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STUDIES OF WINPLC7 V4 PROGRAMMING ENVIRONMENT IN DEVELOPING ROBOTIC WORKCELL CONTROL SYSTEM

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Summary: The considered problem of using programmable logical controller VIPA series SYSTEM 100V in developing robotic workcell control system on base of the industrial robot MP-9S with pneumatic drive. Indication of number of cycles was displayed on text panel TD-03, setting up of which is performed by using TDWizard software. The presented fragment of robotic workcell control program is performed using LADDER language in WinPLC7 V4.42 programming environment.

Key words: logical controller, industrial robot, pneumatic drive, software, program, language.

INTRODUCTION

Due to the rapid development of microprocessor technology the programmable controllers are used widely in various systems to regulate and control technological processes. Using relatively cheap, reliable, compact microprocessing means, designed for industrial environments significantly simplify the design process of control systems, facilitate their maintenance, and improve efficiency of used automated equipment [5].

VIPA controllers have proved their work in many various industrial branches in different countries. One of their main fields of applications is automotive industry, control of conveyors and automated warehouses as well as control of food and beverage production. There are several controller series manufactured by VIPA, which differ by their features and designed to solve various complexity tasks [17].

Compact design and good price/performance ratio makes controllers System 100V series as especially suited for applications with the great number of I/O points. However, compatibility with SIMATIC S7- 300 relative to set of instructions and advanced communication capabilities allow to use them for enough complex tasks, which require distributed control, including in combination with other VIPA controllers and third parties controllers. The product family includes several models of controllers with built-in I/O channels and with support of features in formation of interrupt signals, fast counters and pulse outputs. Quantity of I/O channels can be increased through expansion modules. This family includes modules distributed I/O for PROFIBUS and

CANOpen networks. Processor modules and expansion modules are mounted directly on 35 mm DIN-rail.

Series System 100V has modular design. This means that the user can select the combination of modules which the best suits to certain task and modify it flexibly in case of expanding or changing system requirements. All I/O modules and interface modules are versatile that is they can be used with any CPU of this series. In this case, it is possible to select the processor module with optimal performance for a particular purpose [12].

Therefore creation of control system of robotic workcell based on PLC VIPA SYSTEM 100V series is very urgent problem.

OBJECTS AND PROBLEMS

To investigate the possibilities of WinPLC7V4 software package during development of control system of robotic workcell based on PLC VIPA- 115 6BL02 a stand was designed, which simulates the operation of robotic workcell including the load device, industrial robot with a pneumatic actuator MP-9S and an output trough, figure 1.

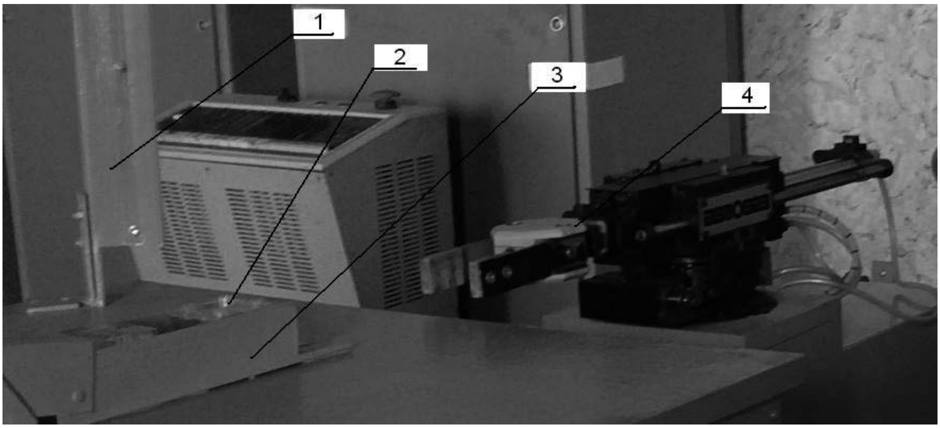

Fig.1. The layout of the robotic workcell based on industrial robot MP-9S:
1 – troughed loading mechanism, 2 - the subject of handling,
3 - outlet trough; 4 - industrial robot MP-9S

The robot MP-9S uses normally closed valve-type distributing devices with electric control. Every movement of executing unit of the robot the self-contained electric valve, type P-EPR3-112 UKhL4, Pnom = 1MPa, Du = 1.6 mm, U = 24V. As an executive drives the pneumatic cylinders are used with linear motion of double-acting piston. Gripper has single acting pneumatic drive. Signals of finishing of predefined movements come from the electromagnetic contacts (CEM). When designing control programs it was adopted both as an time-based principle of control for all segments of handling mechanism, the more so because it is cheaper and provides more reliable operation of given robotic workcell, and as path-based principle with using CEM signals.

Informal description of the operation algorithm of the robotic workcell involves following actions. Objects of handling come in oriented position by gravity along loading device to the gripping area of manipulator. Manipulator located in the lower position and turned to the gripping area must unclamp the gripper, move forward, clamp the object, turn the arm to initial position, turn to unload position, move upward, move the arm forward, move downward, unclamp the object of handling, turn the arm back, clamp the gripper, move the arm forward to transfer the object of handling in output trough, return the arm back and turn to the loading position. After that the cycle repeats.

To study the environment of WinPLC7 and opportunities of VIPA-115 16DI/16DO (CPU 115 6BL02) the activity diagram of movements of industrial robot MP-9S has been developed which is shown at figure 2.

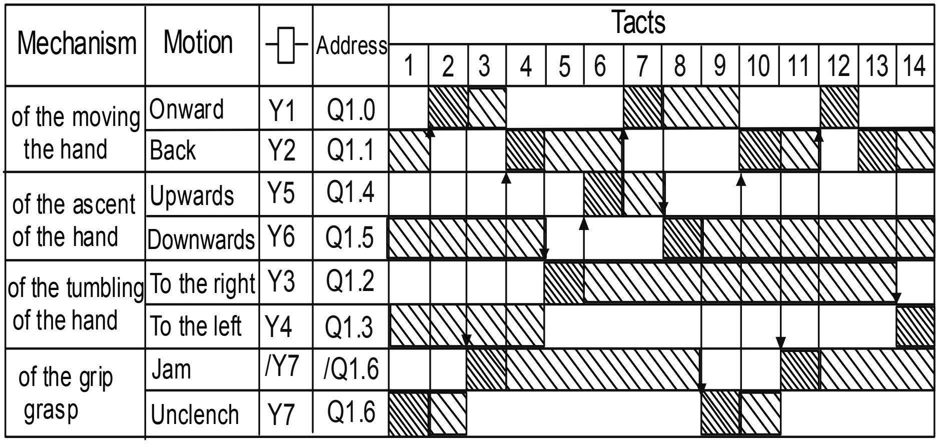

Fig.2. Activity diagram of robotic workcell operation

The control unit is shown in figure 3. The stand scheme includes buttons for selecting operation mode, for manual control, additional relay units of galvanic separation, performed on the interface relays RM84 with socket GZT80, equipped with LED signal module M61R and PLC VIPA-115 6BL02. The controller is powered from a standard power module VIPA 24VDC/2A (207-1BA00). The power supply for electromagnets of pneumatic valves (+,-) is carried out through a developed power unit.

Inputs and outputs of the system are signals (in brackets the notations are given used in synthesis), table 1.

In synthesis of control system it was used path- and time-based principle of control. All movements of the robot arm are controlled according to the path-based principle but gripper is controlled under time basis.

Fig.3. Robotic workcell control unit on the basis of VIPA-115 6BL02 controller

Table 1. **Input and output signals of control system**

Inputs (control buttons)	Inputs (buttons for mode selection)
SB0.0 (I0.0) – manipulator **“Forward”** (**“Manual”** mode**)**/ ***Cycle start*** (***“Automatic”*** *mode*)	SB8.0 (I2.0) – “Manual” mode
SB0.1 (I0.1) – manipulator **“To the right”** (**“Manula”** mode)/ ***Cycle stop*** (***“Automatic”*** *mode*)	SB8.1 (I2.1) – “Automatic” mode
SB0.2 (I0.2) – manipulator “Upward”	SB8.2 (I2.2) – “Cycle” mode
SB0.3 (I0.3) – manipulator “Clamp”	
SB0.4 (I0.4) – manipulator “Backward”	
SB0.5 (I0.5) – manipulator “To the left”	
SB0.6 (I0.6) – manipulator “Downward”	
SB0.7 (I0.7) – manipulator “Unclamp”	Outputs (electromagnets)
Inputs (sensors)	Y1 (Q1.0) – manipulator “Forward”
SQ1 (I1.0) – manipulator is in front pos.	Y2 (Q1.1) – manipulator “Backward”
SQ2 (I1.1) – manipulator is in rear pos.	Y3 (Q1.2) – manipulator “To the right”
SQ3 (I1.2) – manipulator is on the right	Y4 (Q1.3) – manipulator “To the left”
SQ4 (I1.3) – manipulator is on the left	Y5 (Q1.4) – manipulator “Upward”
SQ5 (I1.4) – manipulator is in upper pos.	Y6 (Q1.5) – manipulator “Downward”
SQ6 (I1.5) – manipulator is in lower pos.	Y6 (Q1.6) – manipulator “Unclamp”

In accordance with the cyclogram the program of robotic workcell has been designed using LADDER language, the fragment of which in programming environment WinPLC7 V4.42 (network 28... network 30) is shown in figure 4.

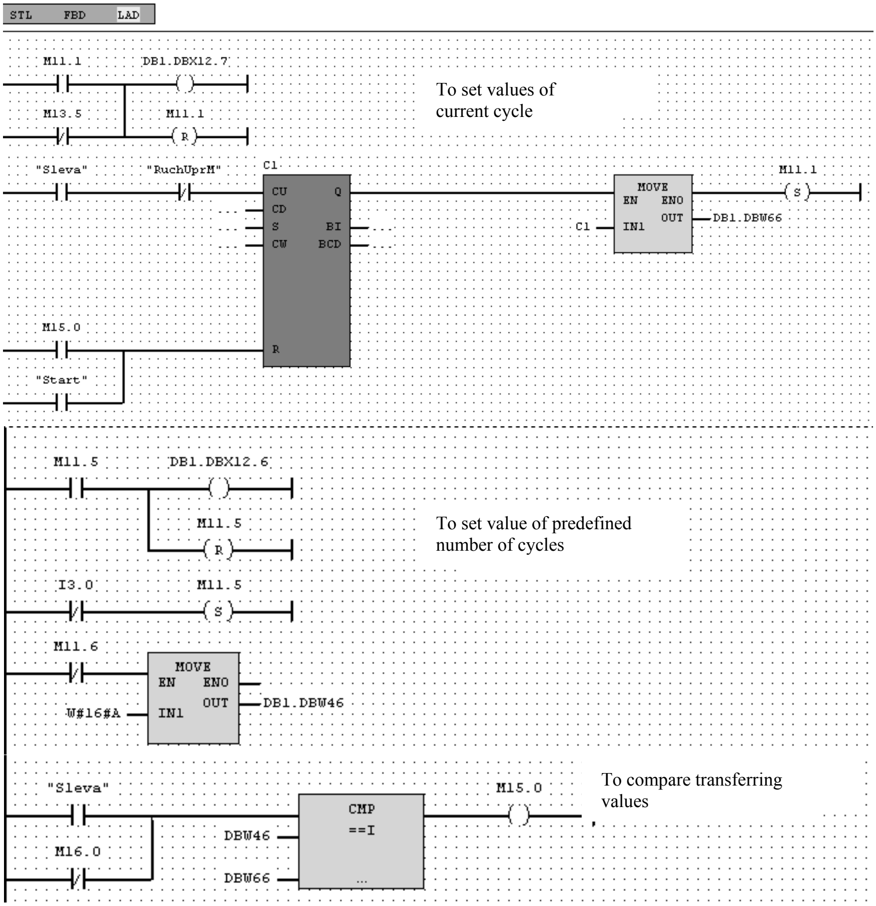

Fig. 4. Program fragment in LADDER language for functioning TD 03

Two input signals are used for program operation in order to switch control modes:

- input I2.0 – "Manual" mode: this mode involves 8 input signals more I0.0-I0.7 (for each movement);
- input I2.1 – "Automatic" mode: this mode involves 2 input signals more:

1. I0.0 – Start – when it is activated the cycle of MP-9S starts
2. I0.1 - Stop – when it is activated the cycle of MP-9S stops.

Programming environment WinPLC7 V4 includes operators MOVE, which allow to transfer numerical value (in hexadecimal format) to defined block and its memory area (e.g. record DB1.DBW46 indicates that the value will be transferred to block DB1 and will be assigned to the memory area DBW46), that is necessary for text display operation TD 03.

Indication of the number of cycles was performed on the text panel TD- 03 setup of which was made through TDWizard software. As a result of setting up the text panel displayed the message "Zad CIKLOV:" and the value of the block DB1 – DBW46. Record to this variable adjusted value of number of defined cycles was carried out by using "move" element. Continuous update of displayed data has been performed by activating the variable responsible for the pop-up message "TEKUSH CIKL:" - DB1-DBW66, figure 5.

Fig.5. Indication of robotic workcell operation on the text panel TD-03

Operator MOVE is used to transmit numerical values by DB1 block to text display TD 03. In block DB1, two messages were preprogrammed, with which appropriate value for memory area (DBW46 and DBW66) will be linked. One message having memory area DBW46, DBX12.6 at the start of the program shows the number of programmed cycles (input value in MOVE element in hexadecimal format *W#16#A*, i.e., 10). The second one (memory area DBW66, DBX12.7) displays the current cycle in triggering sensor I1.3 by using counter into MOVE element the counter value C1 is transmitted, which shows the change in number of cycles on the text display. Once the value of current and programmed value for specified number of cycles are coincide, the cycle MP- 9S stops (comparison of values provides an element WinPLC - comparator). By pressing Start button value the current cycle is reset to 0 and cycle counting begins again. In manual mode cycle counting is not performed.

When configuring PLC by enabling command "PLC Mask" a window with a virtual applied controller and extension units on the front panels is displayed, which reflects the presence of signals at respective inputs and outputs, similarly to operation of the real control system, which is very obvious and allows to quickly debug the control program.

CONCLUSIONS

Application of the software system Win PLC7 V4 allowed synthesizing the robotic workcell control system based on module Vipa-115 series CPU 115 6BL02, with testing programs in real time and allowed to use "TD03 Wizard" function for visual observation of the robotic workcell operation as displaying the current cycle.

The software allows easily adjusting execution time of a movement and provides synchronization of robotic workcell operation according to the limiting current conditions of transition.

Applying the operator "MOVE" in development of control systems allows quickly developing and debugging cyclic programs for real control systems.

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ИСЛЕДОВАНИЯ СРЕДЫ ПРОГРАММИРОВАНИЯ WINPLC7 V4 ПРИ РАЗРАБОТКЕ СИСТЕМ УПРАВЛЕНИЯ РТК

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Аннотация. Рассмотрена проблема использования программируемого логического контроллера серии VIPA SYSTEM 100V при разработке системы управления РТК на базе промышленного робота МП-9С с пневматическим приводом. Заданное количества циклов отображается на текстовой панели TD-03, настройка которой производится с помощью программного обеспечения TDWizard. Приведен фрагмент программы управления РТК выполненый на языке LADDER в среде программирования WinPLC7 V4.42.

Ключевые слова: логический контроллер, промышленный робот, пневматический привод, программное обеспечение, программа, язык.