

“AUTOMATED SEQUENTIAL CONTROLLING OF MODULAR WORKSTATIONS”

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ABSTRACT

Simplification of engineering and precise control of manufacturing and assembly process can result in significant cost efficiency. A planned approach towards integrated control systems using PLC can solve industrial problems. Due to its low cost, PLC's are used widely in and electro-pneumatic technologies for automating the production processes. This work is carried out to develop a design methodology for a automated flexible assembly line to perform a simple cube assembly and develop a configuration for the workstation components to form the layout to achieve maximum output.

KEYWORDS: Programmable Logic Controllers, Electro-Pneumatics, Indralogic PLC Software, Cylinder, DCV-Directional Control Valves, Automated Workstations Modules

INTRODUCTION

Automation is a technology to control the particular process in order to increase reliability and efficiency by means of programmed commands combined with automatic feedback control ^[5]. The resulting system is capable of operating without human intervention. The development of this technology has become increasingly dependent on the use of computers and control systems. Advanced systems represent a level of capability and performance that surpass in many ways the abilities of humans to accomplish the same activities.^[2] A constant demand for better and more efficient manufacturing and process control has led to the requirement for higher quality and reliability in control techniques. With the availability of advanced technology, it has been possible to provide control systems that can reduce maintenance, down time and improve productivity to a great extent and increase in efficiency. By installing efficient and user friendly systems for manufacturing machinery or processors, one can obtain a precise and reliable means for generating quality products.

PROGRAMMABLE LOGIC CONTROLLERS

Programmable Logic Controllers (PLCs) were invented to replace relay control systems. In the 1960's Programmable Logic Controllers were first developed to replace relays and relay control systems ^[1]. Relays, while very useful in some applications, also have some problems. The main problem is the fact that they are mechanical. This means that they wear down and have to be replaced every so often. Also, relays take up quite a bit of space. The greatest disadvantage of this type of system is that it requires frequent maintenance because of the short service life of each component. Programmable logic controllers were developed to solve such problems. PLCs also perform arithmetic operations and control high-speed lines, which cannot be performed using a combination of relays, timers and counters. Since semiconductor devices and microcomputer technology have been rapidly advancing in recent years, PLCs now have a much longer service life. Therefore, little maintenance is required. Almost in any production line, machine function or process can be automated using a PLC. The speed and accuracy of the operation can be greatly enhanced using this type of control system ^[6]. But the biggest benefit in using a PLC is the ability to change and replicate the operation or process while collecting and communicating vital information. PLCs are the control hubs for a wide variety of automated systems and processes. They contain multiple inputs and outputs that use transistors and other circuitry to simulate switches and

relays to control equipment. These are programmable software interfaced via standard computer interfaces and proprietary languages and network options. The development of low cost computer has brought the most recent revolution.

A PLC hardware block diagram is shown in Figure.1. The programming terminal in the diagram is not a part of the PLC, but it is essential to have a terminal for programming or monitoring a PLC. In the diagram, the arrows between blocks indicate the information and power flowing directions. Thus from the external input devices the signals are sent to the PLC where the Program stored in the memory is called and the processed output signal is sent into the output external devices which are connected the mechanical devices like solenoids, motors etc.

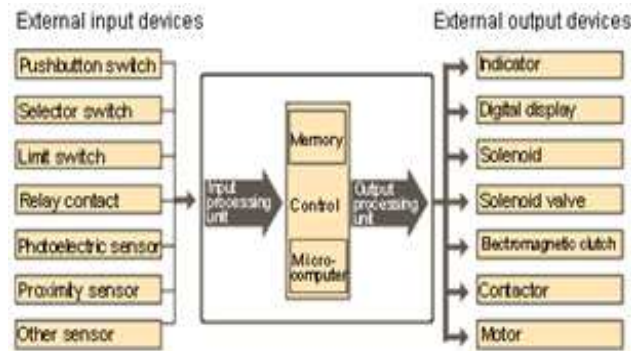


Figure 1: PLC Hardware System Block Diagram

The Programming of PLC can be performed in following programming methods. Those are Ladder Logic Diagrams, Functional Block Diagrams, Sequential Flow Charts, and Graphical Programming Language & Structural Text Language.

Commonly, the language or command for PLC designing is based on the ladder logic diagram. There have numerical of symbol that have been used to developed the ladder logic diagram which every symbols represent the different functions.

Each PLC operational cycle is made up of three separate parts: Input scan at which input terminals are read and the input status table is updated. Program scan at which data in the input status table is applied to the user program, the program is executed and the output status table is executed. Output scan at which data associated with the output status table is transferred to output terminals Thus these Inputs and Outputs from the PLC are connected to the processing units .or any manufacturing system^[2].To automate a material flow to a conveyor belt, special devices are required to sense the presence of objects and also to push the materials. This cap only is done by Pneumatic cylinders which are operated by a Directional control valves, reed switches and a compressor.

ELECTRO-PNEUMATIC SYSTEM

Pneumatic systems are extensively used in industry, where factories are commonly connected with compressed air or other compressed inert gases. This is because a centrally-located and electrically powered compressor that powers cylinders and other pneumatic devices through solenoid valves is often able to provide motive power in a cheaper, safer, more flexible, and more reliable way than a large number of electric motors and actuators. Since the pneumatic system is controlled by an electric circuit, a very accurate positioning and timing can be achieved easily. Basically a Pneumatic system consists of a compressor where air from surrounding is compressed; it is connected with the pressure gauge to maintain the required pressure in the present sequencing station of about 6 bars. From the compressor it is connected to the Direction control Valve which is operated by electric circuit.

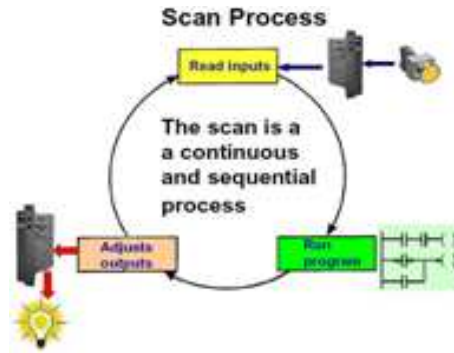
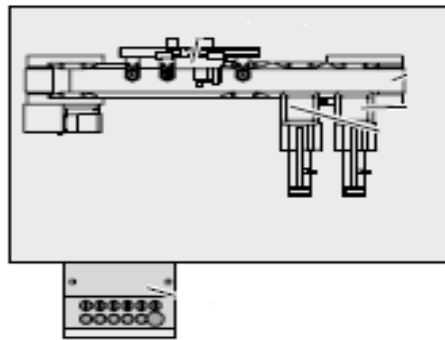


Figure 2: PLC Scan Cycle

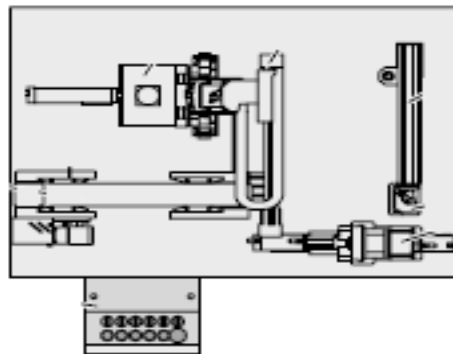
AUTOMATED WORKSTATIONS MODULES

The benefits of using modules in workstations are without compromising performance or methodology the output achieved is more efficient. The assembly process is divided into 3 modules. The layout of each modules are shown below

Loading / Magazine Module



Processing / Assembly Module



Storage Module

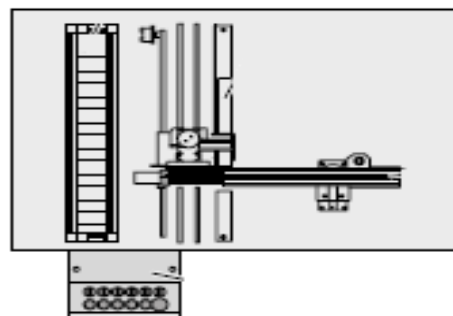


Figure 3: Layout of Automated Workstation Modules

BASIC APPROACH FOR AUTOMATING A WORKSTATION

Considering the second module, the pressing operation is initiated with the sequential control of two double acting cylinders with impulse valves. Both Double acting cylinders are controlled by 5/2 directional control impulse valves. The valve 1 has solenoid designated Y1 & Y2, valve2 has solenoid designated Y3 & Y4. When signal voltage is applied to the solenoid coils Y1 & Y3, the cylinders extend, when voltage signal is applied to Y2 & Y4, the cylinders will retract. Both cylinders have switches with visual displays mounted in their end positions, these are designates B1 to B4.

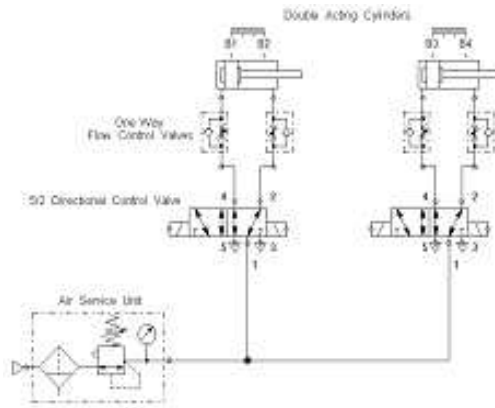


Figure 4: Pneumatic Circuit

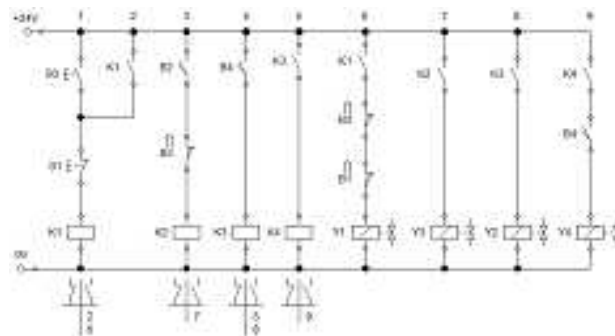


Figure 5: Electrical Circuit Diagram

The extension speed of both cylinders can be infinitely adjusted with a one way flow control valve. For the controlling of pneumatic circuit, electrical circuit is used.

The working sequence of electrical circuit: After switching on the operating voltage, the auxiliary bus bar 2 guides the voltage. When push button S0 is briefly actuated, 24 V positive (+) voltage travels via the actuated cylinder switch B1 which is not yet opened and cylinder switch B1 normally closes the contact K2 to relay K1. The normally open contact K1 in current path 2 closes and forms the latching for relay K1. Changeover contact K1 in current path 3 simultaneously switches the current to the auxiliary bus bar 1. Valve solenoid Y1 receives voltage and cylinder 1 extends. B2 is actuated, switches relay K2, and normally closed contact K2 interrupts the latching circuit for relay K1. Changeover contact K1 in current path 3 switches the voltage to auxiliary bus bar 2. Valve solenoid Y4 receives voltage, cylinder 2 retracts. B3 is actuated and switches Y2, cylinder 1 also retracts to its end position. Indicator light H1 and H2 display the voltage on the auxiliary bus bars 1 & 2.

PLC PROGRAMMING FOR THE MODULAR AUTOMATED WORKSTATIONS

With respect to this approach the electrical and pneumatic circuits can be designed to develop adder logic for pneumatic pressing station. The programming of the sequential operation is developed in PLC software. The programming

developed is the ladder logic with AND, OR, NOT, XOR gates, timers, counters, can be used to control the sequence of the operations with respect to time, and position and displacement.

The software used for developing the program is installed in the computer. The program runs when the PLC system is connected to central processing unit. The PLC utilizes the LAN connection to connect the programming terminal and the internet connection has to be enabled. The software runs only when the PLC is connected to the terminal through LAN connection and the IP address of the terminal and PC system should be the same to run the software. The software used for PLC programming is Rexroth Indralogic software. The PLC Hardware system used is PLC L20 . The program is done using Ladder Diagram & Sequential Flow Chart.

RESULTS

Automated Sequential Controlling of Modular Work Stations

The use of modules for automated sequential controlling of modular workstations results in greater efficiency. The modules can be used for various configuration of work piece & it can also be used individually. There is a reduction in MLT & Production is increased with less human interference.

CONCLUSIONS

This paper presents the complete assembly system automation. The electro- pneumatic circuit diagram can be designed for each modular workstation with the approach shown above. The programming is developed in Indralogic software and PLC system integrated with the workstations.

REFERENCES

1. Serhat Yilmaz, Bekir Cakir, Adem GEDIK and Hasan Dincer “ Speed Control of a Conveyor System by Fuzzy Control Aided PLC” Industrial Electronics, Vol.3 (1999) P 1328-1332
2. Swider, J. Wszolek, G., Carvalho, W. “Programmable controller designed for electro pneumatic systems”, journal of Material Processing Technology, vol. 164, 2005, p 1459-1465.
3. W. Hu, M. Schroeder and A.G. starr, “A knowledge-Based Real-Time diagnostic System for PLC Controlled Manufacturing systems”, (1999) P 499-504.
4. “ History of PLC” as told to Howard Hendricks by Dick Matley, © 199602992 R.Morley
5. “PLC Programming Language Controllers Introduction.” © 1994-2001, Transtronics, Inc.
6. Pneumatic Controls – JOJI.P
7. Mechatronics and Electro-Pneumatics manual by Bosch Rexroth
8. M.P. Groover, Automation, Production Systems and Computer Integrated Manufacturing”, Pearson Education, (Third Edition, 2008)

