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Recognition and Disposal of Faulty Bottles in a Bottle Filling Industry Using PLC and Producing Human Machine Interface by SCADA

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Abstract:-A novel method of detecting faulty bottles in a bottle filling industrial process has been proposed in this paper. Here we analyse the simulation study of one programmable logic controller (PLC) based control system by building up a program using ladder diagram and different addressing modes of SIEMENS PLC. This paper also presents comprehensive simulation of the performance of the different sensors used for sensing the faulty bottles in the moving conveyer belt monitored by PLC. The outputs can also be observed in supervisory control and data acquisition (SCADA) window. The adopted simulation strategy assures a low cost, more reliable, increased flexibility and faster response.

Keywords:- Proximity sensor, scanner, stepper motor, conveyer belt, ladder diagram, PLC, SCADA.

I. INTRODUCTION

In industrial purpose there is a recognized hierarchy of damage control measures based on the priciple that loss of production needs to be reduced to an acceptable level by enginnering means. Automation is the use of control systems and information technology to reduce the need for human work in the production of goods and services. In the scope of industrialization, automation is a step beyond mechanization. Whereas mechanization provides human operator with machinery to assist them with the muscular requirements of work, automation greatly decrease the need for human sensory and mental requirements. In filling industry faulty bottle detection routine is a imperative part being done by several discrete mechanisms working in harmony. It is an endowment of automation [1]-[8] that we can think about this process. So, in the industry the whole system is done by many separate machines like faulty bottle detection system, filling machine, capping machine, labeling process etc.

Here the focal argument issue is about detecting the faulty bottle before entering into the main plant. We have used PLC which allows us using implying delay, timers, and counters.

II. SYSTEM COMPONENTS DESCRIPTION

The various components used by the system implemented here are:

1.1. Programmable Logic Controller

It is a digital electronic device that uses a programmable memory to store instructions and to implement specific functions such as logic, sequence, timing, counting and arithmetic operations to control machines and processes [1]- [4]. In other words, PLC is a solid state/computerized industrial controller that performs discrete or sequential logics in a factory environment. A sequence of instructions can be programmed by the user into the PLC and it can demonstrate the use of these operations into a system.

In this paper the PLC used is a SEIMENS S7 300. Only one station with its 16 logic input and output ports are used. According to requirement, more number of stations can be added thus increasing the potential of this system to be used in very large industries. The components of the PLC in a block diagram are given in fig1.

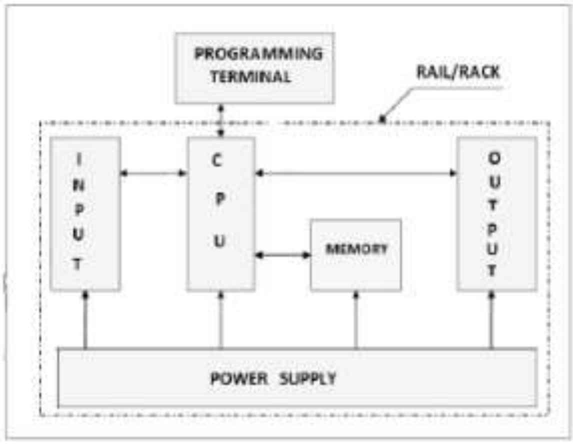


Fig.1 Components of PLC.

1.2. Proximity Switch

A proximity sensor often emits an electromagnetic field or a beam of electromagnetic radiation (infrared, for instance), and looks for changes in the field or return signal. The object being sensed is often referred to as the proximity sensor's target. Different proximity sensor targets demand different sensors.

A proximity switch uses this proximity sensor to trigger ON or OFF certain circuit required for the processing of the system. Here in this particular system, two proximity switches are used to count the bottles. A proximity switch is given in fig 2 and its internal components have been labeled.

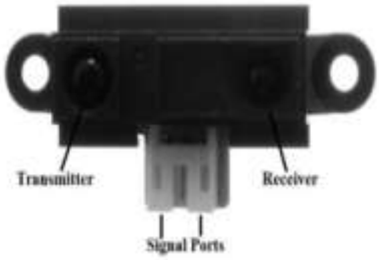


Fig.2 Proximity Switch

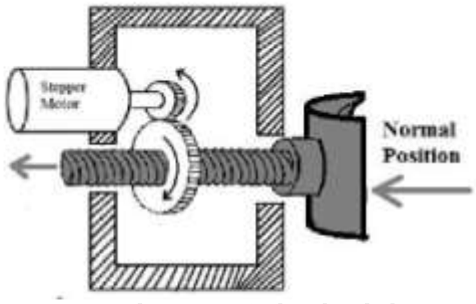
1.3 Scanner

Two Industrial Scanners are placed at a point along the conveyor belt. All the bottles need to pass through this point. A checking is done by these industrial scanners. Firstly a scanner is placed at the top of the belt which checks the nozzle size and then another is placed laterally which checks the figure, shape and size of the bottle. All this is done using pre loaded images of a perfect bottle. The checking is done by comparing this pre loaded image with the bottle being checked.

1.4 The Disposal System

The Disposal of the bottles is done by a very simple mechanical device. This device uses two gears and a stepper motor. The Motor rotates at a fixed angle and thus rotating the gears. The Gear is connected to a screw and fixed to the back side of a plunger. This plunger pushes the bottles from the conveyor belt. Fig 3a gives this mechanism at normal position and fig 3b shows how the mechanism works while the stepper motor shaft is rotated to push the bottle.

According to the scanner output the stepper motor is connected and implemented by the PLC program. When the Scanner detects a fault in the bottle then the check fails and the bottle is pushed. Otherwise the system is kept switched OFF at normal position so as to allow the bottles which have passed the check to move forward.



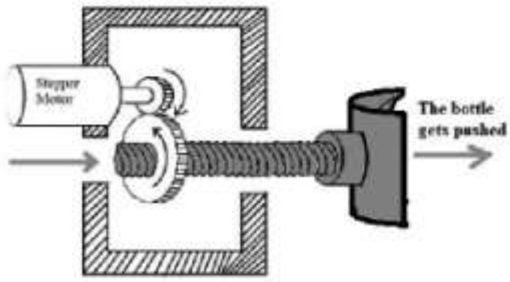


Fig.3a At normal position (When bottle has passed) Fig.3b Bottle is Pushed (When Bottle Fails check)

III. WORKING PRINCIPLE

The whole system is built up with two proximity switch to count bottles passing by, one scanner to scan each bottle and compare with pre-loaded image and one plunger to throw away the faulty bottle from conveyor belt which carries the bottles. The block diagram of system is shown in Fig 4.

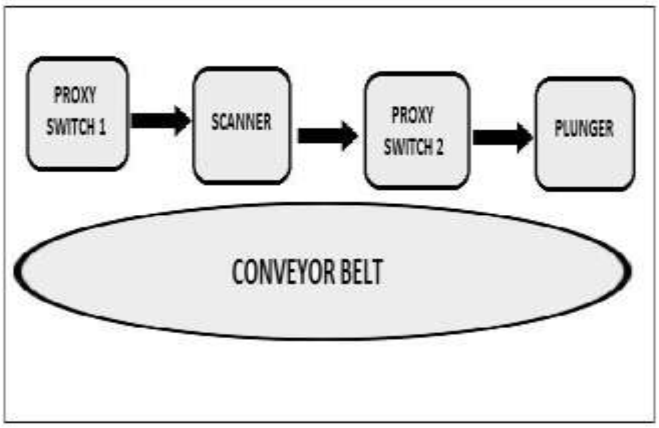


Fig. 4 Block diagram of system.

The bottles are kept in conveyer belt. There are two proximity switches. Proximity switch 1 senses the bottle first and counts it. Scanner scans the bottle and compare with default image of bottle. If there is image mismatch then Plunger will switched ON and throw the bottle on the second conveyer. If there is no mismatch, then plunger will not switch ON and proximity switch 2 counts the number of good bottles.

IV. IMPLEMENTATION

The ladder logic programming has been implemented in PLC step 7 software and the visual interface or the Human Machine interface has been done using WinCC explore edition using Supervisory Control and Data Acquisition logic.

Table 1. Addressing Modes.

Instruction	Mode
Input	**I0.0 – I0.7** **I1.0 – I1.7**
Output	**Q0.0 – Q0.7** **Q1.0 – Q1.7**
Flag	**M0.0 – M0.7** **M1.0 – M1.7**

While building up the required ladder logic we have used different addressing modes [3] of Siemens PLC as mentioned in TABLE 1. Required Inputs are: Start_PB [I0.0], Stop_PB [I0.1], Overload Relay [I0.2], Proximity switch1 [I0.4], Proximity switch 2[I0.6]. Required Outputs are: Conveyer Motor [Q0.1], Scanner [Q0.2], Plunger [Q0.3].

The control philosophy of this process is as follows:

- After pressing start push button [I0.0] bottles are moving on the conveyer belt.
- Number of bottles passing through the conveyer were counted by Proximity switch1 [I0.4] and Proximity switch 2[I0.6] also.

- Scanner [Q0.2] detects the faulty bottle by providing an input pulse.
- When scanner detects faulty bottle then the process should calculate the faulty bottle number by calculating the value of proximity switch 2[I0.6] and proximity switch1 [I0.4].
- Now proximity 2 [I0.6] checks the faulty bottle in front of him. When proximity switch 2 detects that faulty bottle then plunger [Q0.3] actuate and pushed the bottle from the main conveyer [Q0.1] to the 2^{nd} conveyer.

- When we press the stop push button [I0.1] the total process rested.

V. SIMULATION RESULTS AND SCADA OUTPUT

We have performed the whole experiment in simulation mode with the help of ladder logic [10] – [12] written in step7 300 software as mentioned in APPENDIX-A. We also applied required input and observed the following outputs in SCADA [12] window (WinCC explore) as shown in the Fig.5a. and Fig. 5b.

- Number of good bottle.
- Number of faulty bottle.
- Counting of proximity switch 1.
- Counting of proximity switch 2.

Bottles are kept on a moving conveyor belt. Initially plunger is off as shown in the Fig. 5a as no faulty bottle is detected by scanner. But when a faulty bottle is detected by the scanner it sends a signal to proxy switch 2 which on the plunger for moving away the particular bottle from belt as shown in the Fig. 5b.

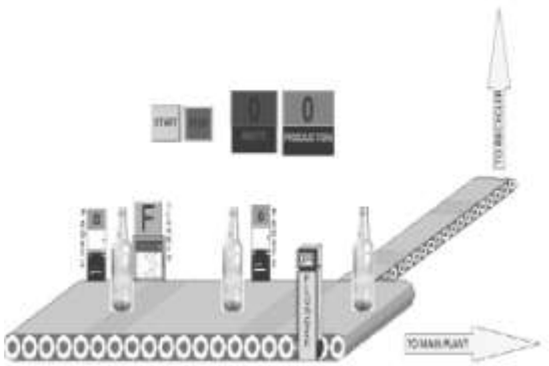


Fig. 5a. Initial stage when plunger off.

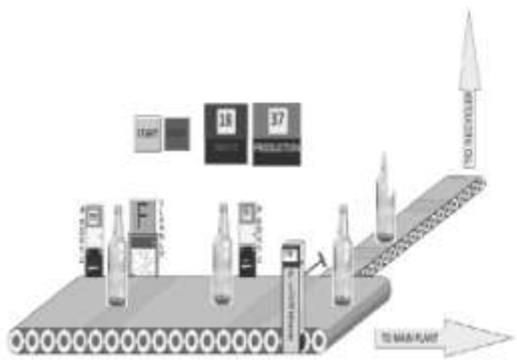


Fig. 5b. Running system.

VI. CONCLUSION

This recapitulation confers the fundamental design of a PLC based faulty bottle identification system that could be effectively used for industrial purpose. A simple assessment logic scheme was used to process the outputs of the above system to indicate whether the bottle is perfect or not. The observation also point out the condition of the both proximity switches and plunger. Further work is requested to improve the decision logic scheme and to use the recent sensors. Moreover this system works simply and is user friendly with very less requirement of human indulgence. A single PLC system can handle many processes altogether thus becoming cost effective for large scale industrial production.

APPENDIX A

The Ladder Logic program implemented for this system is given in figure 6a and 6b

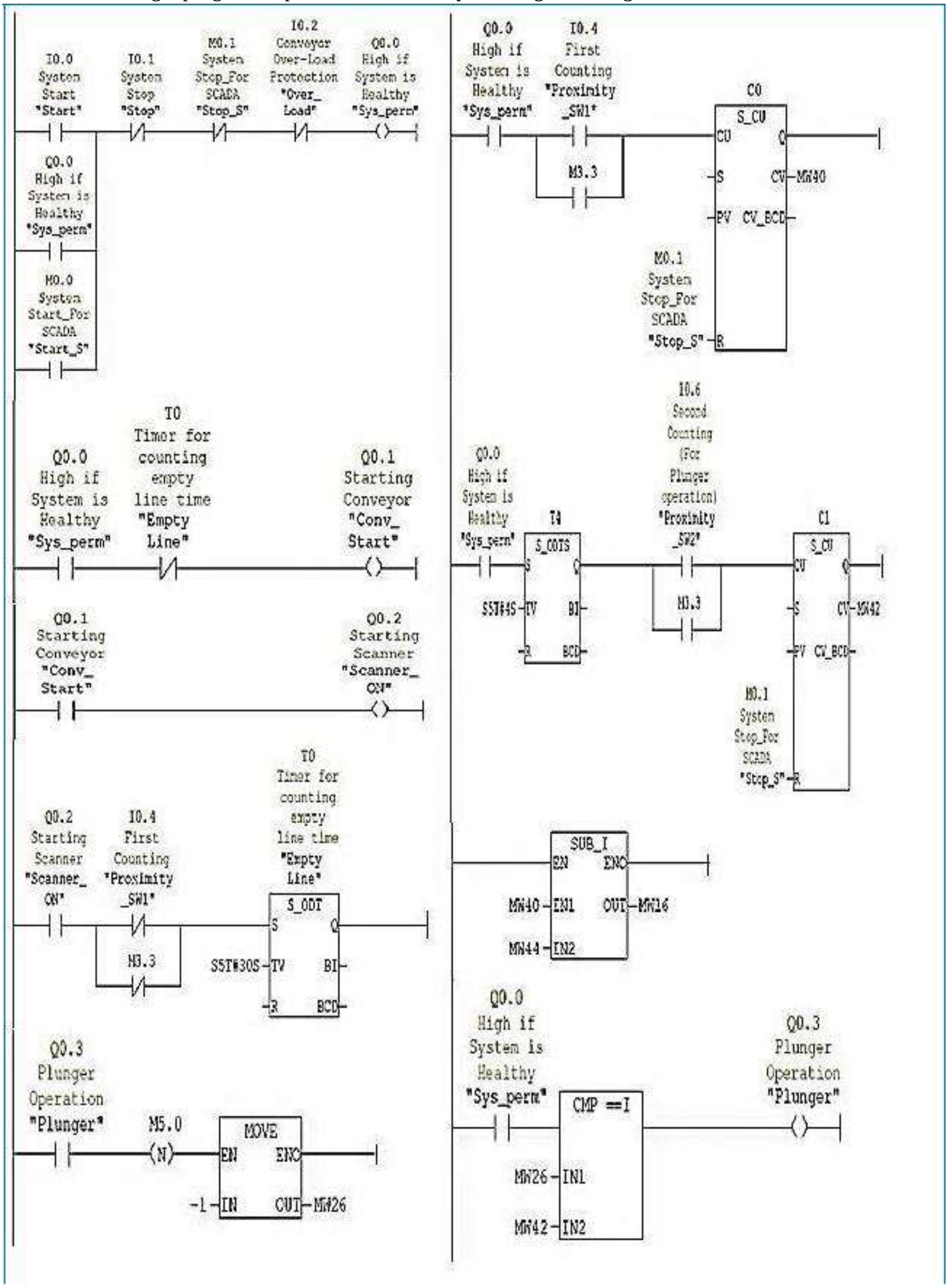


Fig.6a Ladder logic part 1

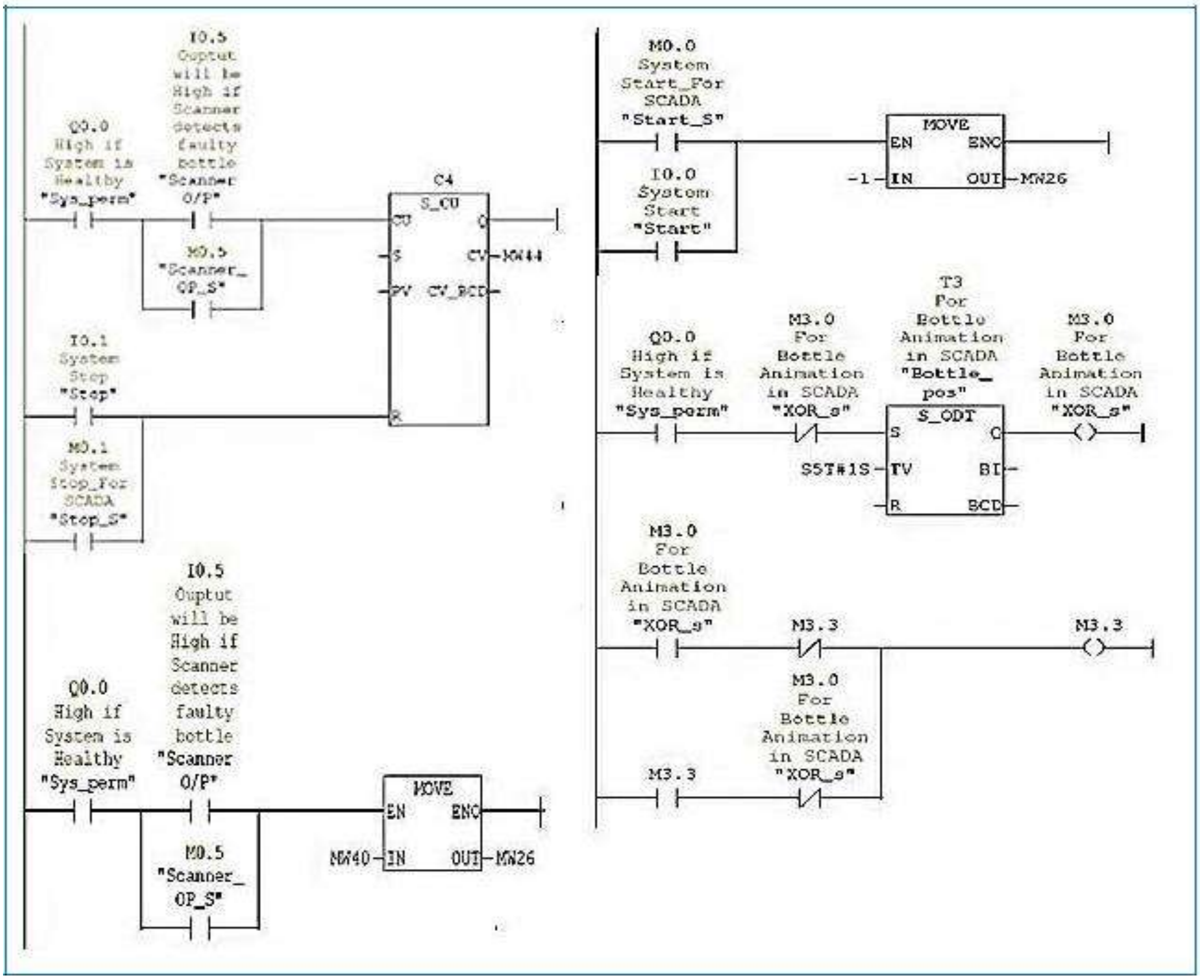


Fig.6b Ladder Logic part 2

REFERENCES

[1] "Programmable Logic Controllers Basic Level", Textbook TP 301, *Festo Didactic GmbH & Co*., D-73770 Denkendorf.

[2] John W. webb, Ronald A. Reis, "Programmable Logic Controller , Principles & Applications," 5th Edition, PHI, 2003.

[3] Bolton, W. Programmable Logic Controllers. 4th ed., 2006, *North Carolina: Elsevier Newnes*.

[4] J. C. Chan, H. L. T. Dy, A. H. Fernando, R. L. Tiu, P. J. G. Viernes, "Design, Fabrication, and Testing of a PLC Training Module Using Siemens S7-300 PLC," *DLSU Engineering e-Journal*,Vol. 1 No. 1, March 2007, pp.43-54.

[5] S. Ghosh, S. Bairagya, C. Roy, S. Dey, S. Goswami, A. Ghosh, "Bottle Filling System using PLC," *ET &TE-2008*.

[6] A. Saha, S. Kundu, A. Ghosh, "Mini cement plant using PLC," Conference proceedings, *MDCCT-2012*, 6-7 february, 2012, Burdwan University

[7] Hao, L. and Ruilin, P. (2005). Application of Centralized PLC Automation Control in Painting Line of Steel Plant. Proceeding of the *4th Asian Conference on Industrial Automation and Robotics*, Landmark Hotel, Thailand

[8] "Working with step 7 V5.2, Getting Started", Siemens AG, *edition- Dec. 2012.*

[9] "Ladder Logic (LAD) for S7-300 and S7-400 Programming, Reference Manual," Siemens AG, *edition-Dec. 2012.*

[10] I.A Bryan, E.A Bryan, Programmable Controllers Theory and Implementation, Second Edition,1997.

[11] Axel Daniels & Wayne Salter, What is SCADA, *CERN-CNL-2000-003* Vol. XXXV, issue no. 3.

[12] Tony Stafford, Taking Back – A SCADA case study, *Camrosa Water District, California*. July 2002, J.P.