An Industrial Packaging Line Design Using PLC

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ABSTRACT: *The paper describes the using of Programmable Logic Control (PLC) in a liquid packaging line. The aim is to explain the proper design and installment of PLC to obtain a high efficiently production line. The proposed design main advantages could be summaries in that the movement of the conveyer is well controlled and the exact desired stop point is achieved. This reflects on increasing the accuracy and minimizing the waste. The type of the PLC used in the design is MITSUBISHI FX-32MT.control process of packaging line is through (PLC) system of the type MITSUBISHI.*

Keywords: *P LC, Ladder diagram, Solenoid valve.*

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1. Introduction

The term automation system identifies the technology that uses automatic control system to manage machine and process reducing the need for human intervention.

The automation is introduced to perform repetitive, complex or heavy operations where the environment is unsafe or unsuitable for human operators. Moreover, automation is employed to obtain a high quality and fast production process [1].Many method are used for this goal .PLC,s are considered as automatic control tools that give better performance compared with other tools. This due to the way of programming which depend on accurate programming langue's such as ladder diagram used in this paper. The main objective of this design is to:

- Implementation of packaging line using PLC system.
- Study of control systems and special PLC control to know the advantages and disadvantages of the control system.
- To know the difference between the physical component (hardware) and simulation (software).

The steps taken in the design were:

- Building up the software (logixpro).
- Running simulations programs.
- Hardware design.
- Comparison of simulation results with those obtained from experimental test.

2. PLC Control architecture

Programmable controllers (the shortened name used for programmable logic controllers) are much like personal computers in that the user can be overwhelmed by the vast array of options and configurations available. Also, like personal computers, the best teacher of which one to select is experience. As one gains experience with the various options and configurations available, it becomes less confusing to be able to select the unit that will best perform in a particular application [2].

As more manufacturers become involved in PLC production and development, and PLC capabilities expand, the programming language is also expanding. This is necessary to allow the programming of these advanced capabilities. Also, manufacturers tend to develop their own versions of ladder logic language (the language used to program PLCs).

This complicates learning to program PLC's in general since one language cannot be learned that is applicable to all types. However, as with other computer languages, once the basics of PLC operation and programming in ladder logic are learned, adapting to the various manufacturers' devices is not a complicated process [2].

A programmable controller, as illustrated in Figure 1, consists of two basic sections:

- The central processing unit
- The input/output interface system [3].

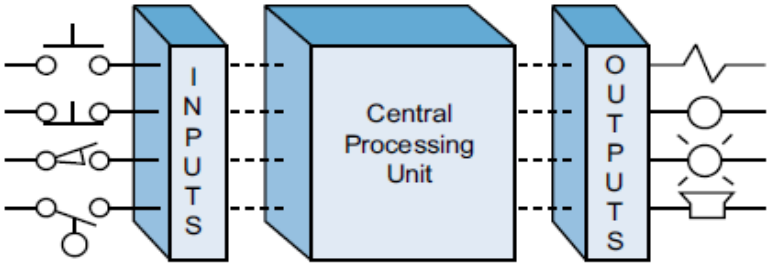

Fig 1 Programmable controller block diagram [3].

2. PLC Advantages

- Flexibility: One single Programmable Logic Controller can easily run many machines.
- Correcting Errors: In old days, with wired relay-type panels, any program alterations required time for rewiring of panels and devices. With PLC control any change in circuit design or sequence is as simple as retyping the logic. Correcting errors in PLC is extremely short and cost effective.
- Space Efficient: Today's Programmable Logic Control memory is getting bigger and bigger this means that we can generate more and more contacts, coils, timers, sequencers, counters and so on. We can have thousands of contact timers and counters in a single PLC. Imagine what it would be like to have so many things in one panel.
- Low Cost: Prices of Programmable Logic Controllers vary from few hundreds to few thousands. This is nothing compared to the prices of the contact and coils and timers that you would pay to match the same things. Add to that the installation cost, the shipping cost and so on.
- Testing: A Programmable Logic Control program can be tested and evaluated in a lab. The program can be tested, validated and corrected saving very valuable time.
- Visual observation: When running a PLC program a visual operation can be seen on the screen. Hence troubleshooting a circuit is really quick, easy and simple [4].

3. PLC Disadvantages

- Because it is a new technology, so that should require training.
- Some applications that perform a single function, is not efficient in the use of PLC.
- Limited usage environments, high temperatures and harsh vibrations can disrupt electronic equipment on the PLC.
- Need extra security equipment such as really.
- PLC is not considered necessary when applied to industrial systems that do not need to change the wiring [5].

The next flow chart explains the project sequence:

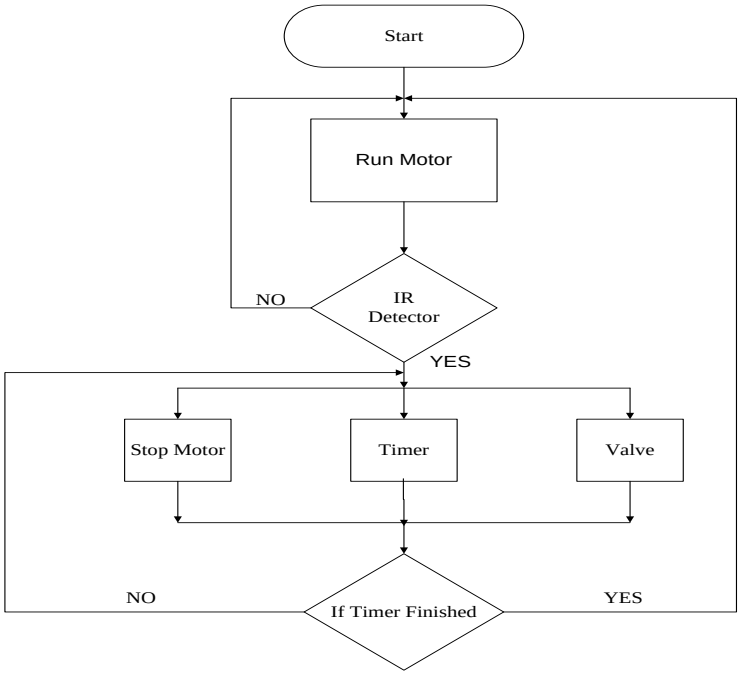

Fig 2 Flow Chart of the propose system

3. Hardware Design OF THE PACKAGE SYSTEM

1. Programmable Logic Control

Programmable logic controllers, also called programmable controllers or PLCs, are solid-state members of the computer family, using integrated circuits instead of electromechanical devices to implement control functions [3].

2. Solenoid Valve

A solenoid valve is an electromechanical valve that can be used to control the flow of liquid or gas. The solenoid converts an electrical signal in to a mechanical movement. The signal is sent to a coil and the movement occurs inside the valve.

A coil is assembled on to the valve body on an armature tube with an armature tube or moving core inside. The moving core is held in place by a counter spring. When the coil is charged the armature is attracted by its magnetic field and the main seal either opens or closes leaving a passage through the valve orifice [6].

Fig 3 Solenoid Valve [7]

3. Servomotor

The motors which are utilized as DC servo motors, generally have separate DC source for field winding and armature winding. The control can be archived either by controlling the field current or armature current. Field control has some specific advantages over armature control and on the other hand armature control has also some specific advantages over field control. Which type of control should be applied to the DC servo motor, is being decided depending upon its specific applications [8].

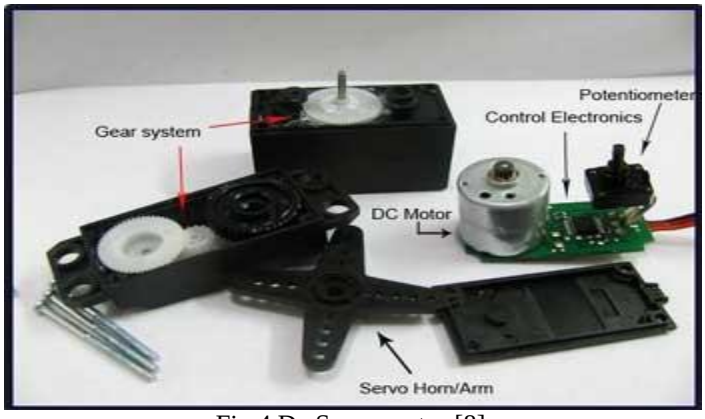

Fig 4 Dc Servo motor [8]

4. Software

When the system begins to implement must be first design by simulator decided for this purpose.

1. PLC Ladder diagram

- Identify the parts of an electrical machine control diagram including rungs, branches, rails, contacts, and loads.
- Correctly design and draw a simple electrical machine control diagram.
- Recognize the difference between an electronic diagram and an electrical machine diagram.
- Recognize the diagramming symbols for common components such as switches, control transformers, relays, fuses, and time delay relays.
- Understand the more common machine control terminology [2].

2. Simulation

Simulation of a system is the imitation of the operation of a real-world system over time [9]. Simulation requires a model, which is a representation of a system used to answer questions, without doing experiments on the real system. Experiments may be too expensive or dangerous, the time-scale of the dynamics too long to allow performing experiments in a reasonable time interval, variables of interest may be inaccessible (may not be measurable or observable), and so on. A model can be seen as a simplified system that reflects some properties of the real system [10] [11].

Simulation known logixpro produce by allanbradly Company will be used in this system.

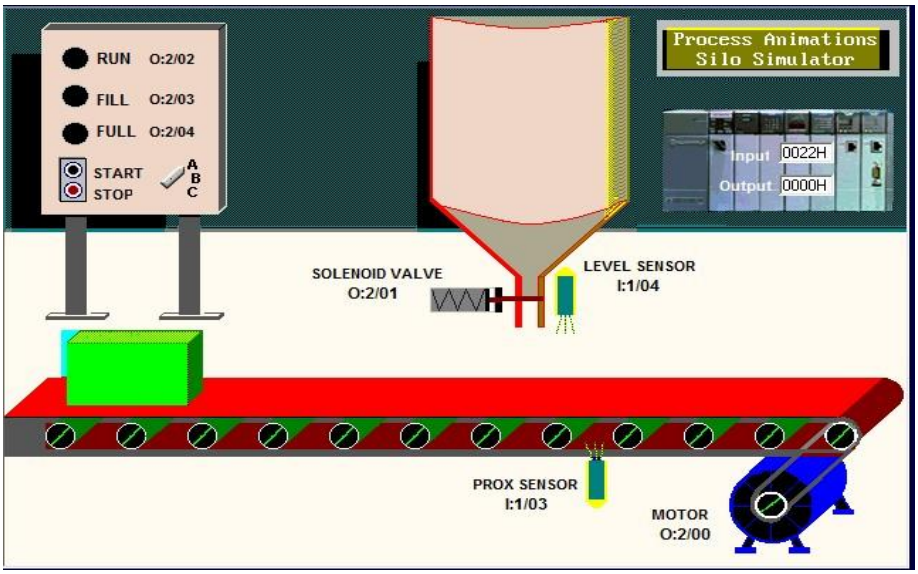

Fig.5 Screen captured of the proposed simulation program

Completely design a ladder control circuit which will automatically position and fill the bottles which are continuously sequenced along the conveyer.

Fig 6 PLC ladder diagram

The program will explained as following:

- The sequence can be stopped and restart at any time using the panel mounted stop and start push button.
- The run light will remain energized as long as the system is operating automatically.
- The run light, conveyer motor and solenoid valve will de-energize where the system is halted via the stop switch.

- The fill light will be energizing while the package is filling.
- The full light will energize when the package is full and will remain that way until the package has moved clear of the IR sensor.
- Stop the conveyer when the right edge of the package is first sense by the proximity sensor.
- With the package in position and conveyer stopped, open solenoid valve and allow the package to fill, filling should stop when the level sensor goes true.
- The fill light will be energizing while the package is filling.
- The full light will energize when the package is full and will remain that way until the package has moved clear of the proximity sensor.
- Once the package is full, momentarily pressing the start switch will move the package off the conveyer and bring a new package into position.

5. PLC hardware configuration

- There are three in puts to the plc, The first input decided for starting the system (start push button) and assigned by X0, The second input is decided for stopping the system (stop push button) and it assigned by X2.The plc include 24v dc as internal source to be utilized for input and output because the input and output into the plc is always amount of voltages equal to 24 v dc.
- The common of the two push buttons are connected to the internal source common of the plc while the other terminals are connected directly to the input of the PLC(X0,X1) respectively .However the sensor signal is connected to the plc via an interface circuit composed of IR transmitter and receiver sensor with uln2003 and relay.
- As for output five elements are connected to the plc output port, a dc servomotor is connected to Y2 (first output) via a relay while the solenoid valve is directly connected to Y1 (second output) and three indicators are (conveyer run, fill run, stop) are connected to (Y4, Y5, Y6) respectively through relay.

6. Results

The system designed by using PLC that represented a new technology compare with relay control (classical control).although simplicity to write and understand the ladder diagram program and the result that achieved is more accurate. Easy to finding errors A PLC can easily accept a new module in a slot or get an expansion. And the table below shows that difference between two types of control system.

Characteristic	PLC System	Classical Control
Cost	High	Low
Operation speed	Fast	Slow
Installation	Simple to program and install	Time consuming for design and installation
Physical size	Compact	Bulky

Table 1. Show the Comparison of control systems

7. Future Recommendations

To grantee the continued of the system its recommended to Build backup system such as classic control system and improve it to toggle automatically in case that if the main system stopped under any error occurred or to maintenance purpose.

8. Conclusion

The primary goal of this paper to implement packaging line system using plc system, In the beginning a flow chart of the system were developed to understanding system then a simulation program of whole system were done by using logixpro and followed by the implementation of the system using Mitsubishi plc. Then many test to confirm the performance and the obtain result were compared to the simulation results and found fairly satisfying.

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