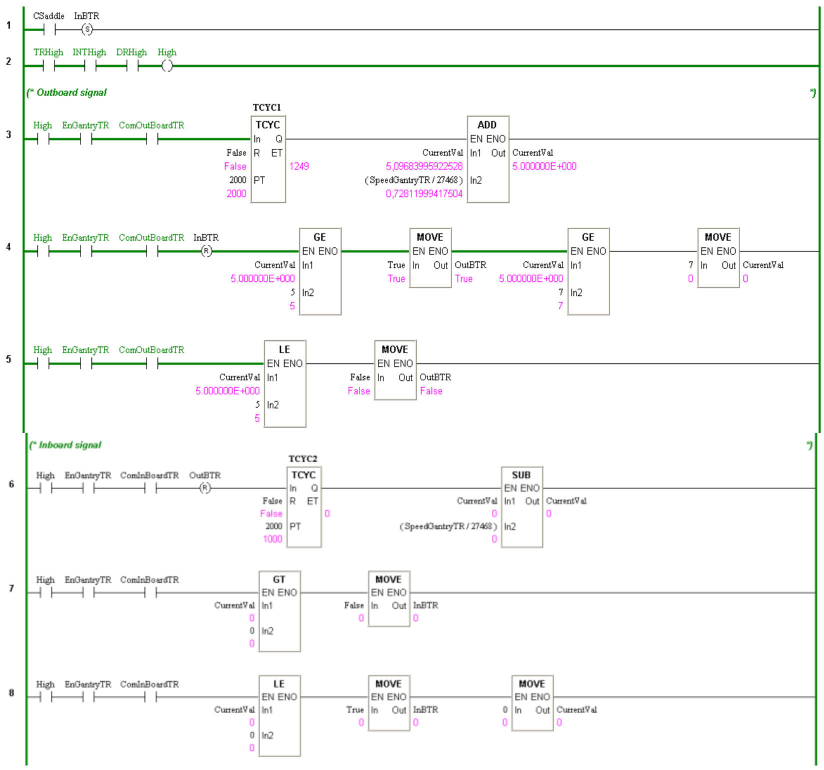

Fig. 7 PLC program control.

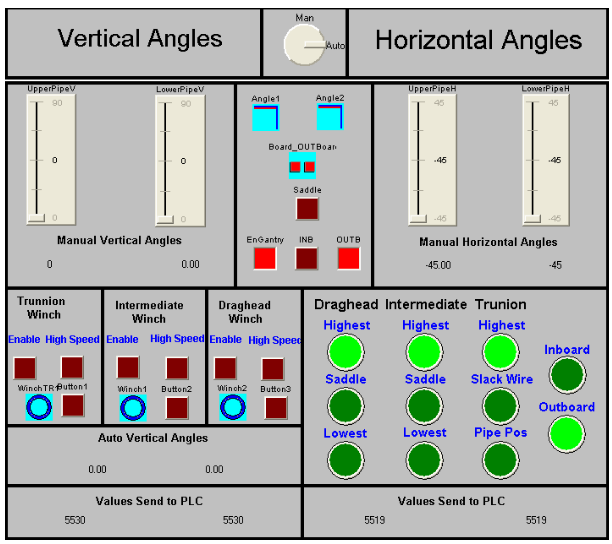

Fig. 8 Template for simulation.

If the value is smaller than the intermediate winch rope, than the angle will be a value between 0-90º.The physical value is converted to a value between 5530 and 27648 which simulates the 4-20 mA that a sensor usually sends. In similar way the conversion for lower pipe angle is made.

In the manual mode, when the customer moves the slider, the values of the ropes are stored in variables and when switching to auto mode it sends the value converted to PLC. If the winch is inboard the command for hoisting must not be activated (a program in PLC will control the commands). For the gantries movement a template was created, taking into consideration the commands received from the PLC: Enable gantry, Inboard/Outboard command, speed (analogue signal). The interface simulation template is presented in Fig 8.

4. Conclusions

Automation and control of the complex systems, like the naval systems, need to use smart procedures, equipment and IT support. IT software industry has become more and more used in the naval industry and it tends to solve all kind of problems in different stages of the ship, design, exploitation, maintenance.

This kind of software is the basis for Marine Industry development in which knowledge of mechanical, electrical, electronic, pneumatic, hydraulic, chemistry engineering is required. SCADA and PicsPro are two of the software needed to control and monitor all the engineering on a lotof the naval system. The use of such systems, like SCADA or Pics Pro can improve the work time, like the commissioning for the SCADA system, which is almost not needed. It can make easier the training of the operators and are friendly use software. The specialized intelligent technology is generally expensive to implement and specialist training is very demanding, but the investment is easy recuperated from the total benefit they are bringing.

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