ISSN (Print) : 2320 – 3765
ISSN (Online): 2278 – 8875

International Journal of Advanced Research in Electrical, Electronics and Instrumentation Engineering

(An UGC Approved Journal)

Website: www.ijareeie.com

Vol. 6, Issue 8, August 2017

Auto & Manual Control of Robotic Arm Using PLC

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ABSTRACT: The main objective of this project is to control the Robotic Arm manually and automatically by using Programmable Logic Control(PLC) to pick the moving object on a conveyor belt. In industries highly advanced robots are used ,but still the controlling is done by manually or processors like aurdino, microprocessors etc. There are several disadvantages by using these processors like micro controllers cannot work in the environments with the high levels of vibrations, corrosion, humidity , and other environmental factors. All these problems are overcome by using Programmable Logic Controller (PLC) which acts as a brain to control the robotic arm. This project focuses to create and build more compact, useful and cheaper robotic arm to perform various functions where human is proven too dangerous to perform a specific task and also to eliminate human errors to get more precise work.

KEYWORDS : Programmable Logic Control, robotic arm, manually and automatic control, PMDC motor.

I. INTRODUCTION

Automation is the one of most important factor for development in present industrial world. It helps in the growth of productivity, efficiency of the product and its quality by reducing the humans efforts. Industrial automation includes sophisticated equipment which are used daily such as medical equipment (radiography, X-ray machines etc.), automobiles, refrigerators and other electronics equipment . Among all of these outcomes, the robotic arm is one of them, which is widely used in industrial purposes.A Robotic arm is similar to a human hand which has a free rotating joint (rotation) and a translation joint (displacement) for the movement of the arm This motor is usually driven by electric motor or hydraulic system (pistons) . These actuators are controlled by a Programmable Logic Controller (PLC). This robotic arm is designed to be used in the industries for fast and reliably picking the object from one place and placing it in another place.

In this project PLC is used as the brain to control the robotic arm .There are two modes to control the robotic arm and they are Auto mode (automatic) and manual mode .As there are many languages to develop a program in the PLC but for this project Ladder logic is used to develop the program.

II. DESCRIPTION OF PROGRAMMABLE LOGIC CONTROLLER (PLC)

The main reason for developing the PLC is to replace the electromagnetic relays as logic elements instead a solid state digital computer with a stored program.

Fig.1:PLC

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It is easily programmable. Its life time is long and programming changes can be easily performed. It is heart of the project. The input analog electric signals is converted to suitable digital signals and these signals are applied to the PLC .It executes the input signals by manipulating, computing, processing them to control the output devices. It is shown in the fig.1.

PLC has Switch Mode Power Supply (SMPS) to convert power from 220 volts AC supply to 24 volts DC supply .It has a Central processing unit (CPU) which process the given program and gives the required output .PLC has the card selection in it based on the type of input given .There are four cards in the flexsys rail PLC namely 10DI card (10 digital input card) to which digital inputs are applied through the connector C2 and C3 . It has 6AVI card where analog inputs are applied through the connector C4. Two 8TO cards (eight terminal output) where output is connected through the connectors C5, C6, and C7. PLC is made to control the machinery of production lines. A PLC is designed for multiple input and outputs are they logically programmed in different forms, such as ladder diagram, a structural text and a functional block diagram and stored in the PLC memory. PLC is re programmable device and it can have monitors online to know the status of the operation. The fig.2 given below shows the card selection of PLC.

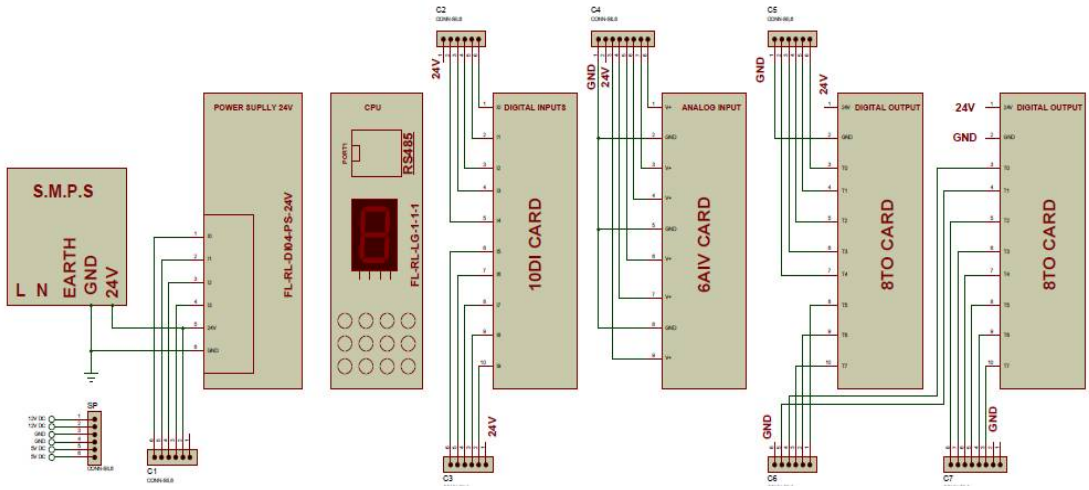

Fig.2: Card selection of PLC

CPU will act as the brain of the whole system and controls all the commands given by the user. This is how a PLC will work as shown in the fig.2.

III. BLOCK DIAGRAM

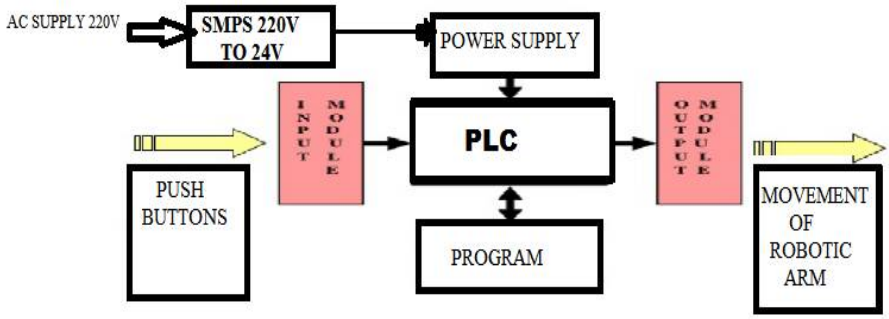

Fig.3: Block diagram of project

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The 220V AC supply is converted into 24V DC supply by the switch mode power supply (SMPS) because PLC has only two states of switching 0V and 24V (low and high) and it is given to the PLC. When the 24V of DC voltage is applied to the PLC, the input module receives input signal from push buttons as shown in fig.3. A program from external PC is dumped into the PLC then CPU of the PLC performs the task based on the requirement of the user. The output is obtained from the output module and the output is movement of the robotic arm.

IV. PROGRAM

There are many language to develop a program in PLC like functional block diagram, structural text and other languages but for this robotic arm ladder diagram is used is develop the program because it is very to understand and does not required any software knowledge like C+, C++, and java to implement the program. There are simple logic's like normally open switch, normally close switch and many other functions like up counter, down counter , window and many other functions. Normally open is a switch which is open in normal condition and the output is 0V or Low once the switch is activated it is a closed switch and the output is 24V or High. Even the normally close switch working is also same but it is reverse operation. In normal condition the switch is closed and output is 24V once the switch is activated it is a open switch and the output is 0V. Let us take the example of this robotic arm program for better understanding of the logic's involved in the program

IV.I Program for mode selection

The fig.4 shown is for mode selection of robotic arm auto mode or manual mode. At the line 1 two normally closed switches and the output is connected. The first switch is for with address %IX0 and the other switch is for auto with address %QX16513 and the output manual with address QX16512. At the line 3 there is a normally open switch mode with address same as the mode in line 1 and the output is auto with same address of auto in line 1. Once the supply is given both the switches at line 1are normally closed so the output is shown as manual mode. For auto mode the mode switch in the line 1 is activated and now it is a open switch and the switch in line 3 will get activated because the address of both switches are same the switch in line 3is normally open switch once it is activated is gets closed and auto mode will be activated.

Fig.4: Program for mode selection

IV.II Program for Hold-ON circuit

A HOLD ON circuit has two normally open switch (NO) which are normally opened and named as AUTO and START switches, one Normally Close switch (NC) as stop switch and has a output coil. A memory of output coil is connected across START coil. The whole program can be controlled by the start and stop coils. When the start button is pressed and the Auto mode is activated then the whole circuit is in ON condition. The circuit will not have any control on the system to STOP the program until and unless the stop button is achieved or pressed. The NO coil of memory addressed as MX0 LEFT will be activated when the output is high i.e., when the start switch is closed. It provides a continues input signal and the circuit is in ON condition. When the output is low the memory coil is opened. This is how a HOLD ON circuit will work as shown in fig.5.

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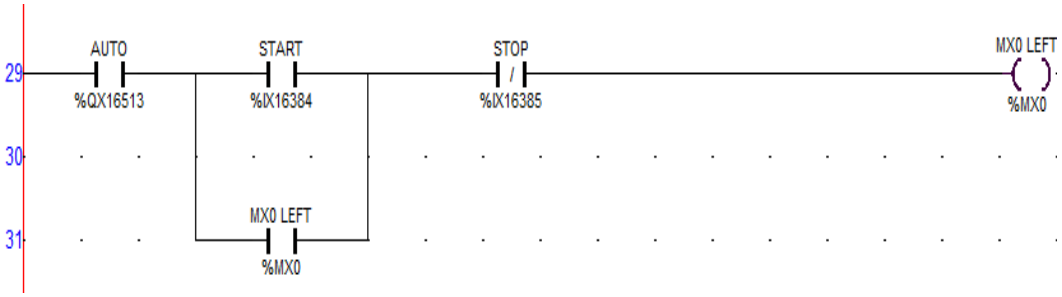

Fig.5: Program for HOLD-ON circuit

In auto mode according to the preset value can be set in the timer, according to that preset value motor will perform any one of the actions such as jaw open, jaw close, arm up, arm down, arm right or arm left action. But in manual mode the specific switch should be closed in order to perform a specific task. Here arm up/down limit switch and arm right/left limit switch is used to limit the motion of the arm up to the required level.

V. SCHEMATIC OF OPERATION

Flexys rail PLC can be operated in two modes either Auto mode or Manual mode. SMPS converts 220V AC to 24V DC because relays need 12V DC supply to operate. In this project the Relay is a basically fault sensing device and also it is a electrically activated switch . It internally consists of a coil which creates a magnetic field that will attract a movable lever which results in changing of switch contacts.

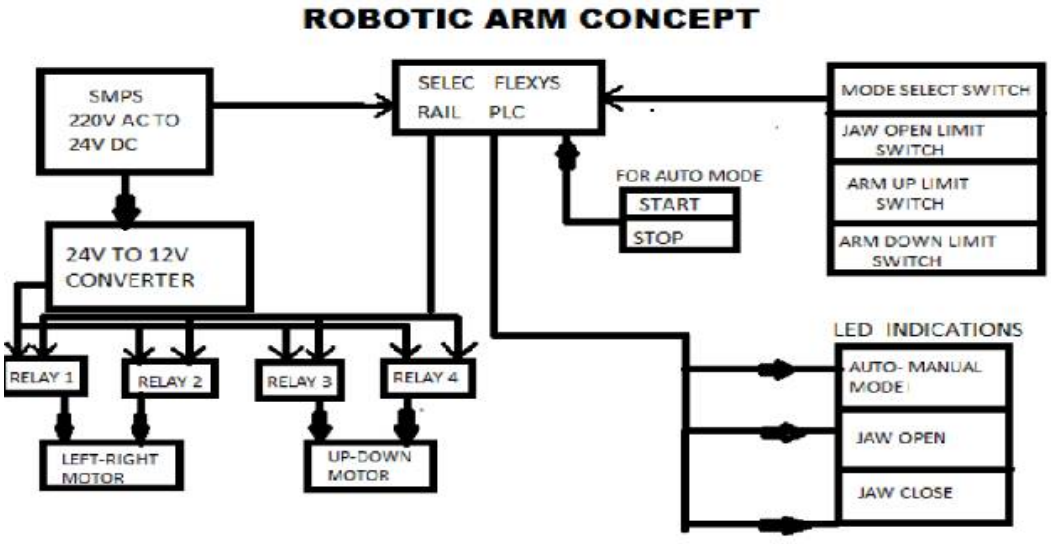

Fig.6: schematic of operation

The relay used in this robotic arm is JQC-3FC (T73) DC 12V relay the working of this relay is same as other relays. LM317 is a three terminal adjustable positive voltage regulator .It has the capacity to supply excess of 1.5A current . It has output voltage range of 1.2V to 37V .Because it requires only two resistors to set the output voltage it is very easy to handle during the operation .LM317 is also used to make a programmable card selection. It is provided

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with safe area compensation, thermal shutdown and internal current limiting which makes it blow out proof. It also eliminates stoking fixed voltages.

There are three limiting switches they are arm up, arm down and jaw open limit switch. These switches are used in manual mode in order to limit the position of the arm. There are four relays, two relays will operate for left and right motion of arm and another two relays will operate for up and down motion of the arm. There are two LEDs to indicate whether the arm is operated in auto mode or manual mode as shown in fig.6. In auto mode the arm is controlled automatically according to the program dumped and the input given to the PLC. But in manual mode the user should operate for the position of the arm by push buttons and DPDT switches. Here limit switches are provided for arm up/down and arm left/right in order to avoid the breakage of the robotic arm.

V.I Input Port

Input port gives the information about all the input signals and supply. From connector C2 we take 5 connections to start switch, stop switch, jaw open switch, jaw close switch and arm up switch. From connector C3 we take 3 connections to different switches such as arm down, arm left and arm right switches.

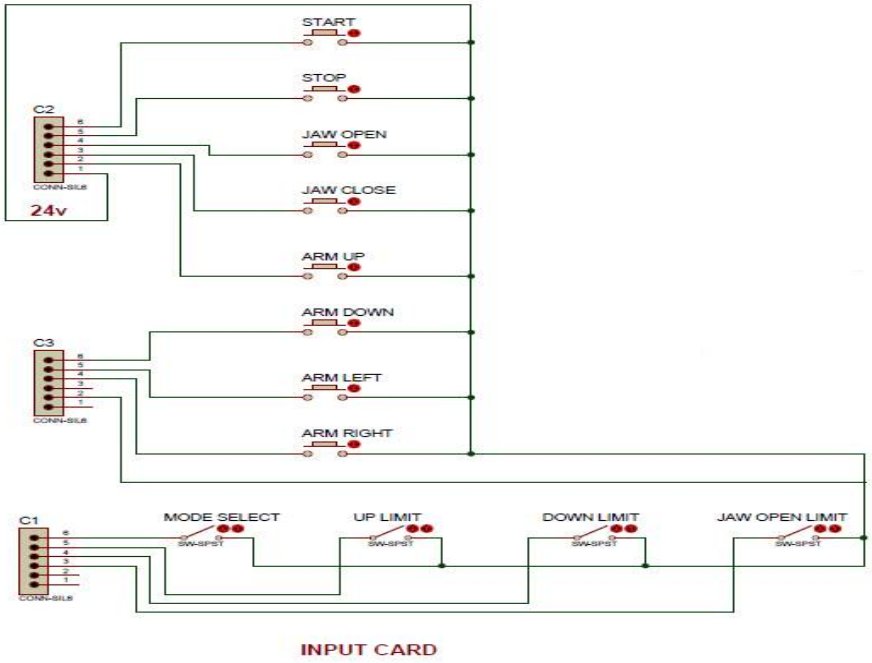

Fig.7: Input port of PLC

From C1 we have up limit, jaw open limit and mode selection switches.These are automatically closed in auto mode according to the program and externally we have to close the switch in manual mode as shown in Fig 7.

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V.II Output Port

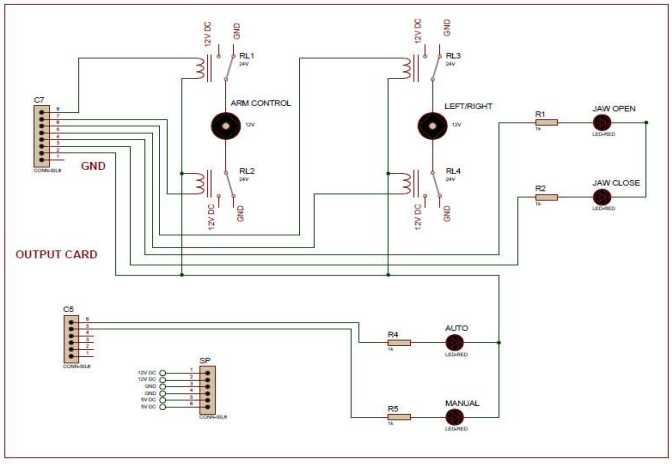

Fig.8: Output port of PLC

Output port helps to carry the processed output from the CPU of the PLC to the motors where specific operation of the arm is performed. This post consists of the 4 relays in which two relays are used to control the robotic arm in either up or down and another two relays to control the arm in left or right motion. Relays after of 12V and motors are also of 12V. From connector C7 those relays after connected in order to drive the motors. From connector C5 connections are made for auto and manual mode as shown in the fig 8.The hard ware model for the project has been given in fig.8.

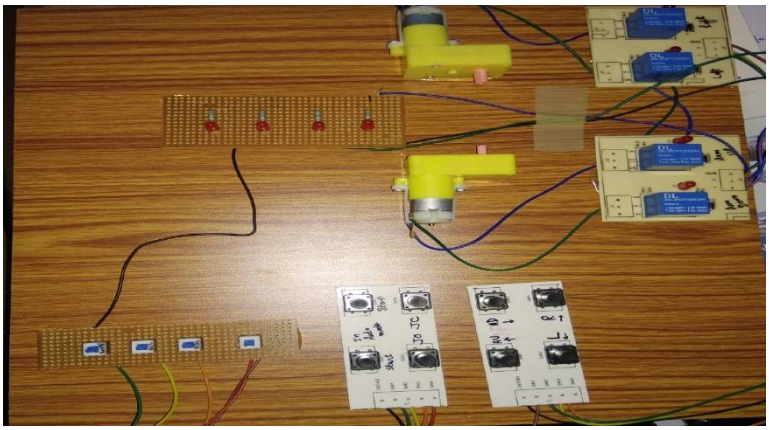

Fig.8: Hardware model

VI. CONCLUSION

A control system is made for controlling the robotic arm by using PLC. After a detailed study a best possible solution for designing and constructing a robotic arm which includes PLC, and its components, DC motors, power supply unit and many other components. The program is developed to operate and control the robotic arm in manual operational modes and automatic operational modes. Conclusively this project helps about dealing with the difficult problems and finding better solution for industrial automation. This project for designing the robotic arm has given a approach to learn and helps to do more about this subject in the future.

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