PRACTICAL APPLICATION WITH PLC IN MANIPULATION OF A ROBOTIC ARM

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Abstract: *This paper presents the use of a robotic arm PLC Siemens in order not using CNC commands. This is done by programming the PLC ladder diagram language that makes movement on the three axes of the arm by means of stepper motors. Required command console PLC is built with the help of a touch screen HMI Weintek. In the user interface are introduced distances and displacement speeds on the three axes.*

1. INTRODUCTION

Industrial robots have emerged in response to the human need for automation of production processes, especially those repetitive. Besides stationary industrial robots, built mainly from the need to increase productivity in recent years have also been used the mobile robots. The main activities that can be taken by industrial mobile robots are linked to transport and manipulating objects and sometimes achievement of processes (painting, inspection, assembly, etc.).

In order to optimize the execution of these activities, many current field studies based programming lead to the cognitive attributes (reason, perception, understanding and learning)

that the abstraction, generalization, specialization, representation, knowledge, concentration, socialization gives robots a level high intelligence.

Industrial robots are point of intersection of the latest discoveries in a number of areas: mechanics, automation, electronics, computers and drives. The complexity of this sector is reflected on the mechanical architecture and the system management.

The automation of the manufacturing processes was required by the general effort of the industrial manufacturers to obtain high productivity and to improve the quality and reliability of products. The decrease of manufacturing costs and the improvement of work conditions are aimed. PLC's are used in numerous applications, particularly in industry and has a number of advantages, most of which important are reducing production time and lower costs. In principle, any application that requires electrical control needs a PLC. [2, 3]

Sending commands from the PLC program to the robotic arm elements require the use of stepper motors, which makes the transmission travels on mechanical components. Robotic arm allows movement in three axes and is equipped with three stepper motors.

2. APPLICATION COMPONENTS

2.1. PLC Siemens CPU 313C

PLC (Programmable Logic Controller) Siemens CPU 313C is composed of a power supply, a CPU and modules input and output (I/O modules). It monitors and controls equipment (installation) using Step7 software which through the addresses accessed I/O modules and internal elements entering the programming applications.

2.2. HMI Weintek

All PLCs do not dispose a graphical interface control (Human Machine Interface - HMI), requiring the use of an HMI to enter input data and monitor progress made by the program (*fig. 1*).

HMI MT8070 iH is a touch screen produced by Weintek, which facilitates the creation of a graphic interface for a large number of PLCs found on the market. MT8000 series is the new generation of HMI from Weintek.

EasyBuilder Pro is software developed by Weintek for programming various types of graphical user interface to controlling and command the various types of PLCs. The software has a diverse library of images, buttons, graphics, and sound monitoring screen, but also allows the insertion of other elements that can be used to create interfaces, depending on the project conducted.

Fig. 1 - Touch screen Weintek

2.3. Stepper motors

The applications of the stepper motors are limited to cases where high power is not required (usual powers between field's microwatt and kilowatt).

Stepper motors are used in low power applications that are characterized by quick movements, precise, repeatable: xy plotters, floppy disk drive, moving print head printers, operating mechanisms and pressure oriented robots axial displacement systems elements optical, tables positioning 2D drilling machines, in aviation etc. [1]

The stepper motor is used in control schemes with software systems and pulse. The use of computers for the control of complex processes is necessary to process signals, impulses form is what can be done with stepper motors.

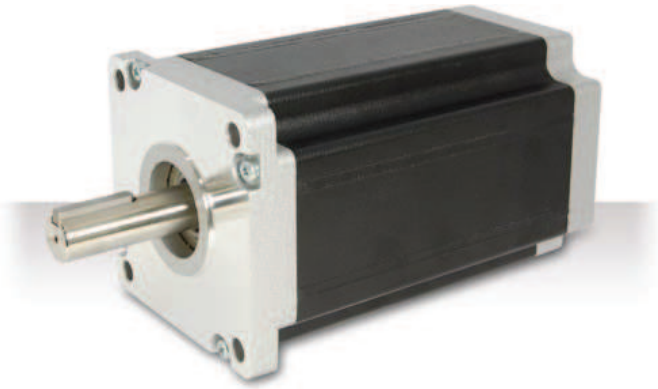

Fig. 2 - Stepper motor Nema 42

Nema 42 stepper motor was developed primarily for users who have restricted installation space available and want a motor with increased torque (*fig. 2*). Nema 42 motor uses advanced magnetics technology to give the couple a level significantly higher than that of a standard motor device.

3. APPLICATION DEPLOYMENT

The project was realized using two software: Simatic Step 7 Manager, software for programming PLCs manufactured by Siemens, and EasyBuilder Pro software used to create graphical interfaces used in the simulation.

The programming using Ladder Diagrams appeared in the case of programmable controllers due to the necessity to have an easy programming way which allows the realization of applications without having complex programming knowledge.

The Ladder Diagrams are taken from electrical field and they inherit certain names and representations from this field. The base elements of the ladder diagrams are the contacts and coils. [5]

3.1. Movement of robotic arm in the PLC

For starters we established the entries will start or stop operation scheme, starting scheme is through the PLC inputs I124.0, I124.1 so that starting or stopping operation scheme is performed by simply flipping the inputs who are rebound.

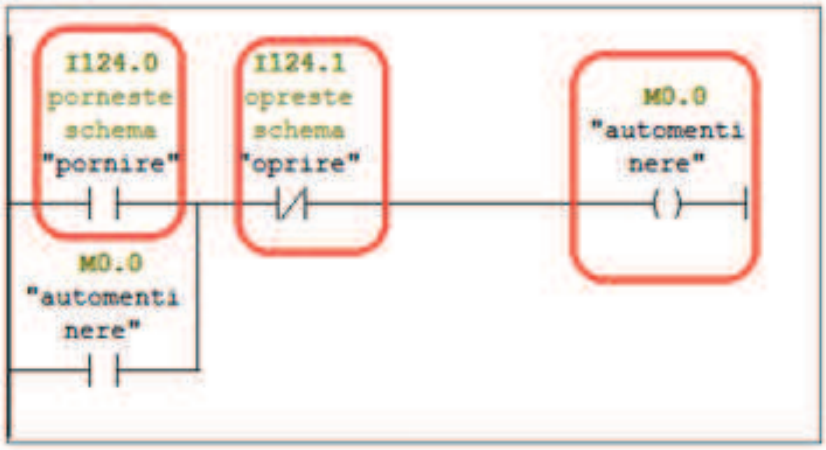

Fig. 3 - Start/Stop of process

In *figure 4* it can be observed operation outputs Q124.0, Q124.1, Q124.2, these outputs are required to give impulses of the stepper motors through frequency converters, which are connected to the PLC terminals corresponding user exit.

As can be seen these outputs will be active when the program starts and the necessary buttons are enabled conditioning the axes functions as timers to be in working. These output besides the impulses getting from the operating time are on also for the markers corresponding directions.

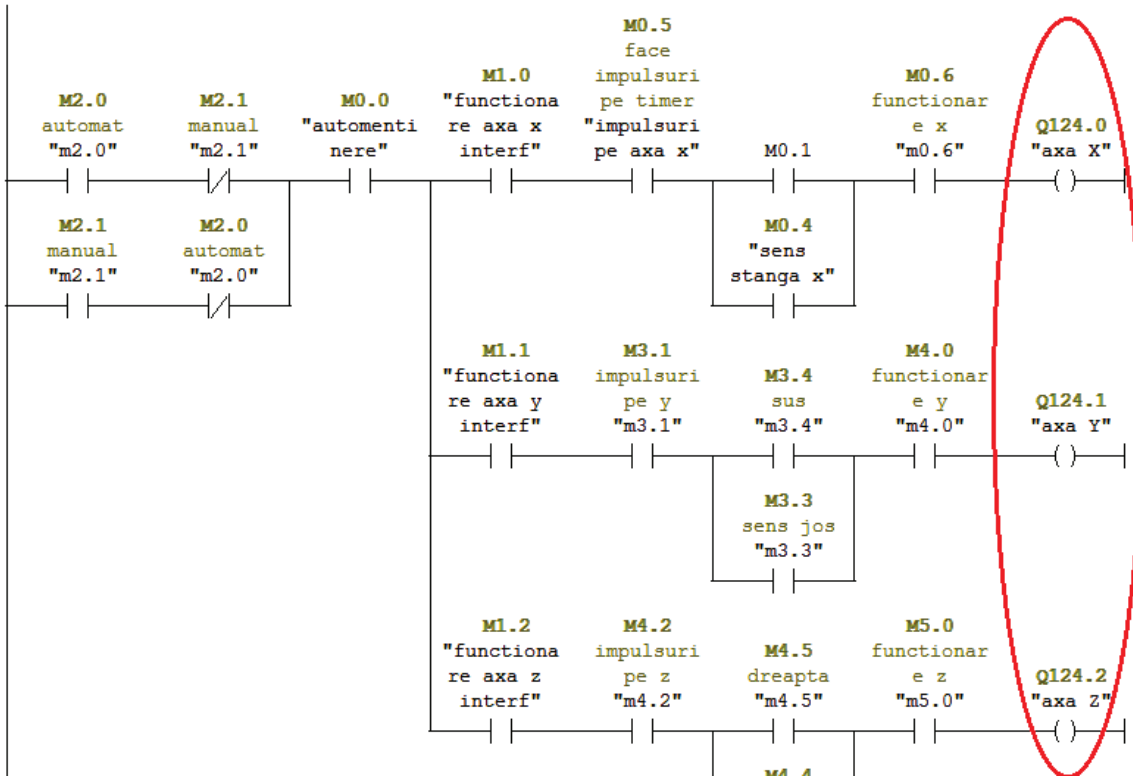

Fig. 4 - Commands on X, Y, Z axis

Time relay is one of the most important components of the programing in the works scheme we decided that it will be active only when one of the two inputs automatic/manual is active. In the network has introduced a marker M1.5 in order to establish its operation only when we want, marker M1.5 is designed for interface.

For making impulses every 30ms (value set by us) we inserted a marker M0.5 (*fig. 5*), it starts and stops the relay operation time doing a loop sending one pulse every 30ms.

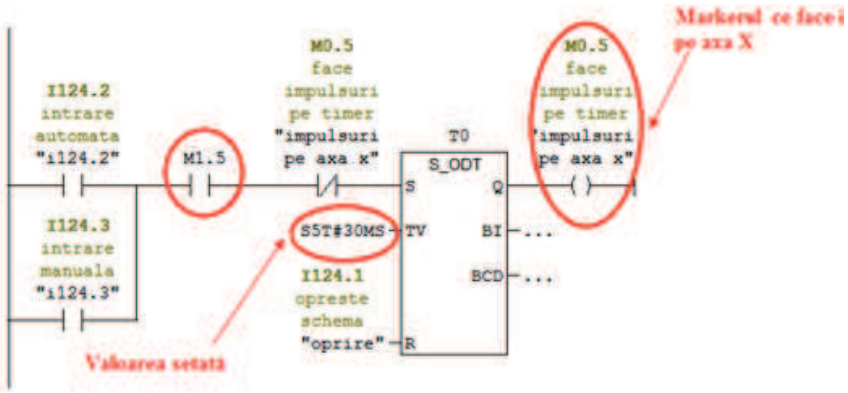

Fig. 5 - Making impulses 30ms

Time relay sends these pulses and impulses counter that counts up the number if entry CU (count up) incrementing by 1 the value of each pulse received from the relay time or the entry CD (count down) it decrements by 1 the value of the which is in the time counter.

4. HMI INTERFACE OF THE PROGRAM

4.1 Main menu panel

Main Menu panel (*figure 6*) present major information to any user, while having windows (screens) for additional axes robotic arm that works. This panel consists of buttons with which we communicate with the other interface windows, buttons and switches automatic and manual start and stop the operation of the program

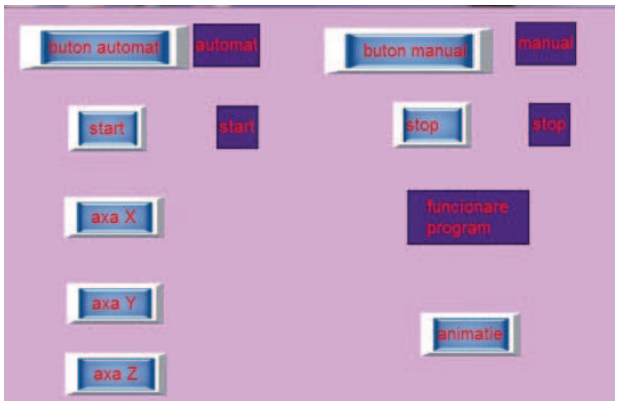

Fig. 6 - Main menu panel

Start and stop buttons are buttons of starting and stopping set the programmed bit, we're still here and start and stop lights working distance when inputs I124.0 (start) and I124.1 (stop) operates the same from the PLC program (*fig. 3*).

4.2. X axis menu

Accessing window X axis is done by pressing the X axis in the Main Menu window. In this window you can find the main buttons for operating the robotic arm on the direction of X (*fig. 7*).

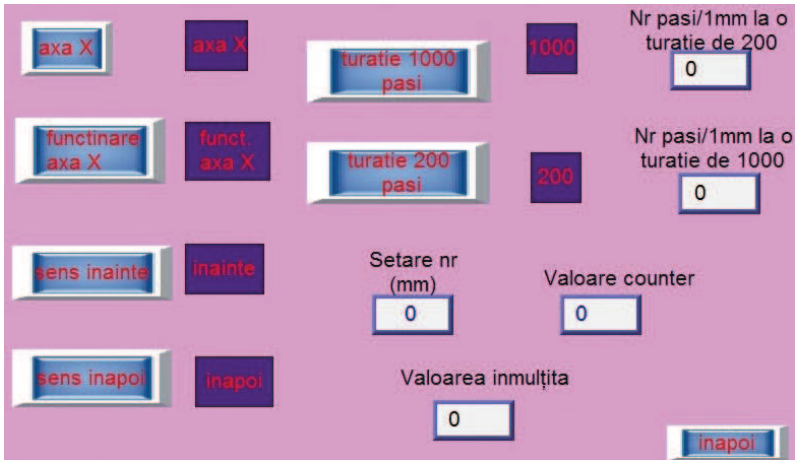

Fig.7 - Menu of X axis

The numerical indicators, *setare paşi/mm la o turaţie de 200*, *valoarea înmulţită, valoare counter, setare paşi/mm la o turaţie de 1000* and numerical button *setare număr* we finding also on the windows of Y and Z axis.

The numeric display can be set from Weintek panel and input to the PLC through the marker word (*fig. 8*):

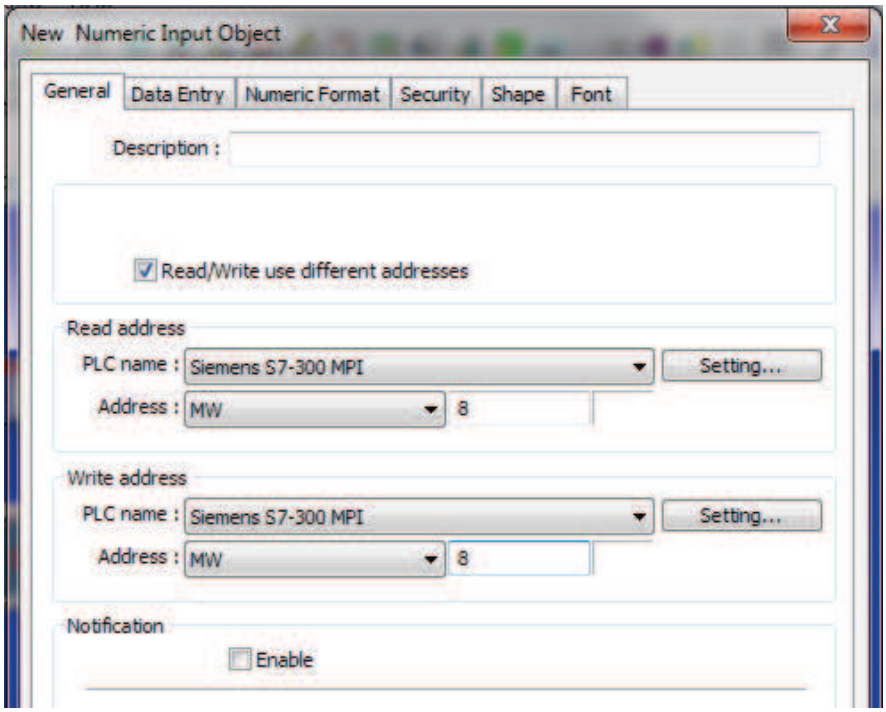

Fig. 8 - Setting of the numeric display

Numeric indicator *Setare paşi/mm la o turatie de 200* (MW8) indicates how many steps must be at a speed of 200 steps in order to move a millimeter.

The button Axa X (M1.0) starts axis x along with relay output time (timer) and output counter.

LED Axa X (M1.0) indicates the function on X axis, the button works when the X axis button is pressed. The button Sens înainte (M0.3) controls robotic arm in the forward direction.

The interface consists of windows which make it possible to navigate between the X, Y and Z of the robotic arm. It performs the following commands:

- Establish starting and stopping application with Weintek panel,
- Set the distance you want to made the arm on the axes X, Y and Z,
- Setting impulses which they receive stepping motors, engines impulses have different configurations from 200 to 12800 pulses.
- Setting the direction of movement of the robotic arm in the X, Y and Z.

In this window is represented the functioning of the robot arm on the directions X and Y accessing is done from the Main Menu window. Window animation follows the movement

of the robotic arm on the X and Y directions in both automatic and manual modes (*fig. 9*). This shows how the robotic arm moves in X and Y was set as the the range of movement of the arm on axis.

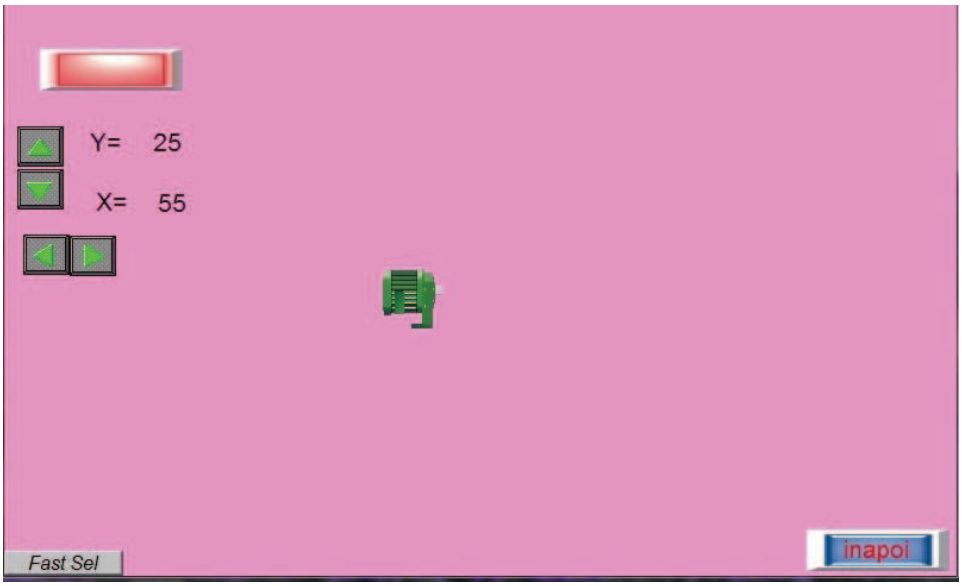

Fig. 9 - Manual mode

5. CONCLUSIONS

The paper highlights the utility and importance of programmable automates in the control of the industrial processes, command the function over 3 axis of a robotic arm, in order not using CNC commands.

This is done by programming the PLC ladder diagram language that makes movement on the three axes of the arm by means of stepper motors. PLC command console is built with the help of a touch screen Weintek for introducing the distances and displacement speeds on the three axes. It allows to start and stop the application on the panel WEINTEK, as well as monitor the movement on the axes

PLC programming has the advantage of creating artificial intelligence by implementing control algorithms in the software and the ability to perform movements based on data provided by the sensors imposed by the developed.

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