CONTROLING THE ROBOTIC ARM USING HUMAN MACHINE INTERFACE AND PLC MODICON M340

Siniša G. MINIĆ[1] and Miloš VORKAPIĆ[2]

Abstract: Remote cotrol management has enabled engineers to easily and quickly operate the facility management directly from their work place, making it possible to connect production facilities in large systems (which are localized at a distance of several hundred kilometers). Placing the observed object into the network with the computer that manages that object (PLC) data acquisition is achieved and thus the management is realized. For monitoring these systems there are multiple ways, depending on the management (parameters that govern). Monitoring can be realized by using video surveillance or collecting data / telemetry parameters (liquid level, temperature of the manufacturing process, the position of measuring by the encoder, etc.) which offers one of the most important systems for managing and monitoring, today's SCADA (Supervisory Control And Data Acquistion) system. Our work is based precisely on these three areas: management, communication with the user and the monitoring of one production process.

Keywords: Controling, HMI, initilization, PLC, processing unit, robotic arm, SCADA.

INTRODUCTION

This paper presents an outline on the remote control that can be applied in all areas of industry. These are usually mid harmful to human health, high temperature, radiation, etc. present management combines several independent segments. A model of the robotic arm (manipulator), which represents building management. This model (scale model) is simplified but represents a real complex high-tech robotic malipulator with five degrees of freedom. Instead it could use any model similar purposes. The second segment of the software platform modular type which is very flexible in terms of expanding the functions and upgrades. This module is equipped with a data card that allows you to send control instructions and receiving feedback. It is located right next to the building which is operated in connection with the control panel located at a remote location from which to manage. The control panel (touch display) separately programmed. Feedback is obtained through a video camera, which is positioned next to the robot arm and sends feedback on the position of the hands over the internet. In this way he achieved a complete management system remotely.

SETTING THE TASK

There are complete solutions management system remotely, which are integrated with an object which is managed. However, it is often necessary for designing new management for the existing plant. This paper illustrates a concept or solution, to construct a remote control that has a wide range of applications in already existing therapeutic systems. Such a system can be a very good application of the following systems: metal foundries where there are very high temperatures, X-ray and explosive devices, automotive industry, the process of packing goods in any area, etc. This task is described remote management system that is part of the production line and performs an operation of moving goods.

The main task is to implement a system that allows you to control a robotic arm remotely using the PLCs (Modicon M340) and the touch display (Magelis), with whom you can set the control commands. The system which is controled, is monitored by a video camera, where the image is transmitted through the Internet to the place where management gets a complete insight into the behavior of the system and on that basis it can make some necessary interventions. Management defines a user using HDMI (Human Machine Interface) and it may issue the following commands: 1) Automatic mode (the robotic arm moves the object from one place to another, eg, a product from a strip into the packaging for transport), and 2) Manual mode, which allows the user to manage the robotic arm at his own risk, free movement.

Communication with HMI and PLC is achieved by using Ethernet communications. This enables the object or building management and monitoring system to be located at a distance from 10 to 40 kilometers (example for ten Gigabit Ethernet connection). In this way, there is a complete insight into the functioning system of the management, which is shown in the following picture (see Fig. 1).

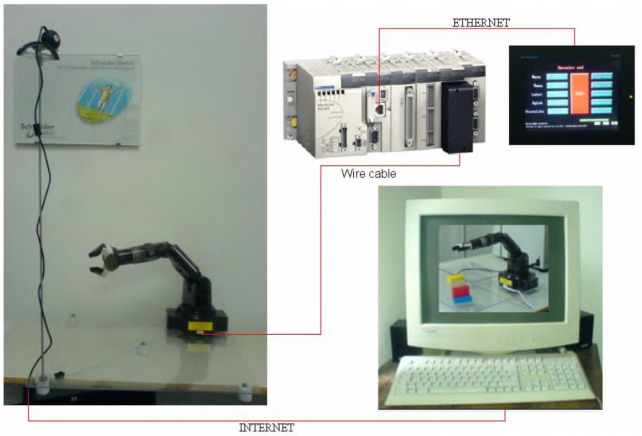

Fig.1 – *Management system.*

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DESCRIPTION OF THE HARDWARE STRUCTURE

Modicon M340 automatized platform

Modicon M340 programmable logic controller, shown in Fig. 2, in terms of hardware is organized in modules. This means that the above-mentioned components of the controller (processor, power supply, input-output, as well as Application-specific units) modules that are pluged on the free slots (places designed for modules) carrier, building a desired configuration of the controller.

In Fig. 2 is presented power supply (PSU), which can be powered from a DC or alternating external source, depending on the type of unit.

Behind it comes processing unit 'CPU'.

These two units are the basic unit of the controller, and always take up a starting position on the carrier. The rest of the modular structure is changeable in principle.

It consists, in most cases of, the input - output modules, either discrete or analog, and / or Application-specific modules such as eg. counting modules (designed for counting pulses coming from the sensor), then some network modules such as Ethernet module to communicate via Ethernet with other Modicon M340 modular platforms. It is, of course, in the optional modules.

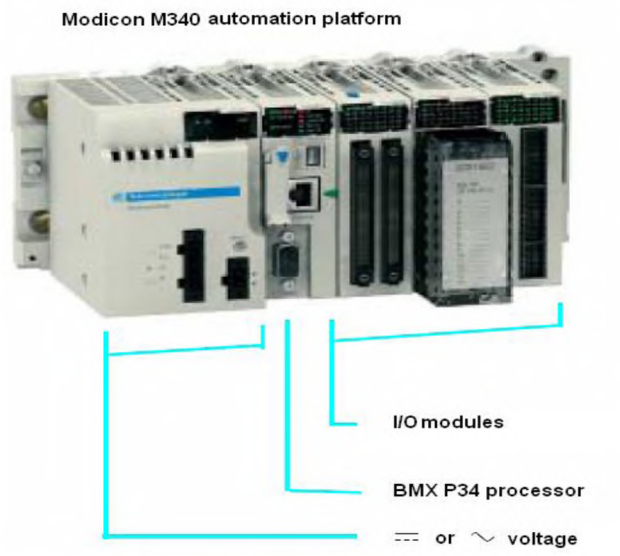

Fig.2 – *Modicon M340 automatized platform.*

Description of the hardware structure HMI

As the HMI device in this system, it is used touch-screen Magelis XBT GT 4330, from Schneider Electric, Telemecanique brand. The screen size is 7.5 inches. Display resolution is 640x480. It has two Serial and one USB port to communicate with other devices. In Fig. 3, you can see Magelis XBT GT4330.

Magelis XBTGT 4330 connects to the controller (PLC) via a special cable for Serial Communication (xbtz 9780). For Magelis cable we connect to COM2 (RJ 45 connector, RS-485) and the controller to MiniDin connector (7 pin), see Fig. 4.

Fig.3 – *Magelis XBT GT 4330.*

Fig.4 – *Communication Magelis with the controler.*

Robotic arm

There are five degrees of the movement, where each level starts with one DC motor with 3 volts supply. Bringing a positive or negative voltage, the motor is driven in one direction or the other and in this way we control the robotic arm. As we don't have the position sensors, we don't have the feedback information about the position of the arm, so the management comes to that each time the robotic arm first starts, it comes back to the starting position and in that way initialization of the first stage is performed, from where begins several consecutive steps that define a path that performs a specific action. In automatic mode, this sequence is repeated by pressing the start button until pressing the stop button. In manual mode, the management has the ability to control each motor individually and in that way we can form a desirable path that performs desired action. This robotic arm is relatively in small size, but it is an excellent indicator of the principles of operation and functioning of industrial robotic arms that perform highly complex actions.

SOFTWARE IMPLEMENTATION

The application Vijeo Designer consists of four windows (see Fig. 5):

1) The initial window, which allows you to select the desired mode (automatic or manualmode), or help, which describes the use of applications;

2) Automatic mode (opens after clicking on automatic mode);

3) Manuel mode (opens after clicking on manual mode),

4) Help.

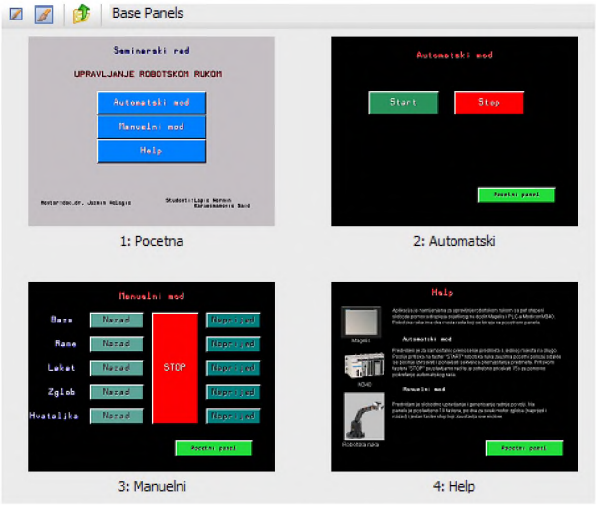

Fig.5 – *The layout of the window application.*

The windows are shown in Fig. 5 and they are implemented using a text and rectangular options that are on the taskbar. You then need to define all the variables used in the program, it is important to indicate the type of a variable, the variable source and its address.

SOFTWARE FOR PLC MODICON M340

After opening a new project tehere has also opened a window in which are shown all the parts of the project together, with the tools which are needed to develop one such program. Once we form one such project then Unity Pro has the appearance as shown in Fig. 6.

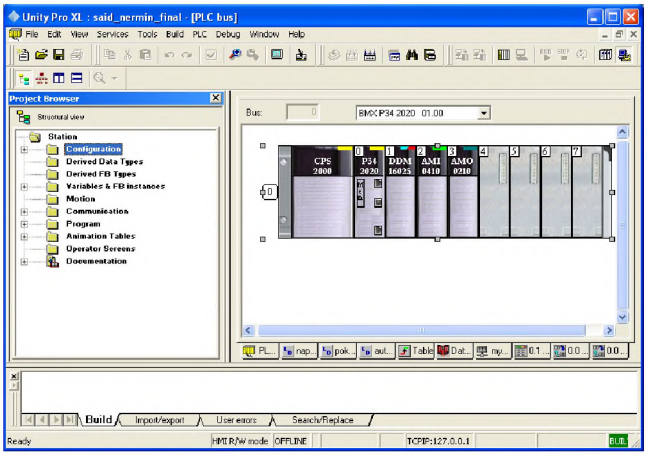

Fig.6 – *The layout of the project.*

When the configuration of hardware and connection is over, then we approach to write the application program. In folder "Communication" you can find a folder "Section" in where we form the sections in which the program is written. While forming the section, you can choose one of five offered ways of writing the program. Within one section it is possible to write with only one language, but each section independently can be written in any language in which users can cobine multiple programming languages, making it easier to write complex applications. For example, Boolean functions is easier to write using Lederovih chart, while the communicating via Modbus network is much easier to implement using sheet language. CPU cyclically reads and realizes sections, and with that it is enabled binding sections in a single unit. Program for the management of robotic arm is divided into three sections: power supply, movement and auto man, where each section defines the specific operation.

Power supply

Since one of the ends of the relay outputs is connected to a single point, as shown in Fig. 7. It is always necessary, over one of the two relays,at a common point, to bring +3 V or-3V.

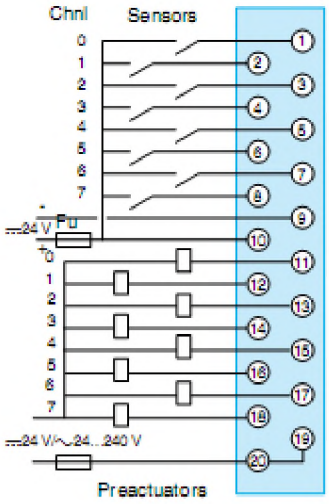

Fig.7 – *The scheme circuit of relay outputs.*

This is realized in a way that instead of the motor on to the terminal clamps 16 and 17 is brought +3 V and -3 V, respectively. So there are always included on of the two relays (but not in any case, at the same time) and one of the relays, which forwards that voltage on to the motor which is powered. Selecting the relay, through which we bring positive or negative voltage, changes the direction of rotation of the motors, which are connected to terminals from 11 to 15, as shown in the following Fig. 8.

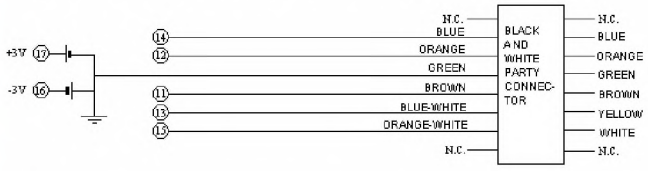

Fig.8 – *The scheme that shows connection of the robotic arm to the PLC.*

From these diagram you can see that, by pressing one button activates a variable that always includes two relays, one for selecting the voltage and the other to forward the voltage to the corresponding motor.

Movements

The automatic mode is a series of voltage pulses,that are cyclically repeated. This is achieved by using 15 variables (movement" 1" to movement15") which are set one after another with exactly specified time interval and include two relays, who provide the intended function of the robotic arm. In the first seven movements the intialization is performed and other 8 define a sequence that moves the boxes from one place to another. Since the robotic arm has

no sensors that provide information about the position, all the movements are determined by the time duration of the actuating voltages for each motor individually. This is achieved by using a timer and the associated supporting logic that gives the impulse for each variable. The appearance of a part of the program is shown in the following Fig. 9.

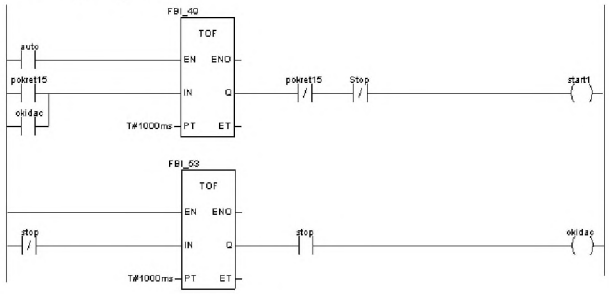

Fig.9 – *The appearance of a part of the program.*

After the last variable state, sets the auxiliary variable "Start1" that allows a return to variable "movement 8" and in that way form an infinite loop that spins up until pressing the button "STOP". Beside the mentioned variables, there is a variable" trigger" which is set by pressing the button" STOP" - which triggers all the timers to count and set it to zero in order to be ready for the new operation (rework) after a possible interruption of automatic mode. This will not affect the output states because then the negation of variable " stop " is zero. Automatic mode eables variable" Auto" which is set by choosing the mentioned mode. The list of movements that define the operation of the robotic arm, is as follows:

Initialization:

Movement 1=> Base back to the end
Movement 2=> Shoulder back to the end
Movement 3=> Elbow back to the end
Movement 4=> Wrist forward to the end
Movement 5=> Clamp forward to the end
Movement 6=> Elbow forward (forming a slope at the elbow)
Movement 7=> Shoulder forward to the floor

***The sequence of moving elements*:**

Movement 8=> Clamp forward (Grabbing the elements)
Movement 9=> Shoulder back (lifting)
Movement 10=> Base forward (carrying the elements)
Movement 11=> Shoulder forward (descenting)
Movement 12=> Clamp back (dropping the elements)
Movement 13=> Shoulder back (lifting)
Movement 14=> Base back (returnig the arm fo the new element)
Movement 15=> Shoulder forward (lowering for element)

CONCLUSION

This paper presents a practical example of the management system remotely. The robotic arm to which is applied the management, is designed only for educational purposes, while other equipment (Modicon M340 and Magelis) is professional and can be found in control parts of industrial plants at very high abilities. In this paper many areas of the engineering practice have been covered (management, acquisition and data transmission through network, programming PLCs, video surveillance, etc.) that are necessary to configure the advanced control systems. In industry, the remote control has largely contributed to the security of dealing with complex installations and allowed monitoring and management of industrial plants in environments which are harmful to the health of a human.

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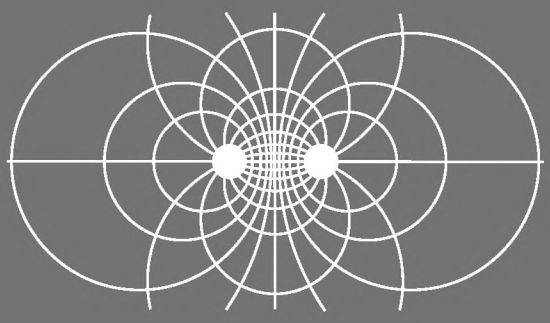

August 31 - September 02, 2015, Niš, SERBIA
University of Niš, Faculty of Electronic Engineering

IZDAVAČ:
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CIP – Katalogizacija u publikaciji
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CIP - Каталогизација у публикацији - Народна библиотека Србије, Београд

621.319(082)(0.034.2)
537.8(082)(0.034.2)
537.6(082)(0.034.2)
537.2(082)(0.034.2)

INTERNATIONAL Conference on Applied Electromagnetics (12 ; 2015 ; Niš)
Proceedings of Full Papers [Elektronski izvor] / 12th International Conference on Applied Electromagnetics ПЕС [Примењена електростатика] 2015, August 31 - September 02, 2015, Niš, Serbia ; [organized by Faculty of Electronic Engineering, University of Niš, Serbia ...[et al.] ; glavni i odgovorni urednik Dragan Tasić]. - Niš : Elektronski fakultet, 2015 (Niš : Unigraf). - 1 elektronski optički disk (CD-ROM) ; 12 cm

Sistemski zahtevi: Nisu navedeni. - Nasl. sa naslovnog ekrana. - Tiraž 150.
- Bibliografija uz svaki rad.

ISBN 978-86-6125-145-0

1. Faculty of Electronic Engineering (Niš)
a) Електромагнетско поље - Зборници b) Електростатичко поље - Зборници c) Статички електрицитет - Зборници
COBISS.SR-ID 217225484

Štampa: "UNIGRAF", Niš

Tiraž: 150 primeraka

ISBN 978-86-6125-145-0