Automatic Packaging Machine & Material Handling Using Programmable Logic Controller (PLC)

Mrs. Ranjita Rout[1], Vivekanand[2], Deokaran yadav[3]
[1, 2, 3] Department of EIE
[1, 2, 3] Gunupur, Orissa, India

Abstract- *The main aim of this project is to perform an automated packaging and material handling using a programmable logic controller. The idea is to automate the process of placing the materials inside a box, detecting good and bad items in terms of weight, and sealing using a packaging tape. The purpose of the study is to replace the manual system being used in the industry, compare the time, and manpower requirement for both the existing system with the proposed automated system. The VMware Workstation programmable logic controller is used to mechanize the system. Sensors such as proximity and load sensor are used to provide the input to the system. The motors and pneumatics serve as the output. We used a ladder diagram as a software that will control the whole system between its input and output components. The experimentation is done through different trials and the rate of travel time is measured thru averaging. It is found out that the system decreases time and manpower requirements for every station as compared with traditional manual system. A reduction of 55% to 70% was observed in terms of time allotment for filling, weighing, and sealing stations. About 90% of full automation without human is specified also in the system. The paper ends with the recommendation of integrating the experimental prototype with the human machine interface or HMI, and feedback mechanisms for the rejected items using artificial intelligence techniques and methods.*

Keywords- Packaging, Programmable Logic Controller, Material Handling, Load, Sensor

I. INTRODUCTION

Nowadays, automation in the industry becomes the global trend in manufacturing and with the success of the Japanese and European industries in terms of production; more and more companies are switching to automation. Automation is certainly the watchword as today's manufacturers face razor-thin profit margins. Companies must automate in order to deliver what today's customer is demanding when he wants it and at the price he wants to pay. The boom in manufacturing is led by the new technologies available today as well as low wages, customization, mass production, flexibility, & most importantly, the information. The main & full purpose of this paper is to design an automated packaging and material handling system. Another purpose is also to help companies planning to switch from traditional product packaging into a more productive and automated packaging system in the assembly line using programmable logic controller. In particular, the following objectives are formulated: (a) to identify the technology that will automate the packaging and material handling, (b) to design a ladder diagram that will automate the system, and (c) to create an experimental prototype that will simulate the automated system. This research is useful as the controls of the machine for a specific job, or a task are processed by the computers. The computer can be programmed depending on the operator (human) decision to perform automatic or not. It can also be beneficial for the future related researches in conducting advance research on industrial automation using programmable logic controllers or the artificial intelligence methods. The company shall benefit with the safe operating system, more efficient factory, faster response time, and few workers also on the actual production line. This paper is focused on automation of packaging and material handling system. Electro-pneumatic and motor control is used for the entire process. The control for the hardware is to be process by the programmable logic controller via the computer. It includes a ladder diagram for programmable logic controller and an actual prototype for the experimentation. The whole system executes the following processes: automation using the programmable logic controller or called as PLC, filling, and packaging.

II. METHODOLOGY

Fig 1. explains the process of material handling and packaging system, which shall be automated using the programmable logic controller. This is a step by step process which corresponds to the input and output peripherals that are needed in programming the ladder diagram. Included in the automation is the placement of box, filling of materials, transferring, checking, and sealing of the final product.

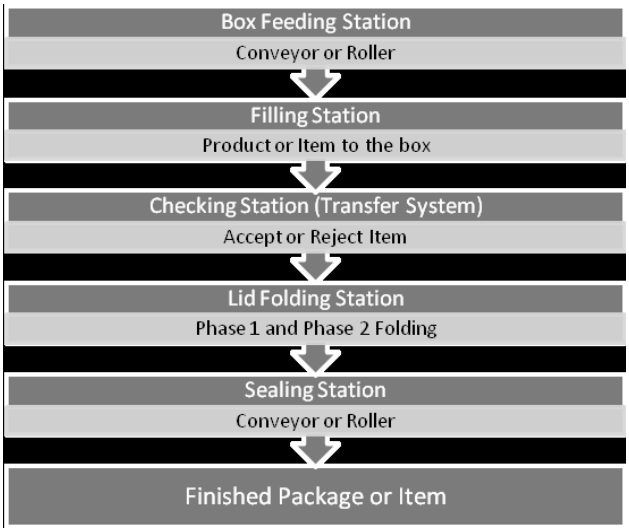

Figure 1. Flow diagram structure of the automated system.

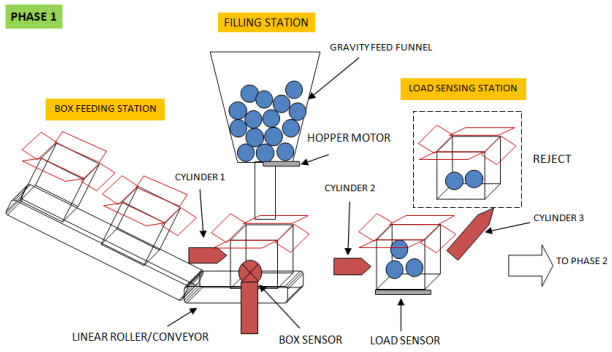

Figure 2. Design project flow for box feeding, filling, and checking stations.

From the manual operation, a programmable logic controller is used to convert the system into an automated process. Input components such as sensors and switches are used to indicate the condition corresponding to the hardware flow diagram of the PLC project design. The programmable logic controller interfaced the system and provided the ladder diagram for the design. Output components such as motors and pneumatic cylinders are used to indicate the desired objective of the system.

Fig. 3. shows the first phase of the system. As shown, it consists of three stations namely box feeding, the filling, and checking stations.

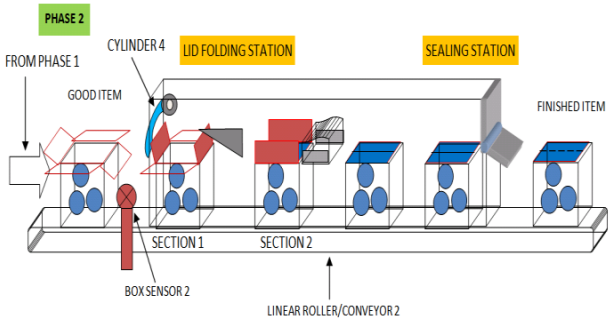

Figure 3. Design project flow for lid folding and sealing stations.

Fig. 3. shows the second phase of the design project. It is composed of two stations namely lid folding and sealing station. A proximity sensor is used to detect the length of the tape that will seal the boxes. A tape cutter made of stainless steel is also used in this station.

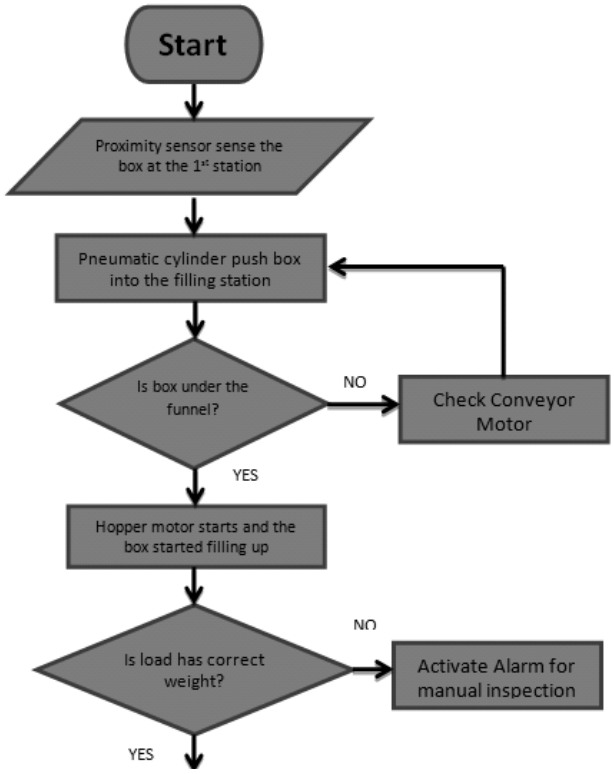

Figure 4.

Below is the discussion of whole operation:

1. When the start button is pressed, box shall be push under the hopper by cylinder 1.
2. Box sensor 1 is provided as to sense the presence of box under the hopper. When a box is detected, hopper motor runs, thus; dropping marbles to the box (box is stationary).

3. A counting sensor is provided as to monitor the correct number of marbles being drop to the box.
4. After the desired numbers of balls is dropped, a load sensor activates as to determine if the loaded box overload, under load, or exact load. Good items are pushed to the next station, and phase by cylinder 2, while the under load box and the over load is pushed away from the line by cylinder 3, which is to be checked manually.
5. Having a good item box or load triggers the conveyor 2, to conduct or start its operation. The approaching box is monitored by the box sensor 2.
6. When a box is sensed by box sensor 2, it shall activate cylinder 4, and folding the lid of the first section of the side of the box.
7. The second lid and section is folded, as the box moved on the specialized lid folding the obstacle, or as the box makes progress on the conveyor.
8. Having a partially closed box, and a continuous running conveyor, it passes to the sealing station which finishes the packaging process. At this station, a packaging tape, and a cutter is positioned on a flip type window as to allow the incoming box to pass beneath it.
9. The tape cutter sensor shall be triggered, if the flip type window is moved from upward to downward position. This shall activate and turned the tape cutter to move downward via cylinder 5, and cut the tape.
10. Having finished the required task, the system shall point out if another process is to be commenced as invoke by the operator.
11. The finished item shall be collected at the end of the line by the on-duty personnel.

III. RESULTS AND DISCUSSIONS

PLC programs are typically written in a special application on a personal computer, and then downloaded by a direct-connection cable or over a network to the PLC. The program is stored in the PLC either in battery-backed-up RAM or some other non-volatile flash memory.

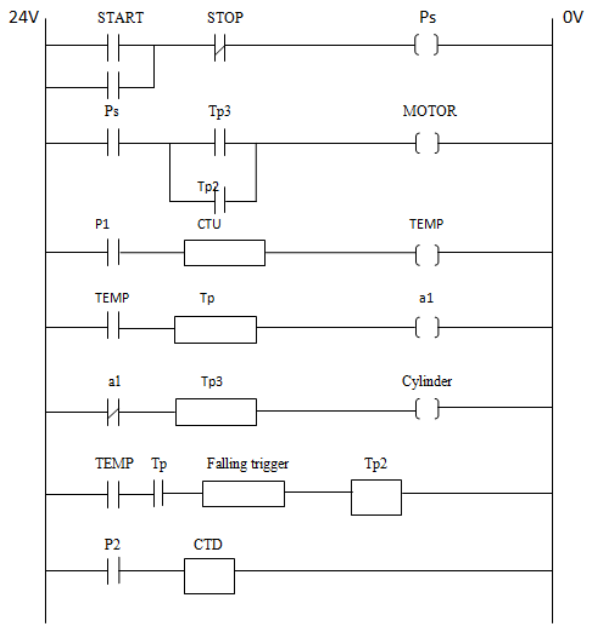

Figure 5.

IV. ADVANTAGES OF PLC

- PLC is armored for severe conditions like higher temperature, dust, moisture, heat, cold, etc.
- Programming a PLC is easier than wiring the relay control panel.
- It can be reprogrammed.
- It takes less floor space then relay control panels.
- A PLC has facility for extending input/output arrangements.
- Maintenance of the PLC is easier, and reliability is greater.

V. FUTURE SCOPE

It can be beneficial for the future related researches in conducting advance research on industrial automation using programmable logic controllers or the artificial intelligence methods

V. CONCLUSION

The automation can be on the same machine level on a production line, or in a whole department where the workers tasks is monitoring, inspection, and maintenance. This paper presented the automation of material handling and packaging in a production line of which this process is done manually in different companies. PLC today are advancing in terms of applicability and capability. The system works during normal operation and greatly improved the automation processes with the use of the PLC ladder diagram. The wiring and installation procedure are also improved because the PLC input and output

devices are assigned with specific addresses, and thus; further simplifies troubleshooting. Cost reduction mainly on the man-power or personnel cost is achieved in this paper. Hence, only one or two personnel are needed for the operation and maintenance with the automated system. These controllers can also be used to mechanize the packaging and material handling, giving a hundred percent fully automated system without any human intervention. Also, another recommendation is that some automation process may also be implemented using the FPGA, a DSP chip, a microcontroller, or an ASIC.

A wide variety of processor chips are now available in the market, which can be used as an alternative to the PLC for automation process.

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