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Inspection, Packaging and Packing Machine Development Based PLC

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***Abstract*—this paper presents an automated controlling system based programmable logic controller (PLC) that consists of two different transporting conveyors; vertical and horizontal. The samples were placed on the horizontal conveyor for transportation from loaded point to packaging point. After the DC motor that drives the horizontal conveyor is energized, the samples move along the conveyor before they reach an inspection sensor that separates the two types of products and drop the chosen sample inside a filling box. When the box is filled with the right amount of samples, the vertical conveyor picks and places these boxes inside vertical shelves. This process is controlled using a Programmable Logic Controllers (PLC)Mitsubishi FX2n-32MT. The experimental results of the prototype were able to fully automate the system and improve the time of inspection and packing. The results show that the machine was done to inspect, package and pack24 boxes (96 samples) in one hour. In addition, the results obtained show that the system able to decreases product time, and increase product rate as compared with traditional manual system.**

Keywords- PLC; packaging; inspection; conveyor belt; inductive sensor;photo sensor;Mitsubishi FX2n-32MT.

I. INTRODUCTION

Automation is to use control systems and information technologies to reduce the need for human work in the production of goods and services. In the scope of in deserialization, automation is a step beyond mechanization. Whereas mechanization provided human operators with machinery to assist them with the muscular requirements of work, automation greatly decreases the need for human sensory and mental requirements as will. Automation plays an increasingly important role in the world economy and in daily experience [1].

PLC plays an important role in the world of automation industry. PLC reduces complexity, increases safety, cheap and PLC based automation system not only guarantees reduced production time, but also a higher productivity both in terms of quantity and quality. PLC is being used in many sectors. A few examples are manufacturing industries, travel industries, printing industries, food industries, plastic industries, leisure (Roller coaster ride and effects control system) etc [2].

In this paper, the main goal is to design and implementation the machine of an automated system that consists of two different transporting conveyors as shown in ***Fig. 1***; vertical and horizontal. The samples are placed on the horizontal conveyor for transportation from loading node to packaging node. A DC motor used to drive the horizontal conveyor in order to move samples along the conveyor, inspection stage used during the transportation on the horizontal conveyor before they reach the final node, then the samples will counted by photo sensor before the conveyor drop them inside a filling box. When the box is filled with the right amount of samples, the vertical conveyor carry and places these boxes inside vertical shelves. This process is controlled using a Programmable Logic Controllers (PLC)Mitsubishi FX2n-32MT.

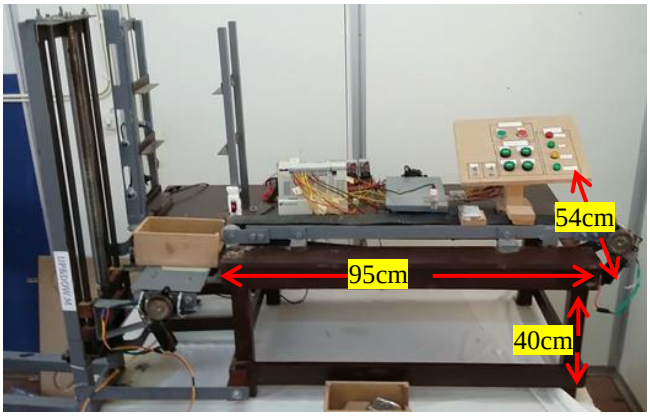

Figure 1. System Prototype.

II. LITERATURE SURVEY

Kiran A. Gupta, Neha Armani, T. C. Manjunath and H. V. Manjunath designed and fabricate an automatic mixing system with conveyor belt based on PLC, to achieve high throughput and improve quality and consistency [3].

Shweta Honrao1 and others, designed and implemented inspection and stored machine based on PLC with implementing a new technique [4].

Rakshak T.B., Mr. Shivashankara B. S proposed a method to Control Automated Multiple Conveyor System for Sorting Process by using PLC. The developed Model sorts Metals

and Non-metals by using PLC with Economical user friendly, Low cost, high accuracy, Reliable [5].
D. S. V. Siva Vardhan, Y. Shivraj Narayan designed and fabricated a machine for simultaneous automatic monitoring and control of two different objects i.e. bottles and trays on a single belt conveyor efficiently using Programmable Logic Controller [6].

III. HARDWARE STRUCTURE AND COMPONENTS

The Automatic inspection, packaging and packing machine system is a combination of electronic, electrical and mechanical parts. Fig. 2 shows block diagram of the system.

- The input devices are devices used to get and give information about the system state, which consists switches (toggle switch and pushbuttons) and sensors (photo and inductive sensors), in order to feed the controller (PLC) by information about the belts status and objects.
- The controller, which is the main element that operate the whole system, by using the information from the sensors to take the counting and movement decision before sending the orders to the output devices by the actuators and the relays.
- The output devices are the actuators that convert an electrical signal into mechanical movement; the principle types of actuators are relays and motors

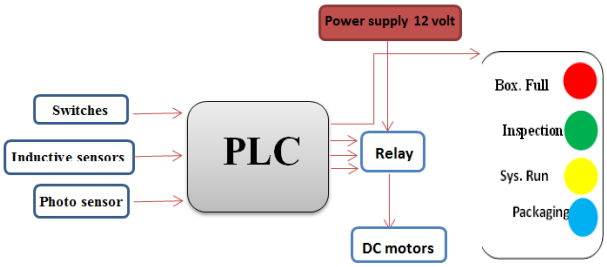

Figure 2. Block Diagram of the System..

A. *Sensors*

Sensors are devices that measure a particular characteristic of an object or system. Sensors are used in everyday objects such as touch-sensitive elevator buttons (tactile sensor) and lamps, which dim or brighten by touching the base. There are also innumerable applications for sensors, which include cars, machines, aerospace, medicine, manufacturing and robotics [7]. In this paper there are six sensors were used (5 inductive sensors and 1 photo sensor).

1) Inductive Proximity Sensors

Five sensors have been used (inductive sensor) and installed in the prototype. Sensor (A) is located above the horizontal conveyor belt to inspection coming samples, while sensor (C) is used to stop the first box at the first level. Sensor (D) is used to reserve a place for the first box in first level. Sensor (E) is used to stop the second box at the second level, while sensor (F) is used to reserve a place for the second box as shown in Fig.3and Fig.4.

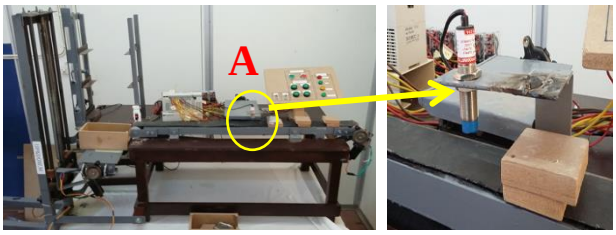

Figure 3. Inspection sensorsInstalled on horizintal conveyor.

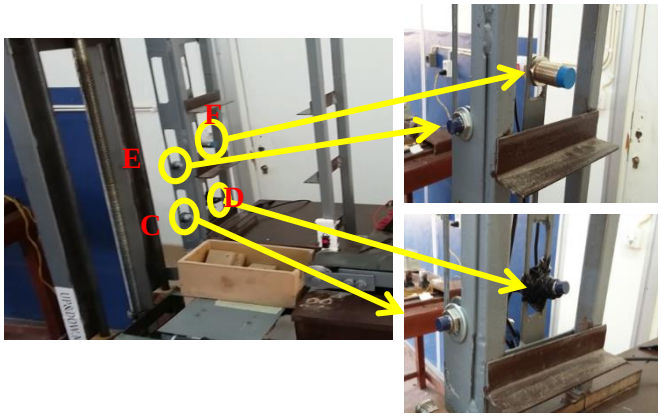

Figure 4. Inductive sensors location on vertical Conveyor.

2) Photoelectric Sensor

The photoelectric sensor (B) is installed at the end of the horizontal conveyor belt in order to count coming samples before packaging; this sensor is responsible for sample numbers filled in the box as shown in Fig.5.

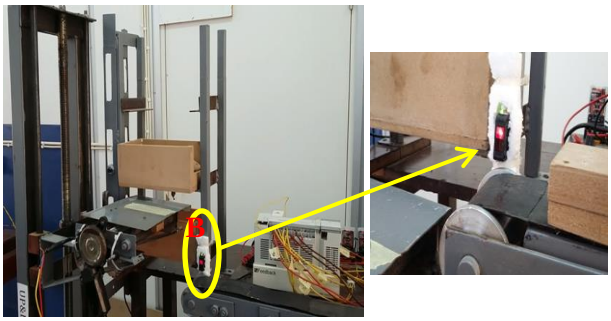

Figure 5. Photoelectric Sensor Setup on the Project.

B. *Actuators*

Actuation defines as the result of a direct physical action on the process, such as motoring and relays. Four motors were installed on the project to perform three different actions.

Motor (A) is used to move the horizontal conveyor belt, motor (B) is used to reject out unwanted samples, while motor (C) is used to raise the boxes up and down, and motor (D) is used to put boxes in empty shelves as shown in Fig.6 and Fig.7.

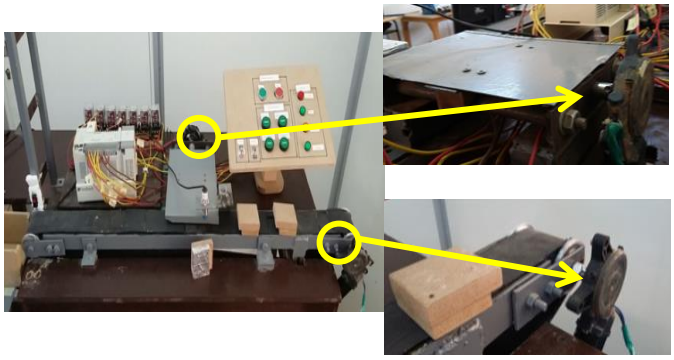

Figure 6. DC Motors for Horizintal Belt and Rejected Samples.

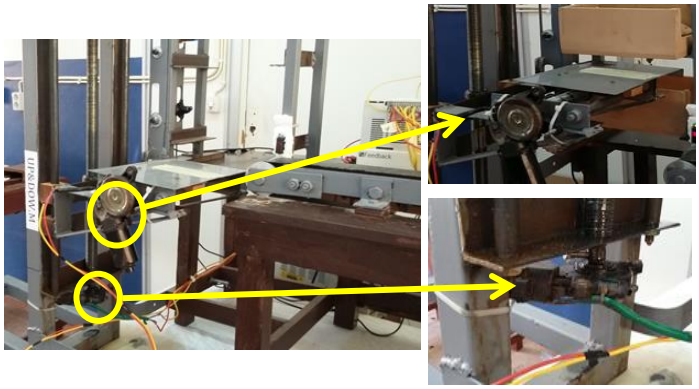

Figure 7. DC Motors for Vertical Belt and Shelves.

C. Control Board and Indicators

The system is controlled using two different methods. The first one is the automatic method which uses a Programmable Logic Controller (PLC) with some relays to control the whole system. The second method is manual control to control the system by manual operation through the use of push buttons as shown in Fig.8.

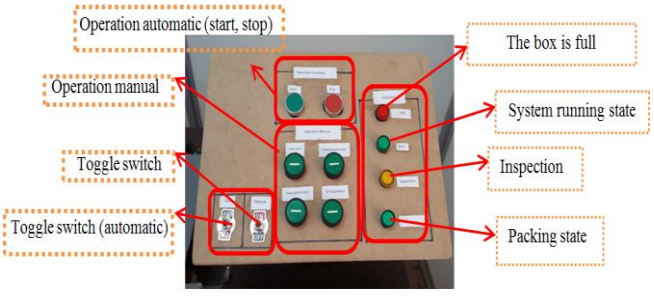

Figure 8. Control Board and Indicators Board..

•Red indicator: To indicate fully box situation.
•Green1 indicator: To indicate that the system is working.
•Yellow indicator: To indicate inspection process for samples.
•Green2 indicator: To indicate packing process.

D. System Wiring and Addressed assigned

The complete system works on 24, 12 volts dc power supply. DC motors works on 12 volts dc with speed of 28 rpm is used to run the conveyor belt. All the sensors are connected to the PLC inputs module and 24 volts dc with common node.Fig.9 and Table 1 show the wiring and addressed of all the sensors and motors.

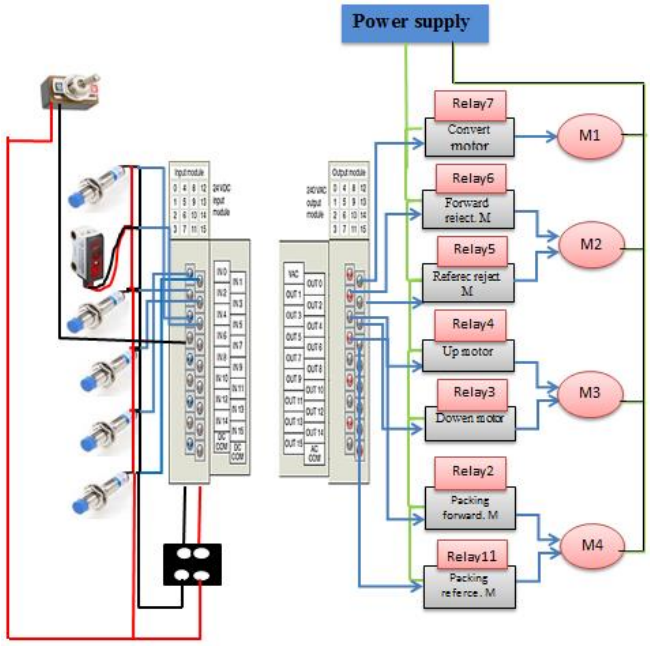

Figure 9. Wiring Diagram of the System..

Table 1: Address Assignment

Symbol		Description
Input	X10	Toggle switch main starter
	X7	Push botton switch
	X4	Inductive sensor (A)
	X5	photoelectric sensor (B)
	X2	Inductive sensor (C)
	X0	Inductive sensor (E)
	X3	Inductive sensor (D)
	X1	Inductive sensor (F)
	C0	Count for operation of motor (B)
	C1	Count of the samples
	T5	Timer packing refernce for first shelf
	T6	Timer down motor for second shelf

Symbol		Description
Out put	Y0	Motor (A) horizontal conv.
	Y1,Y2	Motor (B) samples rejection
	Y7	Green lamp
	Y3,Y4	Motor (C) up and down lift
	Y5,Y6	Motor (D)
	Y10	Red lamp
	T0	Timer refernce reject motor
	T1	Timer short down for first shelf
	T2	Timer packing referee for first shelf
	T3	Timer down motor for first shelf
	T4	Timer short down for second shelf

IV. EXPERIMENTAL RESULTS

The system is running by the user which choose type of operation (manual or Automatic), then after bush button starts, Proximity sensor (A) is used to detect the samples. If the sample is silver, then the sensor stops the conveyor belt and the rejected motor (B) running out to move out the sample (unwanted sample) from the belt as shown in Fig.10.

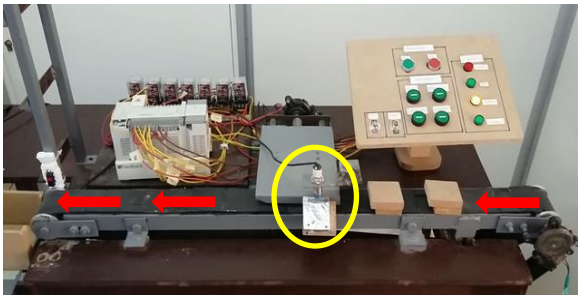

Figure 10. Unwanted Sample rejected out.

Photo sensor (B) is placed at the end of conveyor belt before packaging node, to count number of samples packaged into the box. As the number of packaged samples reached, the sensor stops the horizontal belt and running the vertical belt for sorting.

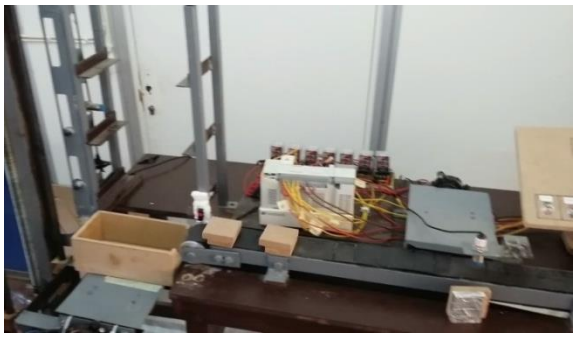

Figure 11. Unwanted Sample rejected out.

The vertical belt is moving up till get an empty shelve to get the box into till all shelves sorted by boxes as shown in Fig.12.

Figure 12. Unwanted Sample rejected out.

A. Fixed parameters of the system

These parameters are fixed for the system designed

- Horizontal and vertical belt speed 28 rpm
- Wood samples (6×6×5) cm (WLH)
- Silver samples (6×6×5) cm (WLH)
- Filling Box (12.5×21.5×9) cm
- Sensors positions
- Three shelves

V. RESULTS

A. Experiment I : Motor Speed 28rpm, 3shleves

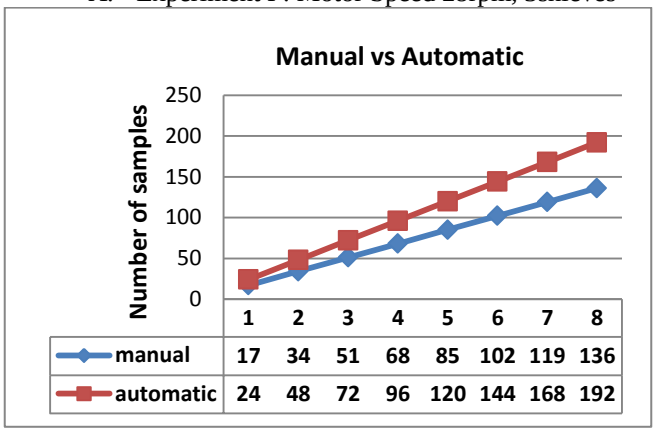

Figure 13. Comparasion between manual and automatic mode.

In Fig. 13, the vertical line indicates the number of boxes sorted in the shelves vs horizontal lines which indicate day hours. it is clearly that the automatic control is about 141 % of manual control.

B. Experiment II : Motor Speed 60rpm, 3shleves

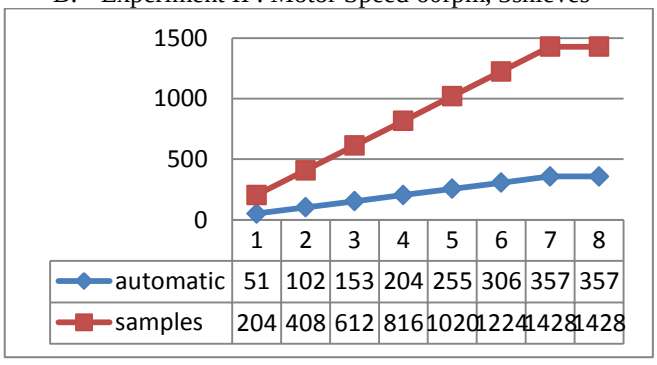

Figure 14. Automatic mode with high speed.

In experimental II, the speed of the motor for horizontal and vertical belt increased twice, here, the number of boxes that filled in one hour was increase which met the project goals for increase products and decrease time for automation systems.

Table 2: Products Rate

	28 rpm		60 rpm
Product Time	**Manual Machine**	**Automatic Machine**	**Automatic Machine**
One hour	17 box	24 box	51 box
One day (8 hours)	137 box	192 box	408
One week (6 working days)	822	1152	2448

VI. CONCLUSION

An automated inspection, packaging and packing machine prototype using PLC Mitsubishi FX 2N has been successfully design, constructed and implement based on control system concepts. Mitsubishi ladder diagram applied for the programming and operation of the presented prototype, during system testing process, the unwanted samples got examined, number of samples to be filled inside the container and the placing process of the containers inside the shelves can be controlled and performed by the system in an efficiently short time. From the experimental result, the automatic inspection, packaging and packing machine was able to packing 24 boxes per one hour, otherwise the manual packing able to packing just 17 boxes.

REFERENCES

[1] "Automation".[Online].Available: http://opensourceecology.org/wiki/Automation. [Accessed: Agus.29, 2017].

[2] Alireza Mousavi, Morad Danishvar and Alexandre Spieser, Programmable Logic Controller (PLC).

[3] Gupta, Kiran A., Neha Armani, T. C. Manjunath, and H. V. Manjunath. "Design and Implementation of PLC Based Industrial Application Prototypes." *Indian Journal of Science and Technology* 10, no. 35 (2017).

[4] Shweta Honrao1 , Radhika Pol2 , Radha Kausale3 and Asst. Prof. Vinita Yerande4. "Inspection and Storage of Product Using PLC." *International Journal of Modren Trends in Engineering and Research* 4, no. 5 (2017).

[5] Rakshak T.B., Mr. Shivashankara B. S. "PLC Controlled Automated Multiple Conveyor System for Sorting Process." *International e-Journal For Technology And Research* Volume 1, Issue 7, July 2017

[6] D. S. V. Siva Vardhan, Y. Shivraj Narayan. " Development of an Automatic Monitoring and Control System for the Objects on the Conveyor Belt" International Conference on Man and Machine Interfacing (2015).

[7] Algitta, Alhade A., S. Mustafa, F. Ibrahim, N. Abdalruof, and M. Yousef. "Automated Packaging Machine Using PLC." International Journal of Innovative Science, Engineering & Technology, Vol. 2 Issue 5, May 2015.

[8] Abueejela, Yousef M., et al. "Automated Drilling Machine Based on PLC." Int J Innov Sci Eng Technol 2.3 (2015): 520-525p.