



Implementation on Opening-Closing Mechanism in the Door Automation based on LogixPro and Silo Simulator

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Abstract: Automation is a technology which uses the control systems and information technologies to make the work zone more comfortable, reduce the human assistance in industries and households. Today automation achieved all the tasks that are beyond the abilities of human like weight, speed, size, persistence, etc. This paper describes the detailed use of software for industrial process of automation with the help of programmable logic controllers (PLC). The software used is LogixPro 500 PLC simulator in which ladder programming is done to achieve the given tasks of automation. Ladder Logic is a graphical programming language and a method of drawing electrical logic schematics which is primarily involuntary without simple contacts that simulates the opening and closing of relays which includes of functions e.g. timers, shift registers, counters, mathematical operations and gives the detailed view for door automation system and silo simulator for designing and debugging a program which will shift the boxes automatically and then fill them. These boxes are continuously sequenced along the conveyor belt.

Keywords: Automation, LogixPro 500 PLC simulator, Ladder Logic, silo simulator

1. INTRODUCTION

Automation is the procedure which reduces the human efforts or we can say automation or automatic control in which control systems are used for operating machines in factories, boilers and ovens, airplanes and automobiles with less human assistance. It was the time when feedback controllers (designed in the 1930s) came into play in industries [1]. Automation is done by the combination of computers with the devices in mechanical, hydraulic, pneumatic, electrical, electronic fields. All these techniques are used in combination to each other in like modern system in factories, airplanes etc. The features of automation include less labor, lower in costs for electricity, material and provides an improved quality and accuracy. Industrial automation includes the role of controller schemes in which PCs control processes, manufacturing machinery, reduces the need for human interference. Processes and systems can also be automated. In the global economy and in day to day experience, automation displays gradually imperative part [2].

A. Automation Tools

Special featured computers are used for automation e.g. programmable logic controllers (PLCs). These computers are used in the inputs integration flow from physical sensors along with output flow to actuators. Service personnel who actually monitor, control all these lines are mostly cite to static engineers. Bank

visits are reduced due to automated teller machines to perform transactions. Generally speaking, automation played an appreciable role in improving the world's economy [2].

B. Convertibility and Turn Around Time

Automation provides some extraordinary powers which deals with the flexibility and convertibility process in the field of manufacturing. Manufacturers are now demanding as they can switch from one product to another easily without any reconstruction of the production lines. By the help of automation humans can save themselves from laborious or other physical works or even automation can do such things which even humans fail to do. But its drawbacks are also there, because we do not have proper source to acquire it. Vast technology is also required for it, which may lead to huge expenditure for a particular institution.

2. PROGRAMMABLE LOGIC CONTROLLER

PLC is a type of computer which is used in devices which require high control .it is used in many industries. It is available in wide range such that it varies from "building block" to big devices. We can construct these for various settings. Programs which are used to control the machine operation are either stored in battery backup or non-volatile temperature memory.

A. Counters and Timers

The chief role of timer is that it can save output for some definite time limit. For example, light in a garage, where we want electricity to shut down after 2 minutes in order to provide someone time enter the house. There are different species of timers:

- Delay-off: A Delay-on timer is triggered by input and starts at acquiring time. It makes up to a planned time already it gets cut off, gets cleared when the permissive input is turned off.
- Delay-on: A Delay-off timer trigger instantly when it is turned on from a programmed time before cutting off counts down start and it is cleared away when the permissive input is turned off.
- Delay-on-retentive: A Delay-on-retentive timer is triggered by input and starts acquiring time then recalls the acquired value; the ladder-logic step goes false and can also be reset only by a reset contact.

Counters are mainly used for calculating components like cans bustling into a box on an association line and occupied to its capacity, the item requirements to be moved on to some else place can be occupied. There are 3 types of counters

- Up counters: It count up to pre-set value and then turn on the CTU (count up output) after pre-set value is achieved, cleared after receiving a reset value.
- Down counters: It count down from a pre-set value, turns on the CTD (count down output) when it reaches 0 and are cleared upon receiving a reset.
- Up/Down counters: It count up/count down and turn on count up/down output when the predetermined value is achieved, clear upon reset.

PLC logix can save time in building structure of computerized control applications and also can raise the safety level in terms of apparatus.



Fig. 1: PLC Logix, PLC Simulation Software

B. PLC Compared with Other Control Systems

PLC is the ordinary industrial process in manufacturing where the installing and maintaining cost of the automation system is very great when compared to the automation prices and system changes are done in its operative life. It consists of input, output strategies suitable using pilot devices and controls of industries [2].

C. PLC Logix

PLC Logix is a simulator which uses PLC that replicates Logix 5000 PLC operation i.e. Rockwell automation. PLC Logix operation consists of an organizer with graphical controller and a point-click method of arranging many input or output. It utilizes 64-bit handling data, blends both arrays, user-defined arrangements to give imitation of the definite world control systems of industries. It requires virtual models that have two layers:

- Graphic model layer: It represents the respective ladder logic and reflecting the different states of operation at time of execution of program.
- Mathematical model layer: The core of PLC simulation is mathematical model layer which use mathematical logic to create a ladder logic program. These mathematical models consist of input and output literals and set up a mathematical relationship between input and output tags.

The application organization use tasks, programs and routine structures. Using interactive 3D animations PLC Logix simulate with real world manufacturing environments. A circuit is controlled by Ladder coding and de-bugging a ladder which is automatically shift and fill the boxes of consecutively sequenced along the conveyor belt running on motor as shown in fig. 1. A reversible motor which is included in the door system, along with a pair of limit switches and an operator control panel and all are connected to our PLC.

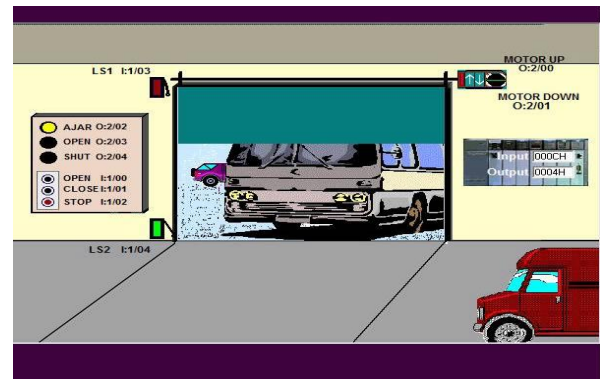


Fig. 2: Industrial Door Automation

D. Ladder Logic

Formerly ladder logic was a theoretical technique in order to design the document and building relay racks. In relay rack shown in fig. 4, 5, 6 and 7, present every device that is characterized in a symbol of ladder diagram. Additional devices apart from the relay rack i.e. heaters, pumps etc. is also shown in the ladder diagram. The steps are true if a track is made between the output and the left side of the step, over asserted (true or "closed") contacts then the output coil storage bit is declared (1) or true. Output is false (0) if there is no track to be outlined and the "coil" by analogy to relays is treated "de-energized". To control coils ladder logic has contacts which can make or break circuits.

(1) Rung electromechanical Input: Checkers (contacts)

—[]— is used usually open and closed contact and it is energized when its corresponding coil or an input is control.

—[/]— is used usually closed ("not") contact and it is not energized when its corresponding coil or an input is control.

(2) Rung Output: Actuators (coils)

—()— is used usually inactive coil and energized when its rung is closed. (At rest condition, it is inactive)

—(/)— is used usually active ("not") coil and energized when its rung is open. (At rest condition, it is active)

(3) Digital logic functions

The usage of typical binary representation for switches and lamp status is 'zero' for un-actuated or de-energized and 'one' for actuated or energized.

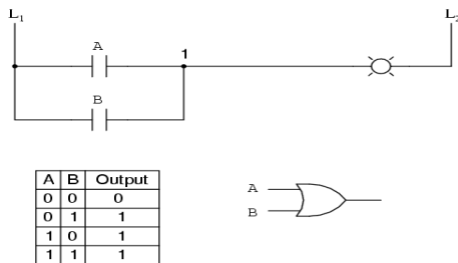


Fig. 3: OR Logic Function for Contact and Lamp

Now, the lamps will on if one of the contact A or contact B is activated for the lamp because it requires to be energized and for current, it has path from wire L1 to wire 1. After that, the lamp energizes only if contact A and contact B are actuated. If both switch contacts are closed, only then a path is formed between wire L1 and wire 2.

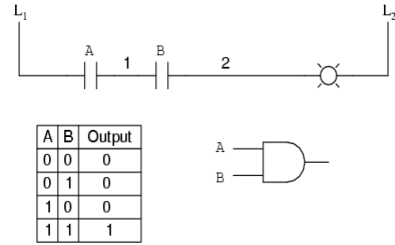


Fig. 4: AND Logic Function for Contact and Lamp

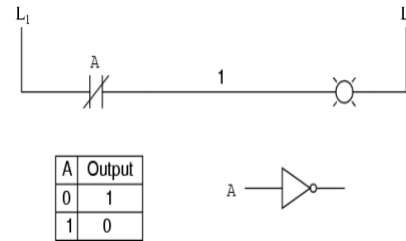


Fig. 5: NOT Logic Function for Contact and Lamp

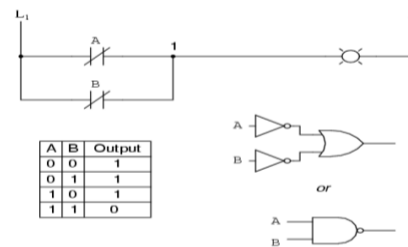


Fig. 6: NAND Logic Function for Contact and Lamp

If the contact is actuated lamp is de-energized and If the contact is not actuated lamp is energized. Ladder diagram has a number of strengths i.e. intuitive and self-documenting, excellent debugging tools and efficient representation for discrete logic [3].

3. SOFTWARE USED

A. LogixPro 500 PLC

To learn the fundamentals of ladder logic programming LogixPro 500 is the ideal tool to use.

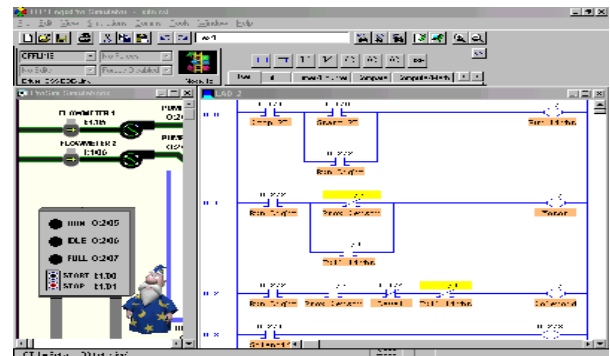


Fig. 7: More Realistic and Challenging Programming

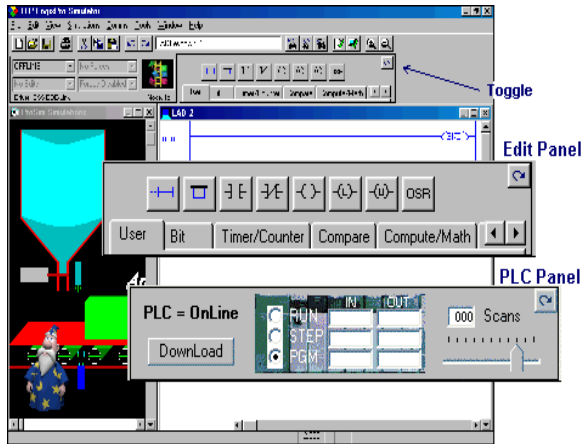


Fig. 8: LogixPro Tools

B. ProSim-II

A ProSim-II simulation is an interactive educational tool. It is designed to help researchers in the accession of the programming skills used to control the process oriented equipment and systems. The processes with animations and display are used with a PLC. PLC emulator gives response to the PLC signals in the same manner as actual process equipment and sensors would do. LogixPro helps us to practice and develop our programming skills. To learn RSLogix, it substitutes the PLC, ladder rung editor and all the electrical components that have used till now but still uses instructors, texts, tutorials, PLC documentation manuals etc. We can download our program to the "PLC" from the PLC Panel and then set it into the "RUN" mode. The scanning of the program is initiated.

LogixPro contains an editor similar to RSLogix which helps to design and edit programs using programming instructions used by Allen Bradley's RSLogix500. It provides a software PLC emulator. We can download programs to it in the same manner as in actual PLC. There is an adjustable Speed Control. When the simulation is slowed it means the PLC is scanning. To observe the response of instructions, set the scan slow enough. Hence, PLC first scans all the instructions and stores their states in memory. Then it comes with the program scan on the bases of priorities of output according to the program logic.

4. SIMULATION RESULTS

A. Silo Simulator

Case 1: Nonstop Action: Ladder coddng, de-bugging a ladder control circuit that is automatically shift and fill the box which has nonstop sequenced along the conveyor belt running on motor. The following conditions will also meet:

- By using panel mounted stop and start switches, conveyor can be stopped and again started at all

time. The system is working automatically and the run light will remain on at that time.

- The system is stopped with stop switch when the run light, solenoid and conveyor motor will de-energize.
- The fill light will energize when the box is filling. The full light will energize and light will remain same until the box has moved clear of the proximity sensor during the box is full.

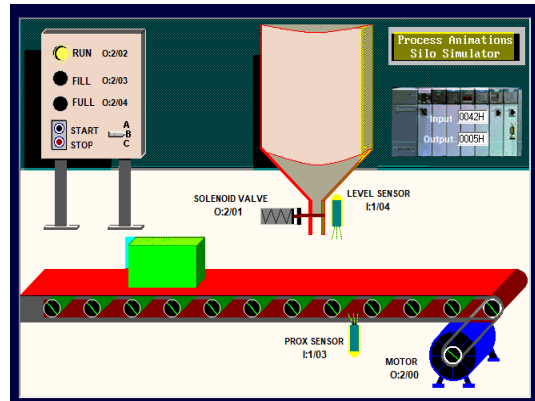


Fig. 9: Running Silo with RUN Lamp ON

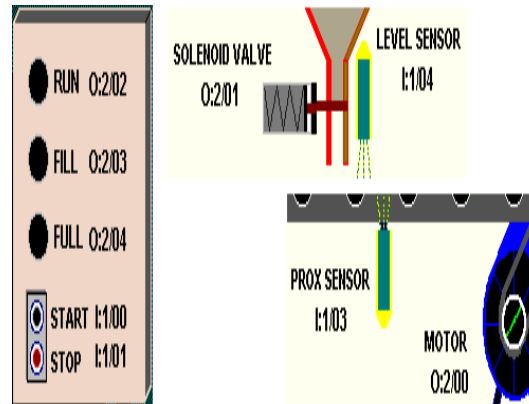


Fig. 10: Proximity Sensor with Motor

Case 2: Container Filling with Manual Restart.

- When the right edge of the box is first sensed by the proximity sensor at that time stop the conveyor belt.
- Open the solenoid valve and allow the box to fill by the box in position and the conveyor stopped at that time. When sensor level goes true, filling should stop. The fill light will be energized when the box is fill.
- When the box is full, move the box off from the conveyor and get a new box into position.

The ladder programming done for this simulation is shown in figure 13.

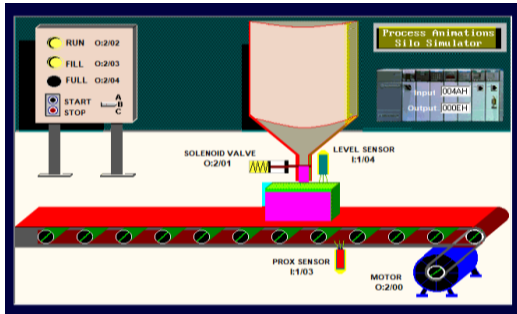


Fig. 11: Filled Silo with RUN and FILL Lamps ON

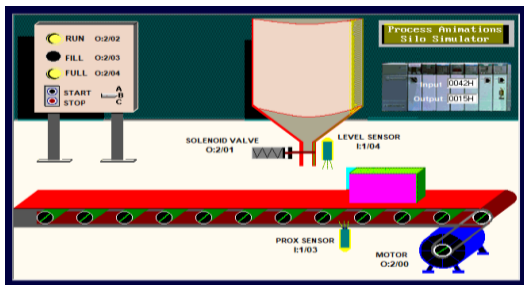


Fig. 12: Silo Filled and Moved with FULL Lamp ON

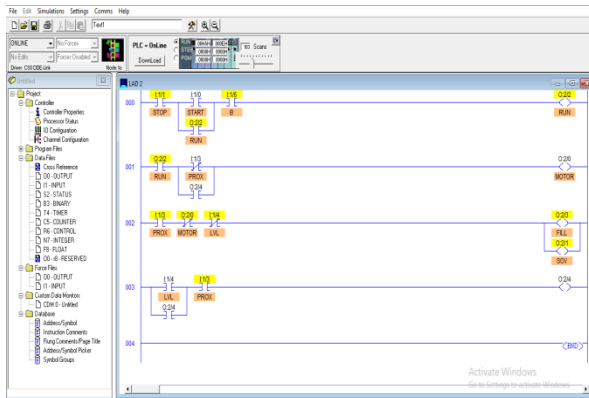


Fig. 13: Ladder programming of silo simulator

B. Door Automation

As we know that the modern electrical automation has made the life more sophisticated, easier and economical.

This program is based on the automatic door control system which is applicable at large industries or at the places where the people are busy and are large in number. Major goal of this program is to provide the fully programmable automatic control system. This system can be used in the areas like hotel, restaurant, airport, seminar hall and in so many industries. In its working condition it could replace the doorman. Therefore it provides an automatic open/close system.

Case 1: A program is designed which simulates the LogixPro door simulation controlled by relay logic instructions. Reversible motor, an operator control panel and a pair of limit switches makes the door

system to run. These components are connected to our PLC. This program will monitor and control the equipment while complying with these conditions:

- To control the movement of the door, the open and close push buttons will be used. When either switch is released, movement will not be maintained.
- If the door is already fully opened, the open switch will not energize the motor and if the door is already fully closed, the close switch will not energize the motor.
- At the same time, both motor windings will be energized under no circumstance

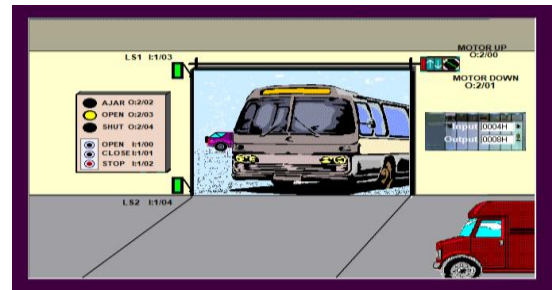


Fig. 14: Fully opened door with OPEN lamp ON

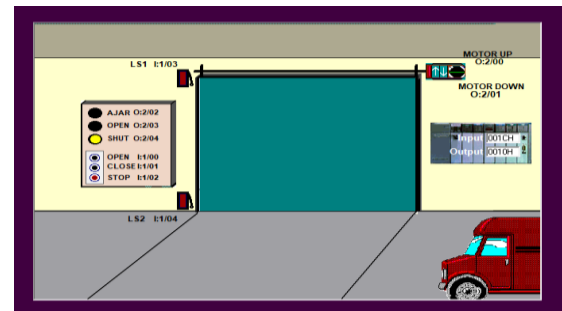


Fig. 15: Fully closed door with SHUT lamp ON

Case 2: To extend the life of the door hardware, we need you to raise one final touch. Starting and stopping the door motion puts a strain on the door hardware but reversing the direction of the door without giving it a chance to fully stop causes an even greater strain. So, we want you to prevent the possibility of immediate reversal after modify your program. As we don't need much of a delay, the following additional criteria should suffice:

- Presently, the door is open; press the close switch will instantly halt movement and when the switch is released, door movement will remain halted.
- Presently, the door is close; press the open switch will instantly halt movement and when the switch is released, door movement will remain halted.
- Once movement is halted and all push buttons have been released then door motion can in either

direction by pressing the appropriate open or close button.

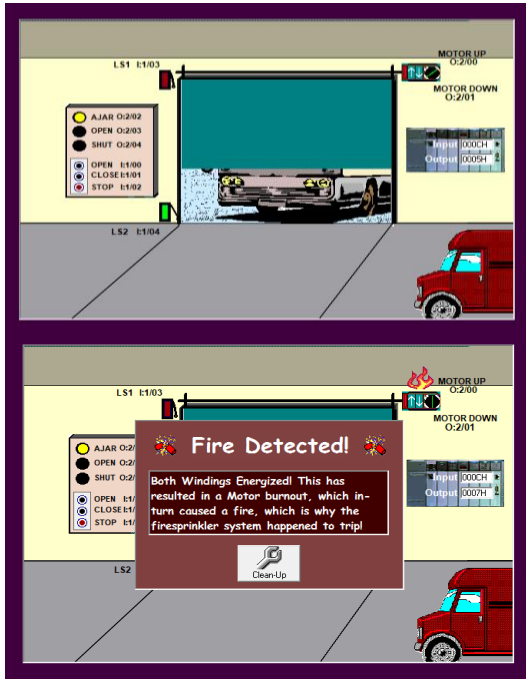


Fig. 16: Door is half opened and Fire is detected when CLOSE button is immediately pushed

The simulation door employs two limits. Upper Limit switch wired Normally Open (N.O.) and Lower limit switch wired Normally Open (N.O.) result that Upper limit switch (door open) goes False (0) when the door reaches the fully open position. Lower limit switch (door closed) goes True (1) when the door reaches the fully closed position.

Upper Limit switch rewired N.C. and Lower limit switch wired N.O. result that Upper limit switch (door open) goes True (1) when Door reaches the fully open position. Lower limit switch (door closed) goes True (1) when door reaches the fully closed position.

Upper Limit switch wired N.O. and Lower limit switch rewired N.C. result that Upper limit switch (door open) goes False (0) when Door reaches the fully open position. Lower limit switch (door closed) goes False (0) when door reaches the fully closed position.

With the completion of this work, objective of the work is fulfilled for building an automatic door control system. This system can be used worldwide and have many applications based on flow of mass. We can definitely increase the potential of this system and this also provides with an opportunity of working in different areas of engineering namely, electronics and software.

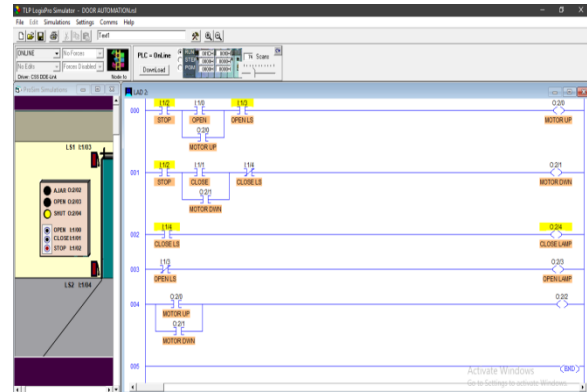


Fig. 17: Ladder programming for Door Automation

5. CONCLUSION

LogixPro consists of ProSim II simulation package with the software simulations of equipment in real-world that is described graphically. It is overlying software to other custom designed PLC training stations that requires hardware PLCs. It uses the RSLogix software package effectively. The operation of the process equipment is simulated in the way it would arrive with real equipment along with the help of LogixPro. The synchronous and connected nature of a realistic industrial process is maintained and provides a way more realistic and challenging programming experience for researchers. This software provides 3D interactive animations which helps engineers to test and troubleshoot ladder logics. Hence, this project perceives a lot of experience and knowledge in the field of automation.

REFERENCES

- [1] Alison Dunn, "The father of invention: Dick Morley looks back on the 40th anniversary of the PLC", Manufacturing Automation, September 12, 2008.
- [2] Yanik, P., "Overview of Programmable Logic Controllers", Cullowhee, NC, United States of America, April 11, 2017.
- [3] Ali Muhammad Ali Mazidi, Janice Gillispie Mazidi and Rolin D. McKinlay. "The 8051 Microcontroller and Embedded systems Using Assembly and C", 2nd Edition, Department of Computer Science and Information Engineering National Cheng Kung University, TAIWAN.
- [4] Keller, William L Jr. Grafset, "A Functional Chart for Sequential Processes", 14th Annual International Programmable Controllers Conference Proceedings, pp. 71-96, 1984.
- [5] Dougall, David J., "Applications and Benefits of real-time simulation for PLC and PC control systems", ISA Transactions. 36, pp. 305-311, 1997.
- [6] Edward W. Kamen Industrial Controls and Manufacturing, "Ladder Logic Diagrams and PLC Implementations", Academic Press, 1999, ISBN: 0123948509.
- [7] Theodore S. Rappaport, "Wireless Communications: Principles and Practice", 2nd Edition, Prentice Hall Communications Engineering and Emerging Technologies Series, 31 Dec. 2001.