

Automatic Box Folding Machine

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Abstract: A PLC is a programmable logic controller which is a type of industrial controller. This paper represents based on graduation project; a simulation and prototype in which a carton box enters a folding machine and automatically folded at lower part. We have used various components in this project such as 12 V power supply, 24 V power supply, main switch, start push button, stop push button, sensors and DC motor. All these components are controlled using PLC. The main aim of this project is to reduce time, manpower, more efficient folded box. In this automatic box folding machine project we use the main switch for safety. Firstly, we take main switch and start push button on when the folding machine is turn on to pass first photo sensor senses carton box after entered manually, box holder will go down to folder arm, box fold the lower part step by step which is left, right, front, and back according to time given. The first author will mainly carried out of designing, implementation and analysis of “Automatic box folding machine” .

Keywords: Programmable Logic Controller (PLC), Box Folding Machine, Automation, CX -Programming

1. Introduction

Cartons were made by hand and held together with tacks and strings in the year 1840's. The folding carton created packaging industry as it is known today, begun in the late 19th century. The carton shape, size, proportions, and material (board) of packages depend on the size and type of product they contain [1]. The processes which involves in the folding of cartons made of paperboard are printing, laminating, cutting, folding and applying some glue on it as the final touch. This manual way of folding cartons boxes consumes a huge amount of energy, time and manpower. The automatic box folding machine system explained in this paper minimizes the usage of energy, time and manpower requirement. This automatic box folding machine system utilizes control using PLC.

1.1 What is Automation?

Automation can be defined as technique, method, or system of operating or controlling a process by highly automatic means such as electronic devices in order to minimize the human intervention. The devices used in automation ranges from small sensors like IR sensors, proximity sensors, thermocouples to large robots and highly efficient computers [2]. The need of human operator and mental exercise has been greatly reduced because of automation. Automation plays an important role in increasing the world economy and also daily experiences. Everything to be performed is downloaded in the intelligent systems in the form of program and no more human monitoring and controlling is required. There are several factors which play an important role that force to employ automation. The first factor is productivity. By using such automated machines productivity increases and industry get more profit for same labor hours. The second factor is high cost of out dated relay automation system that employs hundreds of switches, fuses and contactors. A whole system has to be rewired and operators are also required in order to make a small change. Moreover, the need of operators further increases the labor cost. Hence, in order to make the system flexible, durable, productive and to eliminate human error automation is preferred.

1.2 Industrial Automation

The control of industrial machines and process with the help of computer by replacing human operators is known as Industrial Automation.”Automation is used almost in every field on earth. It is used in industry, home, offices, schools, military applications and in transportation system. The devices employed for automation include different kind of sensors, programmable logic controllers, actuating systems, intelligent control systems, modern control algorithms, robotics, electronic systems and many other devices. Therefore, a robot can be considered as a complex system that is composed of several systems and devices which is;to give a mechanical capabilities (motion and force),a sensorial capabilities (similar to human beings and/or specific others) and intellectual capabilities (for control, decision, and memory)[3].

2. Materials and Methods

2.1 Materials

The materials needed and used in this project where the PLC CP1E is used as the main Controller unit to control the mechanism of this machine. To determine the most suitable PLC to be used in the automation task need several basic considerations to be made namely, number of input/outputs, digital/analog I/O, memory capacity needed,speed and required power for the CPU and coding instructions, manufacturer's service support etc. [4] Four motor were used to control the movement mechanism of this machine. Lastly, the proximity sensor is the main sensor and limit switch as secondary sensor in these box folding machine. It is easy to install and easy to get and affordable to buy it.

- Automation based kits :
 - PLC CP1E
 - Act as brain and control the whole process in this project.
- Folding machine and parts :
 - Metal, Steel and Wood base
 - The materials that fold carton box efficiently.
- Electrical Components :
 - DC motor
- Control the movement of folding arm as well.
 - Proximity Sensor
- Detect carton box after insert manually.
 - Limit Switch

- To control object movement.
 - Timer
- Set time to complete sequels as well.
 - Relay
- Simple switches which are operated both electrically and mechanically.
 - Push button
- ON/OFF and also Emergency stop of the machine.

2.2 Methods

2.2.1 Process of Automatic Box Folding Machine

First we use the SMPS (Switch Mode Power Supply) to convert electrical power efficiently SMPS transfers power. Now this power enters into the PLC. There are multiple inputs and output in PLC which can be digital or analog. PLC works by observing input (via sensors related) , then it process and take action as needed , ie turn on or turn off the output (logic 0 or 1) [5]. To start operate the folding machine, the start push button need to be manually press once. In this process we use D.C. motor for moving box holder and folding purpose. Proximity sensor used to senses the carton box which operate in loading mode [6] and activate to move down towards folding arm. The carton box will stop moving down when limit switch detect. The folding arm will start move step by step from left, right, front, and back. The important to address is the time-frame folding issue [7]. The finally step, the carton box will return back to normal after folding process.

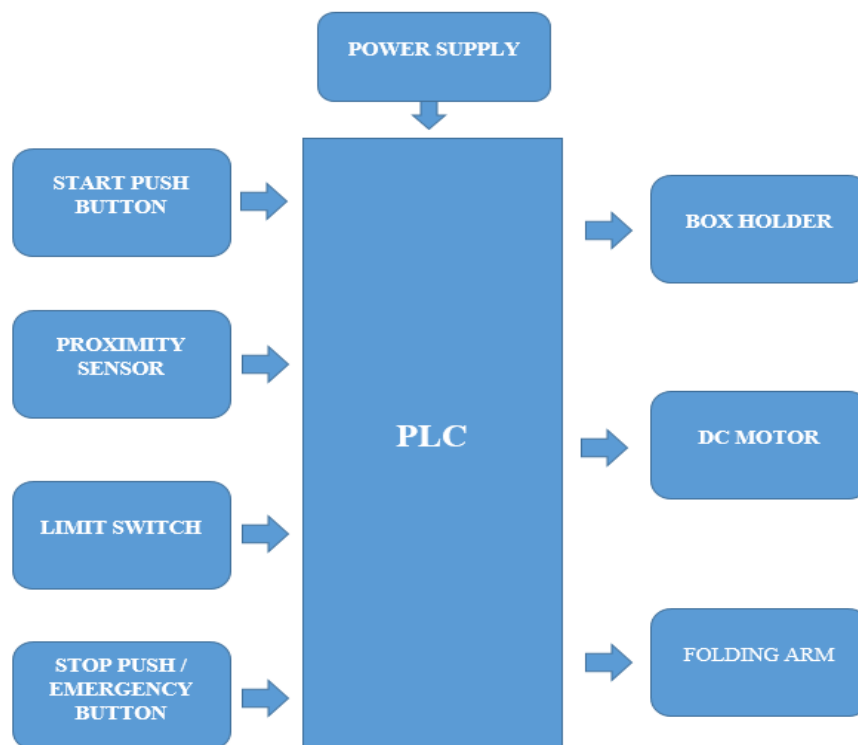


Figure 1: Block diagram of automatic box folding machine

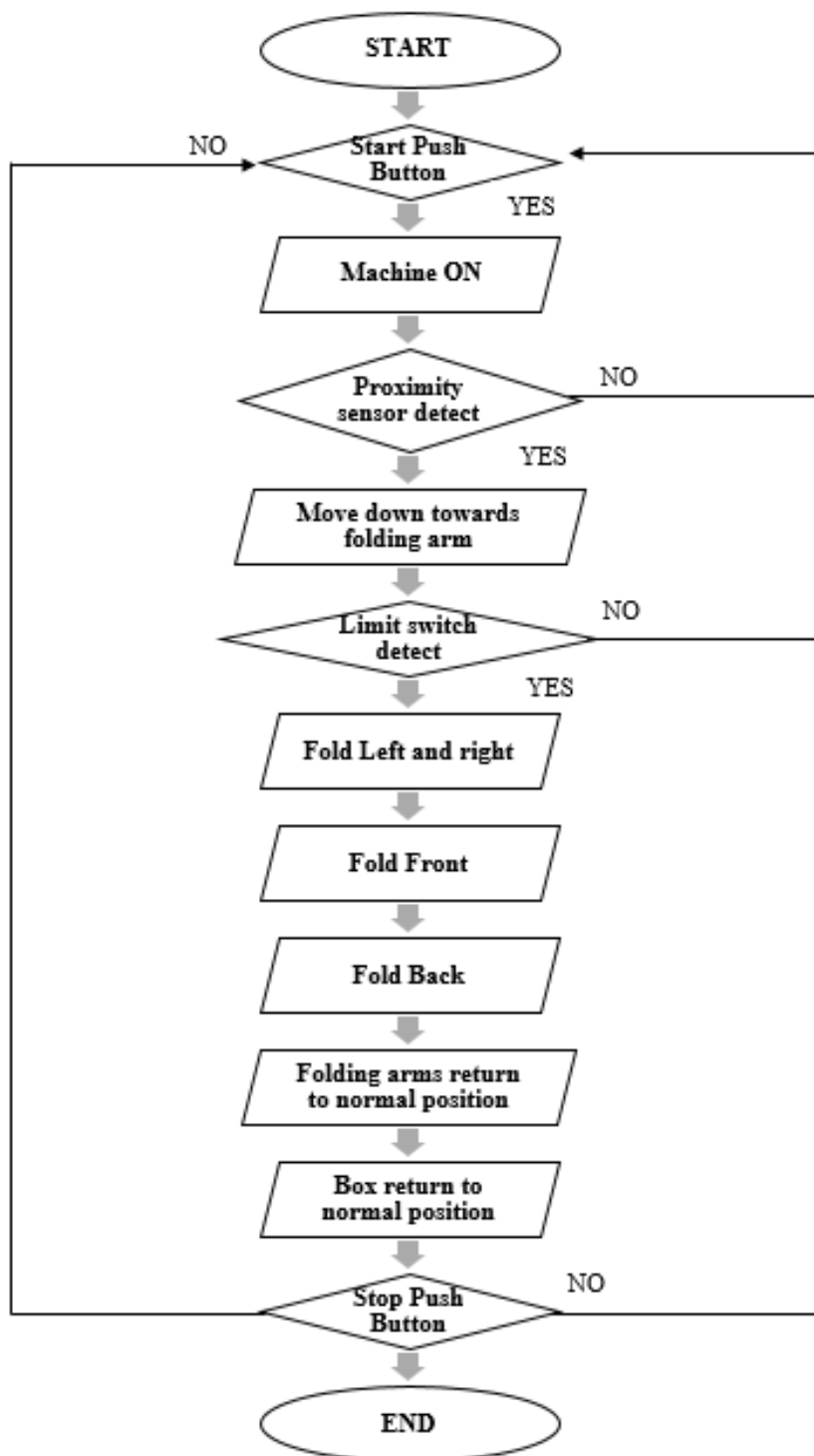


Figure 2: Flow chart of automatic box folding machine

3. Results and Discussion

Firstly, we can write ladder diagram as CX-one programming software and after make sure all process and timing are perfect, then we can compile program to CP1E OMRON PLC. The result of software simulation or testing are shown in Figure 3. Start push button on and box holder will be running when the proximity sensor detect until set time, then stop by limit switch. Folding arms is set according to sequel and time as well.

3.1 Results

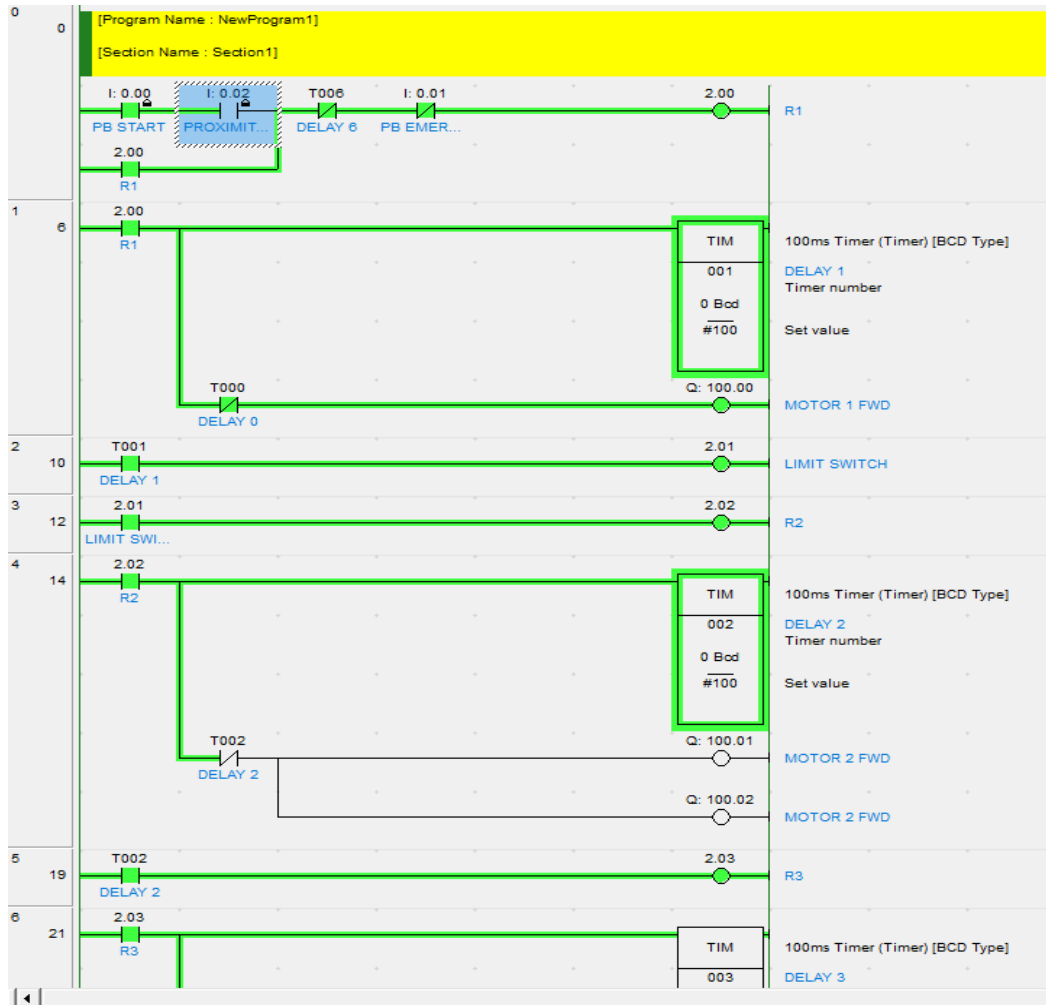


Figure 3: Simulation result using CX-Programmer

3.2 Discussions

In normal operation when the push button start (0.00) is ON, proximity sensor (0.02) will detect after the carton box insert manually. Relay 1 (2.00) and timer 1 (T001) will energize and box holder start move forward. After 1 second, box holder detect limit switch (2.01) and stop. Relay 2 (2.02) and timer 2 (T002) will energize. Motor 2 (100.01, 100.02) start rotate forward to fold box left and right side of box at same time. After 1 second, relay 3 (2.03) will energize and timer 3 (T003) will energize. Motor 3 (100.03) start rotate forward to fold front side of box. After 1 second, relay 4 (2.04) and timer 5 (T005) will energize. Motor 4 (100.4) start rotate forward to fold rear side of box. After 2 seconds, relay 5 (2.05) and timer 5 (T005) will energize. Motor 2 (100.05), motor 3 (100.06), motor 4 (100.07) rotate reverse to return back to normal position. Final step, box holder (100.08) rotate reverse to get normal position. The emergency switch (0.01) is actually interlocking instruction.

3.3 Tables

The process of overall box folding system is done as followings and the input and output components list is shown in Table 1. This process can be express in flowchart as shown in Figure 2.

Table 1: Input and output list

No	Input		Output	
1.	I:0.00	Push button start	Q:100.00	Conveyor motor
2.	I:0.01	Push button stop	Q:100.01	Motor 2 (Left)
3.	I:0.02	Proximity sensor	Q:100.02	Motor 2 (Right)
4.	I:2.01	Limit switch	Q:100.03	Motor 3 (Front)
5.			Q:100.04	Motor 4 (Rear)

3.4 Figures

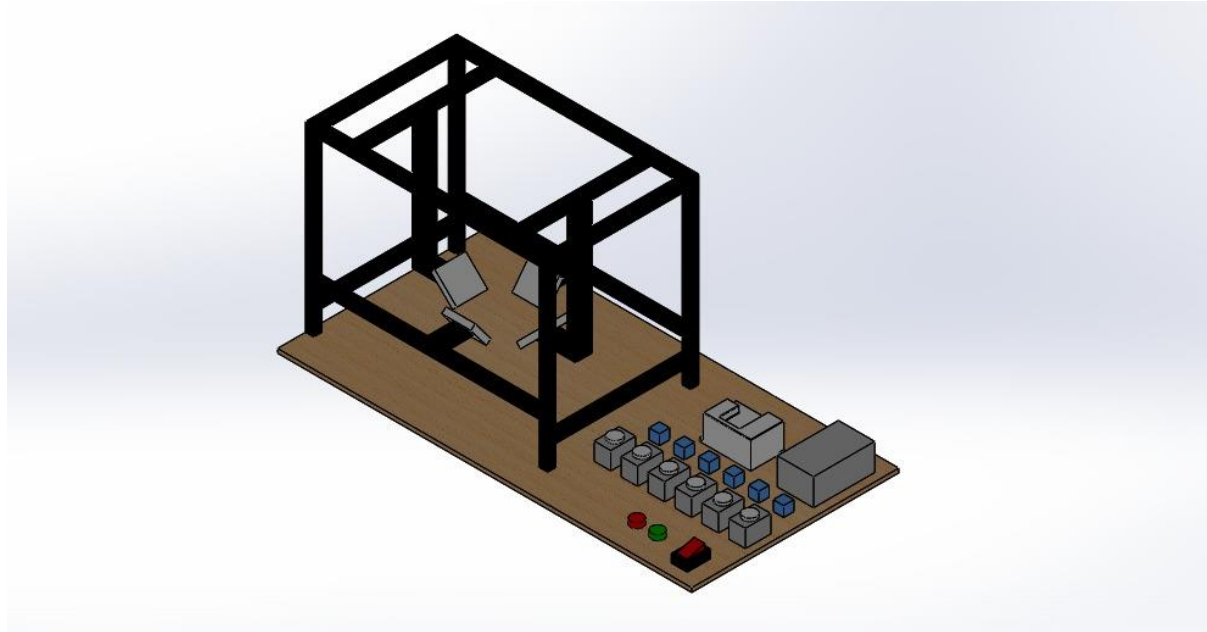


Figure 4: Simulation prototype of Automatic box folding machine

This figure shows the exact project model design using solid works software. From the prototype design we used metal bracket as main body of the machine and also use for folding arm. At the folding part we used plastic plate to fold carton box to avoid damage on surface. Besides that, from wiring part we used power supply 24 V, programmable logic controller (CP1E) as main function of the machine. Furthermore, we also used 5 relays and 6 timers as well. Lastly, we have used push button start to turn on, push button stop to turn off or emergency stop and main switch to turn on the machine.

4. Conclusion

The project start with the objectives mentioned in the problem statement and to achieved all of them. The interfacing of DC Series Motors with Programmable Logic Controller have been implemented well and after doing work on this project and having hand experience of PLC, we have become a good familiar with the use of PLC. It is concluded that PLC is a simple and useful machine in the industry because of its easy languages. In industries many types of processes are being controlled through PLCs, and DC motors. Packaging processes, bottle filling, packets filling etc. are some examples which are controlled by PLCs.

Acknowledgement

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