AUTOMATIC BOTTLE FILLING, CAPPING & EMBOSSING USING PLC

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ABSTRACT

The aim of this paper is to evaluate the advantages of Low Cost Industrial Automation such as repeatability, tighter quality control, waste reduction and Integration with business system, increased productivity and Reduction of labor in the small scale sector. The application of Low Cost Automation (LCA), particularly in small scale industries with simple usage of devices like pneumatic, hydraulic actuators with electrical control to the existing conventional methods will make the automation at low cost to yield higher productivity. This paper was taken up with a view to improve the present system of bottle filling, capping & embossing process with low cost. LCA may step by step increase our Technology rather than depending on foreign technology and productivity even in moderate and small factories and Industries.

Keywords: Ladder Network, LCA, PCA, Payback Period, PLC, Step-7

I. INTRODUCTION

In the recent past, Automation techniques have become one of the effective strategies in the modern manufacturing process. Most of the manual operations involved in the production are being automated to get multifarious benefits. It has therefore become imperative for the firms to get themselves equipped with automation systems to meet the growing demand of goods. With the advent of globalization and liberalization, it is necessary that industries explore methods of enhancing automation and thereby increase the productivity to acquire greater competitiveness in the market [1].

The existing manual systems are to be automated to get preciseness and accuracy in their operations. The preciseness and accuracy of the automation system are achieved through its controller. A better controller always enhances the quality in its operations .Thus there is an everlasting demand to have a better controller in the existing automation systems.

"**Automatic Bottle filling plan**" consist of two major sections filling, capping & embossing each one of them deals with one of the two aspects of overall project.

Section one mainly deals with the total filling process. The Bottle comes from the conveyor to the place where it is going to be filled. The second section consists of the capping process; the cap will be done by the mechanical hand after completion of the capping embossing will be done.

This paper discusses the concepts of Low cost automation for effective implementation in small scale industries and it also aim at the improvement of the present method of manual process, by implementing Pneumatics along with Electronics to attain automation of the required mechanism.

II. DESIGN OBJECTIVE

The main objective of this paper is to show the reduction of manual work and increase the throughput. Depending upon the rules and regulations lay down by the organization of the process has been adopted using PLCs, which can be altered according to the requirements at any time.

In order to design a solution for a problem related to automation, it is imperative for an Engineer to begin it by defining the Control task, that is, to determine what it needs to be done. This information provides the foundation for the control program. To minimize errors, the control task should be defined by those who are familiar with the operation of the machine or the process. Proper definition of the task is directly related to the success of the control program [1].

A. PRESENT CONVENTIONAL METHOD

The conventional method of **Bottle filling, capping & embossing** presently being used by small scale sectors are time consuming and requires a lot of man power. The bottle to be filled is brought manually and it must be ensured that the accurate quantity of liquid must be filled. The so filled bottles are moved to the capping section & then to the embossing section.

Since the complete process is done manually it is liable to the production of unhygienic products.

B. PROPOSED METHOD

The above said process is done using low-cost automation using pneumatics through PLC.

III. SEQUENCE OF OPERATION

The flow chart in figure 1 describes the sequence of operations carried out in proposed process.

Initially the liquid which is to be filled is stored in the container. When the power is switched ON, conveyer belt starts to move. Bottles (B) are placed on the conveyer belt. As soon as the bottle B approaches the position at sensor-1 it will be activated. The clamping cylinder-A gets activated and holds the bottle activating the nozzle (i.e. cylinder-B will get activated). Then the nozzle B1, and the sensor-2 is activated opening the valve and liquid will be filled in the bottle. When specified liquid level reaches in the bottle the sensor-3 will get activated and the valve is closed, moving the nozzle away from the bottle and the clamper releases the bottle.

The bottle will move to the capping and embossing section. When the bottle reaches the clamper-C, the cap is placed on the bottle (i.e. cylinder-D gets activated). As soon as the cap is fixed sensor-5 is activated and bottle is embossed (i.e. cylinder-E gets activated) releasing the bottle and the clamping cylinder. This process continues.

IV. HARDWARE & SOFTWARE

After deciding the efficient sequence of operations for suggested method, the appropriate actuators and sensors are chosen. All the sensors, actuators and other apparatus required for the connections have been taken for the simulation of input/output modules of PLC. By giving the power supply to the PLC, the program is transferred from computer to PLC after final verification by using **step-7 software**.

A. HARDWARE

The hardware used in the process are broadly classified into following categories: DC Motors, Pneumatic Cylinders/Actuators, Sensors, Relays, PLC Trainer.

B. PLC INPUT & OUTPUT SPECIFICATIONS

Inputs, outputs and Flags used in PLC for the proposed design are listed in table 1.

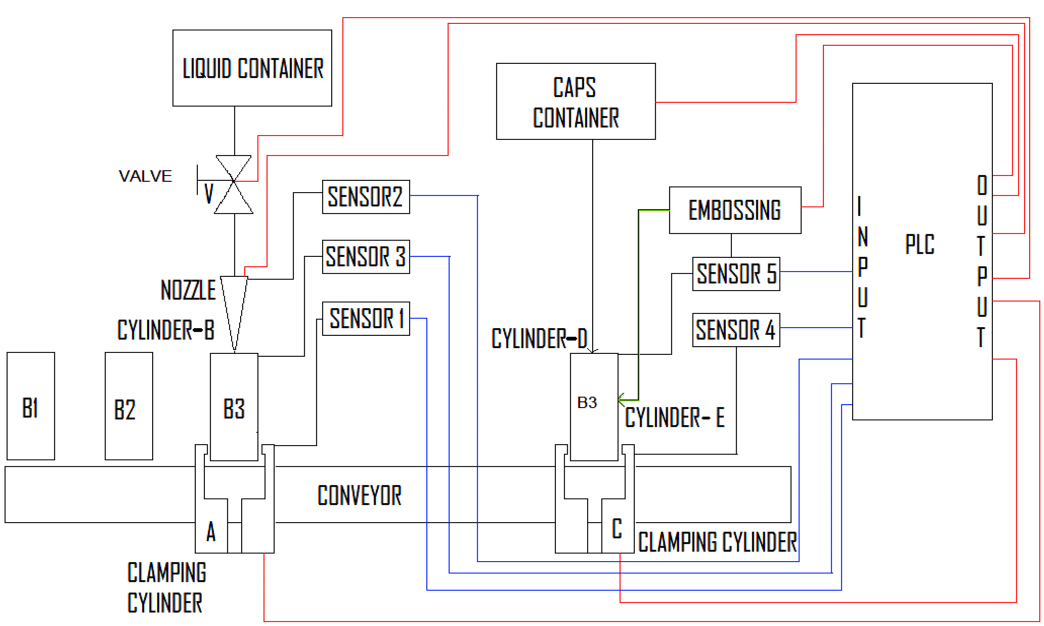

Fig. 1. Sequence of Operation

Table 1. Inputs & outputs

START BUTTON(S/B)	I 0.0
TA+	I 0.1
TA–	I 0.2
TB+	I 0.3
TB–	I 0.4
SENSOR 1	I 0.5
SENSOR 2	I 0.6
TC+	I 1.0
TC–	I 1.1
TD+	I 1.2
TD–	I 1.3
SENSOR 3	I 1.4
TE–	I 1.5
SENSOR 4	I 2.1
TV–	I 0.7
LOOPING BUTTON	I 2.0
SENSOR 5	I 2.2

Outputs

CLAMPING CYLINDER A FORWARDS A+	Q0.1
NOSSLE CYLINDER B FROWARDS B	Q0.2
VOLVE OPENNING AND CLOSE V+	Q0.3
NOSSLE CYLINDER B REVERSE B–	Q0.4
CLAMPING CYLINDER A REVERSE A–	Q0.5
CLAMPING CYLINEDER C FORWARDS C+	Q0.6
CAPPING CYLINDER D FORWARDS D +	Q0.7
EMBOSSING CYLINDER E FORWARD AND REVERSE E+	Q1.0
CAPPING CYLINDER D REVERSE D–	Q1.1
CLAMPING CYLINDER C REVERSE	Q2.0

C. SOFTWARE

In order to program the Siemens PLC-control series S7-300 and S7-400 efficiently and comfortably the software ***S7(Step 7) for Windows*** can be used. The complete S7 instruction set is implemented in the presentations Statement List (STL), Function Block Diagram (SFC) and Ladder Diagram (LAD) [2], [3]. Of course all online-functions are implemented.

V. SIMULATION MODEL & EXPERMENTAL RESULTS

The experimental results are shown below using ladder diagrams.

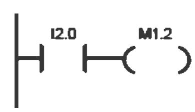

Fig. 2. LADDER NETWORK

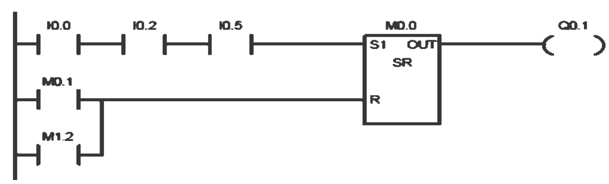

Fig. 3. LADDER NETWORK

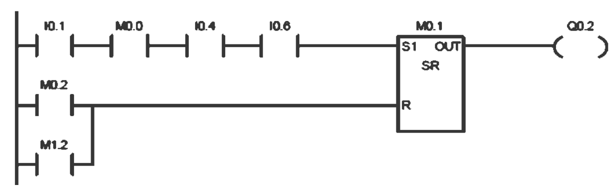

Fig. 4. LADDER NETWORK

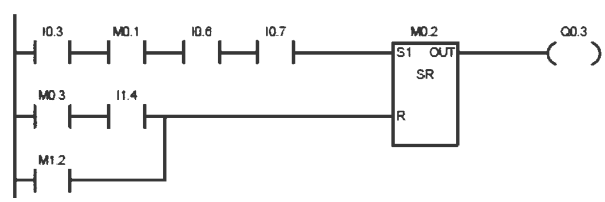

Fig. 5. LADDER NETWORK

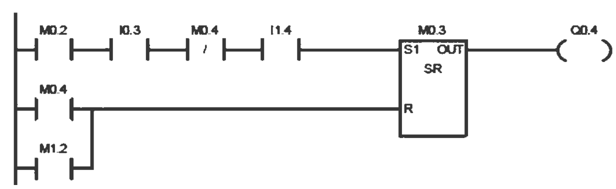

Fig. 6. LADDER NETWORK

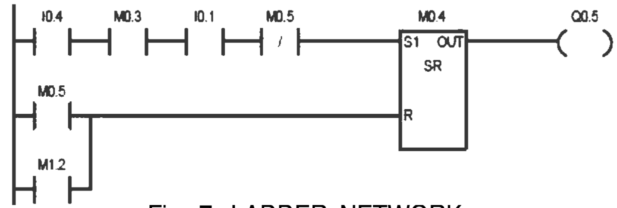

Fig. 7. LADDER NETWORK

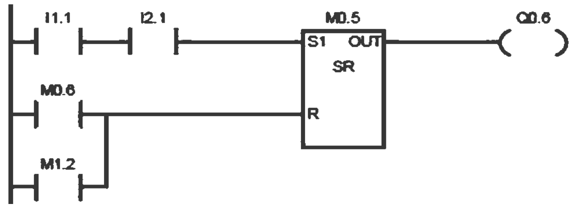

Fig. 8. LADDER NETWORK

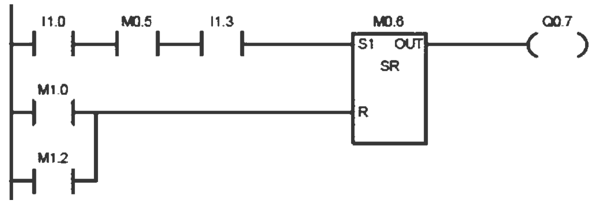

Fig. 9. LADDER NETWORK

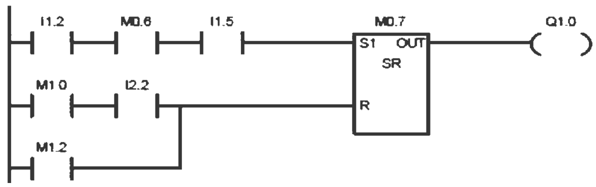

Fig. 10. LADDER NETWORK

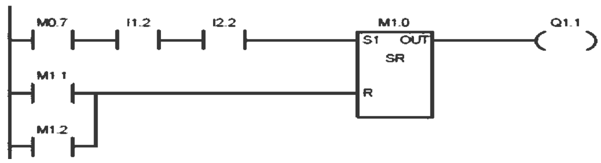

Fig. 11. LADDER NETWORK

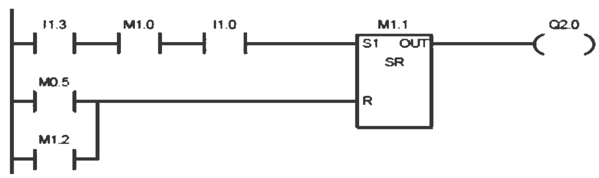

Fig. 12. LADDER NETWORK

VI. COST ANALYSIS

The costs of various elements used in our project were taken into consideration before arriving at an estimated cost of the unit [4]. Estimated Cost is Rs.69,250.00/-. Table 2 gives the breakup of individual of the cost.

Table 2 Cost analysis

Component Name	Quantity	Price per Piece (in Rupees)	Total Price (in Rupees)
Double acting cylinder	4	1900	7600
4/2 Double solenoid control valve	4	1800	7200
Sensors	5	450	2250
Programmable Logic Controller	1	12000	12000
Air compressor	1	18000	18000
Air filter regulator	1	1400	1400
Connecting pipes and wires	Misc	2000	2000
Fabrication	Misc	5000	5000
Driver frame & platform	2	700	1400
Relay circuit	2	800	1600
Single acting cylinder	2	1500	3000
3/2 Solenoid control valve	2	500	1000
Proximity sensor	12	450	5400
Driver motor	2	3000	6000
Total			73,850/-

Table 3 Estimated recovery period

Total Investment (Without Taxes)	Rs. 73,850.00
Number of bottles filled per day manually	300 (aprox...)
Number of bottles filled per day automatically	1000 (aprox...)
Increase in number of pieces per day	700
Profit per piece	Rs. 1.00
Increased profit per Month (Assuming 25 working days)	700 × 25 = Rs. 17,500.00
Amount saved on Labor per Month	Rs.8000.00
Total profit per Month	Rs. 25,500.00

Table 4 Expenditure

Electrical charges	Rs. 4000.00
Maintenance	Rs.2000.00
Total Expenditure per Month	Rs. 6000.00
Net Profit per Month	25500-6000 = Rs. 19,500.00
Depreciation factor (D.F)	0.15

A. Estimated recovery period

Table 3 indicates the estimated recovery period for the investment on the product design.

B. Increased expenditure

Table 4 indicates the estimated increase in the expenditure for up-gradation from manual to automatic Process.

Payback Period = Total Investment / (Net Profit X (1-D.F)) = 4.4 Months = 4 months 12 days

VII. CONCLUSION

The experimental result shown and tested as per the basic requirements of any beverage or food process industry is a low cost automation process technique. A sequence for the given operation has been performed by using pneumatic drives as per the developed circuit. PLC program has been tested thoroughly for the sequence of operation and it is fed to the system. Automation of industries has many advantages, but it must never be regarded as an end itself. The main consideration is recovery of invested capital. Hence a good understanding of the concept of automation techniques is very essential. The application of LCA, particularly in small scale industries with the usage of simple devices like pneumatic and hydraulic actuators with electrical control to the existing conventional methods will make the automation at low cost to yield higher productivity for stability and growth of economy of the nation.

VIII. ACKNOWLEDGEMENT

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