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Automation System for Printing

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***Abstract*: Automation is the key to modernization and has been conceptually understood as a way to increase efficiently and to improve the productivity. Normally in industries printing process is manually operated which involves more man force and hence production time increases. While operating manually, the position and force of the stamping varies from person to person. Due to this the accuracy and production of the product decreases. In this project, the accuracy and production of the product is increased by automating it with the help of Programmable Logic Controller.**

***Keywords*: CPU, PLC system and output relays**

1. Introduction

Automation is a Greek word means self-dedicated. Automation is the key to modernization and has been conceptually understood as a way to increase efficiently and to improve the productivity. Automation is the use of control systems such as computers, controllers to control industrial machinery and processes, to optimize productivity in the production of goods and delivery of services. Automation is a step beyond mechanization. Whereas mechanization provides human operators with machinery to assist them with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements. Automation is now often applied primarily to increase quality in the manufacturing process, where automation can increase quality substantially.

2. Programmable logic controller

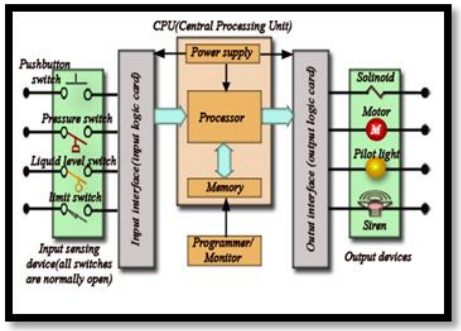


Fig. 1. PLC

A digitally operating electronic apparatus which uses a programmable memory for the internal storage of instructions by implementing specific functions such as logic, sequencing, timing, counting and arithmetic to control through digital or analog input / output modules. It can be viewed as an industrial computer that has a central processor unit, memory, input output interface and a programming device. The central processing unit provides the intelligence of the controller. It accepts data, status information from various sensing devices like limit switches, proximity switches, executes the user control program stored in the memory and gives appropriate output commands to devices such as solenoid valves, switches etc.

A. Components of PLC

The PLC mainly consists of a CPU, memory areas, and appropriate circuits to receive input/output data. We can actually consider the PLC to be a box full of hundreds or thousands of separate relays, counters, timers and data storage locations. They don't physically exist but rather they are simulated and can be considered software counters, timers, etc. Each component of a PLC has a specific function:

- The CPU is the brain of a PLC system. It consists of the microprocessor, memory integrated circuits and circuits necessary to store and retrieve information from memory. It also includes communication ports to the peripherals, other PLCs or programming terminals. The job of the processor is to monitor status or state of input devices, scan and solve the logic of a user program, and control on or off state of output devices.
- *Counters* - These are simulated counters and they can be programmed to count pulses. Typically, these counters can count up, down or both up and down. Since they are simulated they are limited in their counting speed. Some manufacturers also include high-speed counters that are hardware based. We can think of these as physically existing.
- *Timers* - These come in many varieties and increments. The most common type is on-delay type. Others include off - delay and both retentive and non-retentive types. Increments vary from 1 millisecond to1 second.
- *Output Relays (coils)* - These are connected to the outside world. They physically exist and send on/off signals to solenoids, lights, etc. They can be transistors, relays depending upon the model chosen.
- *Data Storage* - Typically there are registers assigned to simply store data. They are usually used as

temporary storage format or data manipulation. They can also typically be used to store data when power is removed from the PLC.

3. Hardware and software used

The DELTA DVP14SS211R programmable controller is a packaged controller containing a power supply, input circuits, output circuits, and a processor. It also has the configuration of adding extension input and output modules.

Software: DELTA WPL Soft 2.30

Programming: Ladder Logic

Communication Protocol: RS 232.

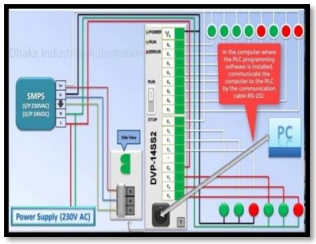


Fig. 2. Communication

4. Components description

A. Color sensor

The color sensor detects the color of the surface, usually in the RGB scale. Color is the result of interaction between a light source, an object and an observer. Color sensor is used in this project since the material is inside the conveyor and other sensors cannot sense the material.

Fig. 3. Color sensor

B. DC motor

A DC motor is an electrical device that converts direct current electrical energy into mechanical energy. A DC motor's speed can be controlled over a wide range using either a variable supply voltage or by changing the strength of current in its field windings. Servo motor is used in this project for the accurate position sensing of the material.

Fig. 4. DC motor

C. Power supply (12V and 24V)

A power supply is a component that supplies power to at least one electrical load. Typically, it converts one type of electrical power to another but it may also convert a different form of energy such as mechanical, solar into electrical energy

Fig. 5. Power supply

D. Pneumatic cylinder

Pneumatic cylinder is a mechanical device which uses the power of compressed gas to produce a force in reciprocating linear motion. This project comprises of two categories of pneumatic cylinders.

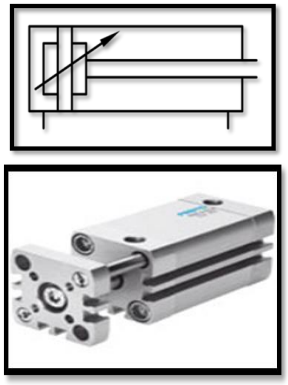


Fig. 6. Pneumatic cylinder

E. Pneumatic gripper

A Pneumatic gripper is a type of pneumatic actuator gripping solution that includes tooling jaws or fingers that grasp an object. Grippers run on compressed air and have the ability to pick up, place, hold, and release objects while an action is being executed. Gripping force provided by gripper: 34.6N

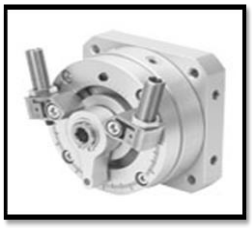


Fig. 7. Pneumatic gripper

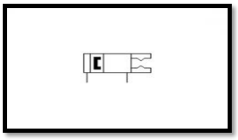


Fig. 8. Pneumatic cylinder

F. Pneumatic solenoid valves

A solenoid valve is an electromechanical device in which the solenoid uses an electric current to generate a magnetic field and thereby operate a mechanism which regulates the opening of fluid flow in a valve. The valve used in this project is described below:

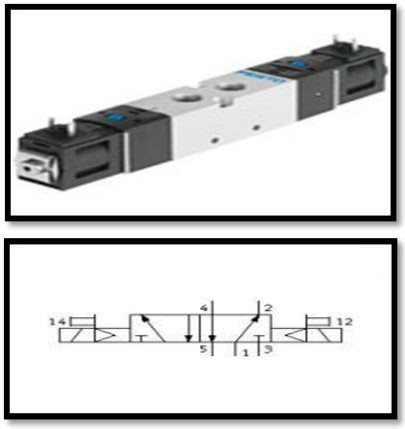


Fig. 9. Pneumatic solenoid valves

G. Pneumatic swivel

The pneumatic swivel unit is used for the angular rotation of the component. The parallel gripper is connected to the shaft of the swivel unit and the rotation is set to 180 degree.

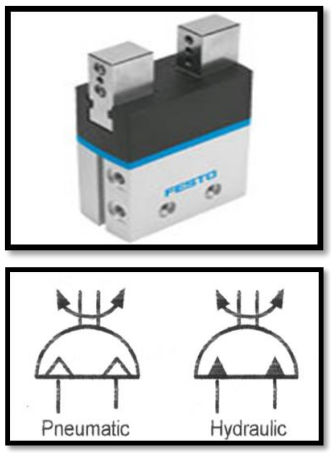


Fig. 10. Pneumatic solenoid valves

H. Input and output extension port

Fig. 11. Input and output extension port

The input and output extension ports are used to add the input and output devices based on our application. In this project the input extension modules consists of 8 ports and output extension module consists of 8 ports.

5. Calculations

Force required for stamping:
F = P*A
F = 4*10^5 * 0.0006
F = 240N

Forces provided by the cylinders:
Plunger cylinder: 422N
Extension and gripper extension cylinder: 660N
Gripping force by the gripper: 34.6N

Material used for stamping: Nylon
Elastic limit of nylon: 50N

Moment of inertia of swivel
I = m * (r^2)/ 2
I = 0.075 *(3.5 *3.5)/2
I = 0.459 Kgm^2.
Torque provided by swivel
T = I*w (omega)
(Omega) w = 2 * 180 / 5 *5
T = 1.153N.

Torque required for driving a conveyor: T = ½*D (F + μ*W*g)
T – Torque
D – Roller diameter
W – Mass of the load
g – Acceleration due to gravity
μ - friction coefficient
F – External force

T = ½*0.067 (0.10 + 0.2 * 0.05 * 9.8)
T = 0.006Nm.

Solenoid:
Power: 2.6W
Voltage: 24V
P = V*I

I = P / V
I = 2.6 / 24
I = 0.108A
Current drawn by 1 solenoid = 0.108A
Current drawn by 5 solenoid = 0.108A * 5 = 0.54A

Force produced by each cylinder:
F = p π (d1^2 – d2^2) / 4.
Where p – gauge pressure
d1 – full bore piston diameter (m)
d2 – piston rod diameter (m).

Force produced by plunger cylinder:
p = 4 bar
d1 = 0.032m
d2 = 0.012m
Therefore F = 276N

Force produced by extension cylinder:
p = 4 bar
d1 = 0.040m
d2 = 0.016m
Therefore F = 422N

6. Working

The project mainly comprises of two stations. Initially it consists of two push buttons (i) Start push button and (ii) Stop push button. Start push button – When this button is pressed, it turns the conveyor motor on. Stop push button – When this button is pressed, the entire process will stop. At first, start button is pressed, the conveyor motor turns on the material on the conveyor starts moving. When the material reaches Station 1 which is sensed by an infrared sensor, the conveyor motor stops. Then the plunger cylinder extends to get dip in the ink pad and enables sensor 2, then again the cylinder retracts to enable sensor 1 .Once sensor 1 is enabled the extension cylinder extends and enables sensor 4 then the plunger cylinder once again extends to stamp on the material and then retracts back and enables sensor 1 and then the extension cylinder retracts back and enables sensor 3 and the conveyor motor starts running. When the material reaches station 2, the conveyor motor stops running since infrared sensor of station 2 is enabled. In station 2 the gripper grips the material and enables sensor 6 and then the gripper extension cylinder moves upwards and enable the sensor 8. Once sensor 8 is enabled, the swivel unit makes a rotation of about 180 degree and enables sensor 10, then the gripper extension cylinder retracts downwards and enables sensor 7. Finally, the gripper ungrips the material on the conveyor and enables sensor 5. After the enabling the sensor 5 the conveyor motor starts running and once the material reaches the end of the station, it is removed manually.

7. Flowchart

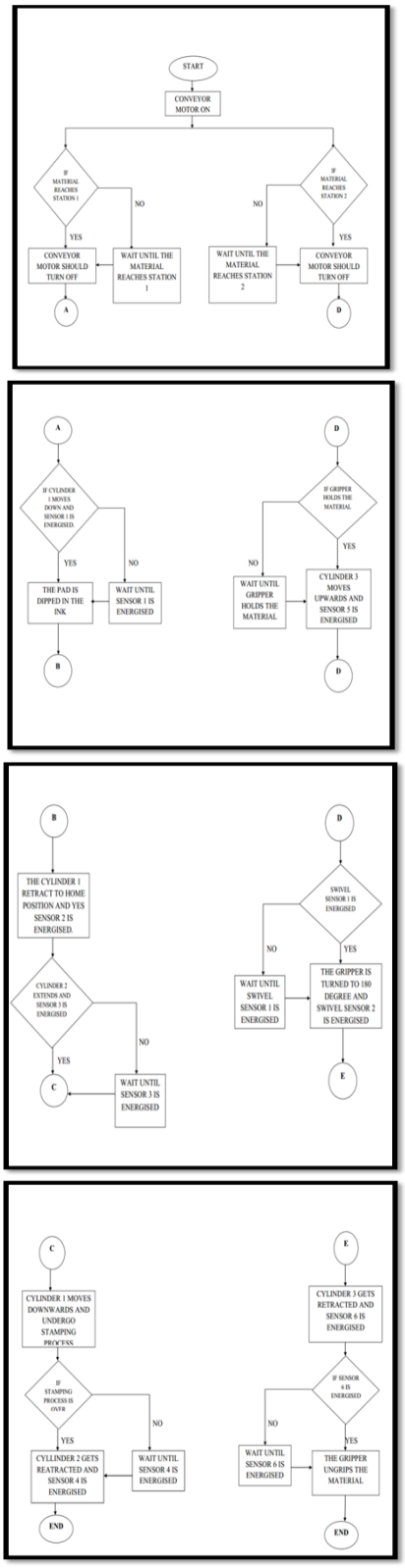


Fig. 12. Flowchart

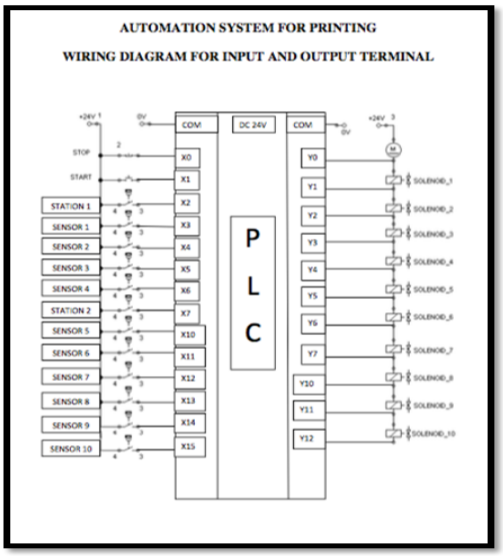


Fig. 13. Writing diagram

8. 3D model

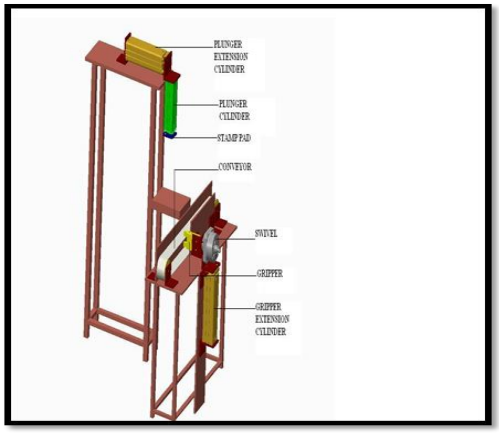


Fig. 14. 3D model

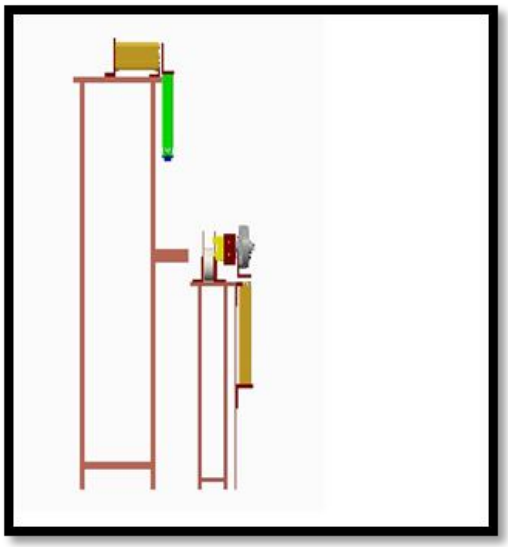
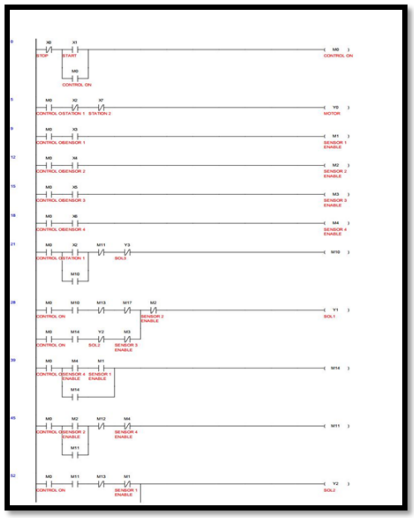
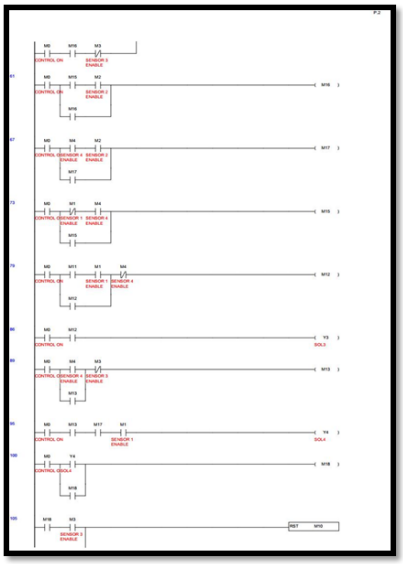
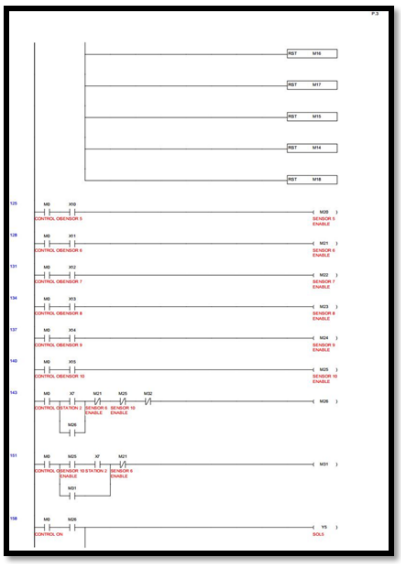


Fig. 15. Front view

9. Ladder diagram







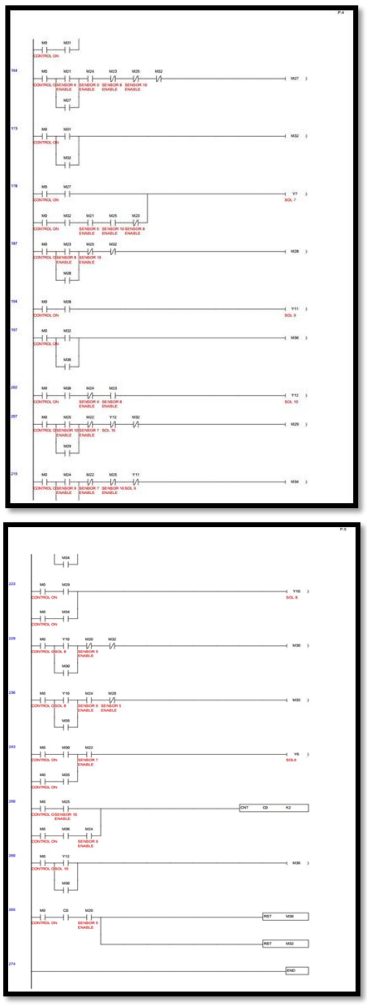


Fig. 16. Ladder diagram

10. Conclusion

Thus the system is modeled and the plc simulation program is executed accordingly and the result is successfully obtained with the following improvement which involves increased accuracy, increased production rate, less man power, less time consumption.

References

[1] Programmable Logic Controllers Principles and Applications – John W. Webb and Ronald A. Reis.
[2] PLC Programming for Industrial Automation – Kevin Collins.
[3] www.festo.com/cms/en-in_in/index.htm – FESTO India.
[4] M. V. Wagh, Vaishali Ghegadmal, Sampada Mapari, Pratik Chavhan, Shanur Shaikh, "Automatic Object Printing Machine Using PLC," in International Journal of Advanced Research in Electronics and Communication Engineering (IJARECE), Volume 6, Issue 5, pp. 393-395, May 2017.
[5] A. Selwin, Mich Priyadharson and Prabhu Kumar Surarapu, "PLC-HMI Based Automatic Screen Printing System," in International Journal of Mechanical Engineering and Technology (IJMET), Volume 8, Issue 10, pp. 101-107, October 2017.

Table 1
Bill of materials, Pneumatic components

S.no	Components name	Specifications	Model no	Manufacturer	Quantity
1	Plunger cylinder	Piston diameter : 32mm stroke length : 100mm	Adngf – 32- 100 – p - a	Festo	1
2	Extension cylinder and gripper cylinder	Piston diameter : 40mm stroke length : 150mm	Adngf – 40 – 150 – p - a	Festo	2
3	Solenoid valves	Size : 20mm flow rate: 700 l/min	Vuvs - l20 - b52 - d - g18 - f7 - 1c1	Festo	5
4	Parallel gripper	Gripper size : 10mm	Dhps - 10 - a	Festo	1
5	Swivel unit	Swivel size : 25mm swivel angle : 180 degree	Dsm - 25 - 270 - p - fw - a - b	Festo	1
6	Pnuematic connecting wires	Wire length : 10m		Festo	10m

Table 2
Electrical components

7	COLOUR SENSORS	24V DC , NO CONTACT	PD12CNC01BPM1T	CARLO GAVAZZI	2
8	DC MOTOR	12V DC , TORQUE : 0.52Nm	RMCS - 5023	RHINO	1
9	POWER SUPPLY	12V DC , 5A , 60W	EC - 0800		1
10	POWER SUPPLY	24V DC , 4.5A , 100W	S8FS - G10024C	OMRON	1
PROGRAMMABLE LOGIC CONTROLLER					
11	PLC	POWER : 24V DC	DVP14SS211R	DELTA	1
12	INPUT POINT EXTENSION	INPUT POINT : 8	DVP08SM11N	DELTA	1
13	OUTPUT POINT EXTENSION	OUTPUT POINT : 8	DVP08SN11R	DELTA	1