ARPN Journal of Engineering and Applied Sciences

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REVIEW ON SYSTEM OPERATION OF AUTO-FEEDER FOR DOOR PANEL PRODUCTION USING PROGRAMMABLE LOGIC CONTROLLER

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ABSTRACT

Programmable Logic Controller (PLC) plays an important role as a part of control system to ensure production process in factories running properly. Consequently, many industries adopt this system as it can increase the production capacity rapidly. In this research, an auto feeder has been designed to replace existing manual operation of a door panel factory. The objective is clear since the factory is keen to increase its production capacity. However they have limited skilful operators. Inefficient, inaccurate and unsafe current manual operations system represents a significant burden for the company. This research utilizes PLC with CX-Programmer and Automation Studio Software to design and realize the mechanism. Simulation tests have been done and the results show that the designed control system works properly. Reliability test has also been conducted using additional Electro-Pneumatic Trainer. Analyses were carried out for performance comparisons of automation with existing manual system. Based on the results obtained, running time for automation system is 33 seconds, and an average of 42.8 seconds for manual operation. Final results of the research show a design of control system for Auto-feeder machine has been successfully created where about 15-20% of production capacity has been increased.

Keywords: automation, programmable logic control, pproductivity, improper.

INTRODUCTION

PLC is widely used in most industrial automations, not only because of its economic benefits but also its role in producing consistent quality-guaranteed product [5]. A PLC is a digital computer used for automation of typical industrial electro-mechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. It is used in many machines in many industries. It is designed for multiple arrangements of digital and analog inputs and outputs. Programs to control machine operations are typically stored in a battery-backed-up or non-volatile memory. A PLC is an example of real-time system since its output results must be produced in response to input conditions within a limited time, otherwise unintended operation may result.

Before the invention of PLC, control, sequencing, and safety interlock logic for manufacturing automobiles mainly composed of relays, cam timers, drum sequencers, and dedicated closed-loop controllers. Since they could be in the hundreds or even thousands, the process for updating such facilities for yearly model change-over had been very time-consuming and costly, as electricians need to rewire the relays individually to change their operational characteristics.

The functionality of the PLC has evolved over many years to include sequential relay control, motion control, process control, distributed control systems, and networking. PLC-like programming combines with remote I/O hardware, allows general-purpose desktop computer to some PLCs in certain applications. Operating systems such as Windows does not lend themselves to deterministic logic execution, with the result that the controller may not always respond to changes of input status with consistency in timing expected from PLCs. Desktop logic applications is used in less critical situations, such as Automation Studio Laboratory and in small facilities where the application is less demanding and critical, because they are generally much less expensive than PLCs [10].

SYSTEM DEVELOPMENT

Development of the system requires two software packages, namely CX-Programmer for Ladder Diagram programming and Automation Studio hardware arrangement and simulation. To run the system, it is necessary to provide components and instruments, such as PLC - OMRON SYSMAC CJ1M Kit, Compressor (4-5 bar), Power Supply (24V), Push Button, double acting cylinder, sensors, directional control valves, and Electro-Pneumatic.

AUTOMATION STUDIO

Automation studio has been used in this experiment. It is a software tool essential to design, simulate, and process animation. It has been created for automation industry, specifically to fulfill engineering, training, and testing requirements. The software can be applied in the design, training and troubleshooting of hydraulics, pneumatics, and electrical control system. The simulation utility makes Automation Studio an efficient tool for certifying automated processes and programs. The following figures below show the configuration with an interface and software panel windows.

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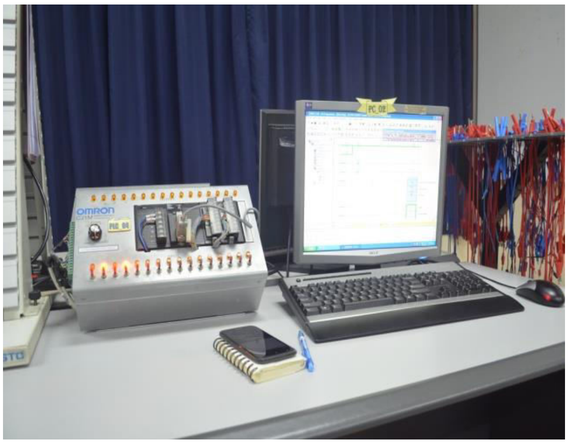

Figure-1. Automation studio with an interface.

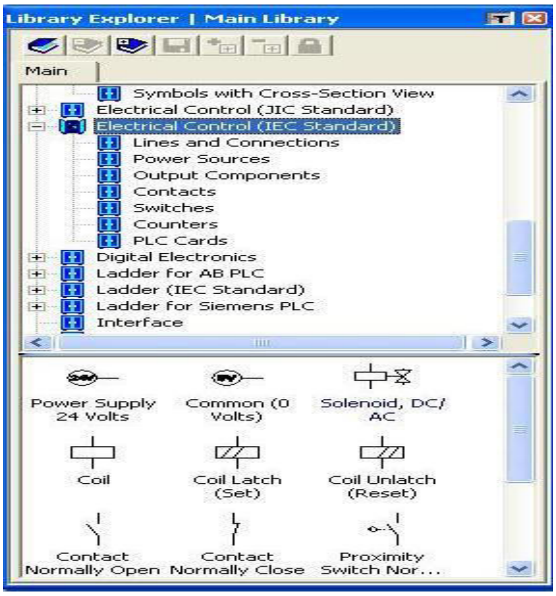

Figure-2. Automation studio configuration.

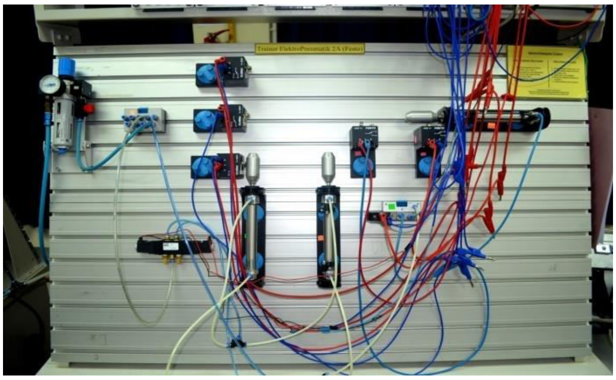

Figure-3. Wiring connection.

PLC INPUT OUTPUT OPERATION STEPS

PLC input consists of push buttons and sensors. The results of analysis for PLC input are shown in Table-1.

There are 8 inputs and 3 outputs involved. Below is the flow of the program for Auto feeder with referring to Figure-6.

Step 1:

i. First, execute the program, the address is ***0.00*** and continuously on the input ***5.01***.
ii. The output ***1.01*** will turn on and extends the pneumatic instrument A and B.

Step 2:

After an object is detected by sensor **5,** the input ***0.05*** is on and stops the pneumatic cylinders A and B. It then contributes to output ***1.03***. The pneumatic cylinder C extends and pushes the object.

Step 3:

i. Pneumatic cylinder C turns on input ***0.04*** to retract again.
ii. After that, input ***0.03*** is on and continue to be on to input ***5.04***.
iii. The timer ***0001*** and counter ***0001*** turn on. The timer delays the input for 30 seconds. After the delay, output ***1.01*** is on and lifts up again. The process is then repeated until the counter reaches a count of ***20*** or sensor ***2*** is activated.

Step 4:

Sensor **2** is to turn on input ***0.06*** to retract the cylinders and terminates the program.

Table-1. PLC input components, their addresses and corresponding functions.

ADDRESS	INPUT COMPONENT	FUNCTION
0.00	Push Button	Close circuit and extend Cylinder A and B
0.01	Sensor 1	Open Circuit
0.02	Sensor 2	Reset Cylinder A and B
0.03	Sensor 3	Retract Cylinder C
0.04	Sensor 4	Turn on Timer and Counter
0.05	Sensor 5	Extend Cylinder C
0.06	Stop Button	Open circuit
0.07	Reset Button	Reset Timer

Table-1 above shows the PLC input components, their addresses and corresponding functions. There are 7 inputs has been set up for each component. These inputs work based on Ladder Diagram which has been programmed in CX-Programmer as shown in Figure-6 in attachment. The system will not stop until sensor 1 has detected object or stop button is pressed.

The PLC output components, their addresses, and functions are shown in Table-2 below, where 3 solenoid valves are set up for each function of cylinder piston A, A and B, and B. Solenoid valve works by regulating air pressure in the cylinder. In this project, a single solenoid valve and a double solenoid are used.

VOL. 11, NO. 8, APRIL 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

Table-2. PLC output and function.

ADDRESS	OUTPUT COMPONENT	FUNCTION
1.01	Solenoid valve (Y1A)	Extends cylinders A and B
1.02	Solenoid valve (Y1B)	Bring cylinders A and B to initial home position
1.03	Solenoid valve (Y2)	Extends and Retracts cylinder C

INSTALLATION AND SIMULATION

CX-Programmer provides an easy way to make a project file that can be uploaded directly into PLC's memory. All PLC mechanism, ladder diagram, address, pre-set PLC memory, I/O table, and program symbol can be defined in the software. Reliability test is conducted using both CX-Programmer and Electro-Pneumatic Trainer. Running time for controller system to complete each step of motion is recorded and compared to manual system.

It is essential to install and connect the pneumatics by inserting pneumatic cylinders, solenoids, compressor and exhaust. After that, a PLC Card is fixed and connected to input and output components. Finally, ladder diagram is constructed to complete the system. Final check and validation of each component and program is very important to avoid errors or missed functions before running the simulations.

There are 3 pneumatic cylinders labeled as A, B, and C. Basically these double-acting cylinders get the power of air pressure to move in both directions for extending and retracting strokes. They have two ports to allow air intake, one for out stroke and another for in stroke. Cylinder A and B use 5/3-way Directional Control Valve (DCV) while cylinder C uses 4/2 way of DCV. There are also 5 sensors labeled as 1-5. A sensor is typically a transducer that capable of detecting objects and provides corresponding output. In this research, proximity sensors are used since they are capable of detecting the presence of nearby objects without having physical contact to avoid any damages to door panels.

MANUAL OPERATION

Observations and interviews have been carried out while visiting the door panel factory. Based on obtained information and data, the steps of manual operation have been identified. Table-4 shows the operating process time in the factory done manually. The process has been divided into 4 stages, and then repeated. Running time for each step is compared with running time control system.

Figure-4. Manual handling operation.

CONCLUSION AND DISCUSSIONS

To conclude this research, it is reasonable to compare the designed automation and the existing manual operation. The results of completed reliability tests are shown in Table-3 whilst test data of manual operation is presented in Table-4 on the right.

Table-3. Complete running time for controller system.

Time (s)				
No. of reading	Step 1 (Lift up)	Step 2 (move forward and retract)	Step 3 (Timer)	Total Time
1	1	2	30	33
2	1	2	30	33
3	1	2	30	33
Average	1	2	30	33

Comparisons between new and old system on time consumption show that the former has obtained 20% shorter cycle time. This means that production capacity can be increased, as well as improvement on working condition such as safety and cleanliness. Lastly the operation in terms of speed, accuracy and precision will be improved with the implementation of the automation system.

Table-4. Complete running time for manual system.

	Time (s)			
No. of reading	**Step 1 Lifting Up**	**Step 2 Placing**	**Step 3 Running**	**Total Time**
1	7.7	5.6	30.3	43.6
2	7.4	5.2	30.1	42.7
3	7.6	5.2	29.3	42.1
Average	7.6	5.3	29.9	**42.8**

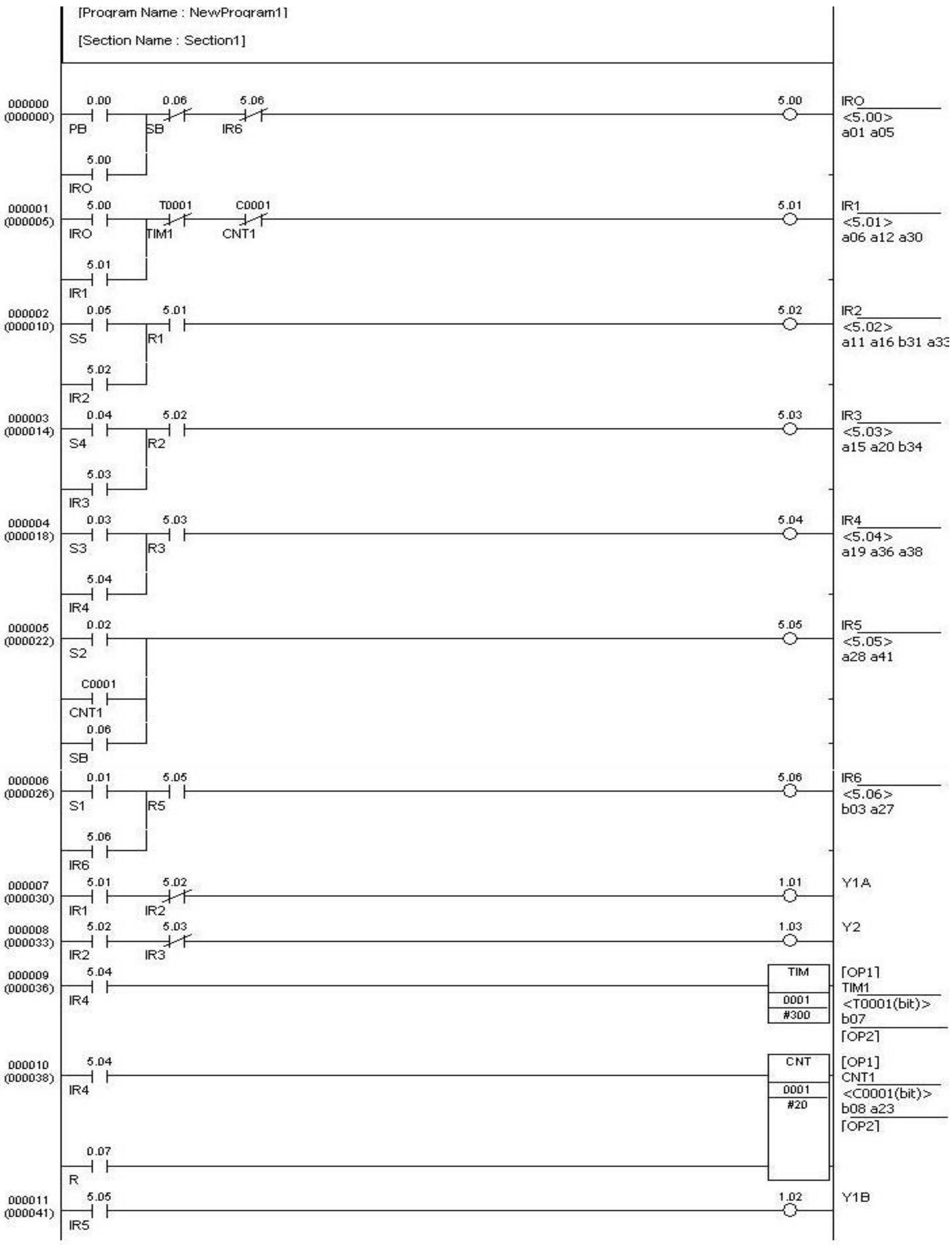

Figure-5. Ladder diagram.

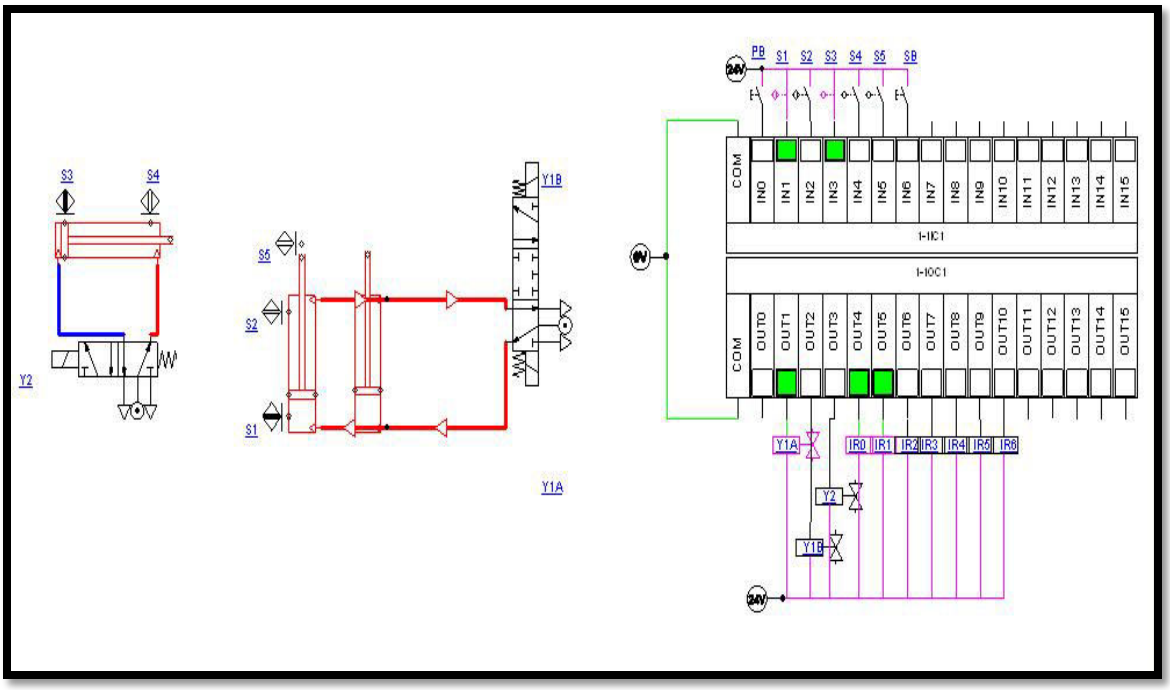

Figure-6. Pneumati diagram

ACKNOWLEDGEMENT

We acknowledge Univesiti Tun Hussein Onn (UTHM) for its Short Term Grant (STG) Vot U119 for Office for Research, Innovation, Commercialization and Consultancy (ORICC), and Ministry of Education Malaysia.

REFERENCES

[1] Adi, S. 2004. Introduction to Programmable Logic Controllers. Politeknik Johor Bahru.

[2] Ahmad Nasir, M.I. 2008. Development of Automated Workstation on Palm Oil Fruit Using PLC System. University of Tun Hussein On Malaysia: Bachelor Degree's Thesis.

[3] Bolton W. 2009. Programmable Logic Controllers.5th Edition: Elsevier Ltd.

[4] J. Swider, G. Wszolek and W. Carvalho. Programmable controller designed for electro-pneumatic systems. Journal of Materials Processing Technology. 164-165 (2005) 1459-1465

[5] James A. Rehg and Glenn J. Sartori. 2009. Programmable Logic Controllers.2^ndEdition, Pearson Prentice Hall.

[6] John W. Webb and Ronald A. Reis. 1999. Programmable Logic Controllers: Principles and Applications. 4th Edition: Pearson Prentice Hall.

[7] Rohner, P. 1996. Automation with Programmable Logic Controllers. University of New South Wales Press.

[8] Rullan, A. 1997. Programmable Logic Controllers versus Personal Computers for Process Control. Elsevier Science Ltd.

[9] Zulkefly, M.E.I 2010. Development of PLC Controlled Aerial Fish Feeding System. University of Tun Hussein On Malaysia: Bachelor Degree's Thesis.https://en.wikipedia.org/wiki/Programmablelogiccontroller.