

Automatic Packing Machine & Material Handling using Programmable Logic Controller (PLC)

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Abstract

This project presents the idea of using programmable logic controller (PLC) in industrial automation. The use of PLC is a major factor. A digital computer used for automation of typical industrial electro-mechanical processes such as control of Machinery on factory assembly lines, amusement rides or light fixtures. The PLC is the main controlling unit & dc motor controls the conveyor belt. To accomplish this system, Dc motor, load cell, Photo-sensors are used.

Keywords: packaging, programmable logic controller, material handling, load cell, sensor and relay card

I. INTRODUCTION

The aim of this project is to modify & restore a nonworking mechanical system with a new system using PLC. Automatic packing machine is controlled by a PLC i.e. programmable logic controller. PLC is a digital computer used for automation of typical industrial electro-mechanical processes such as control of machinery on factory assembly lines, amusement rides or light fixtures.

In this project we have replaced bottle sensing system which is in previous case is purely a PLC support for e.g. “PHOTO-SENSORS”, but due to its limitations we have replaced the system by embedded system which in turn is less expensive than photo-sensors and is highly reliable & flexible for modifying & expansion. Here a load cell which is usually a high cost weight measurement instrument is replaced by a less expensive weight measurement device using a variable resistor.

II. BLOCK DIAGRAM

A liquid medicine filled bottles are picked & placed three at a time from conveyor belt into boxes. Its weight is measured and cross checked for exact approximation of filled liquid medicine to predicted value. If the measured quantity is accurate the box is forwarded for packing i.e. sealing and then loaded into a shipping box using a pick & place robot. If measured quantity is not accurate to predefined value the box is rejected & picked out by a robot & placed to the starting packing point.

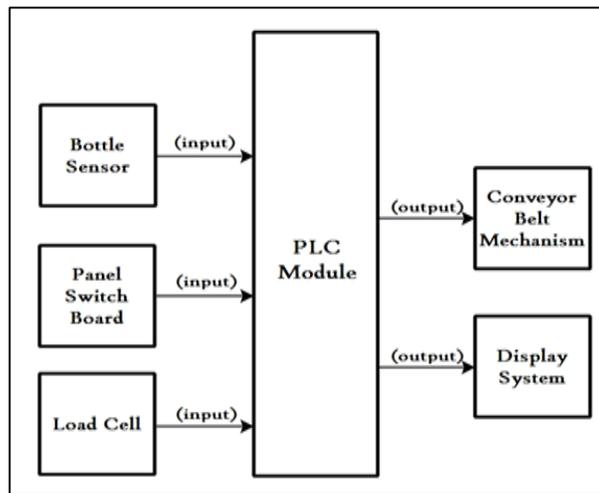


Fig. 1: Block Diagram

III. FLOWCHART

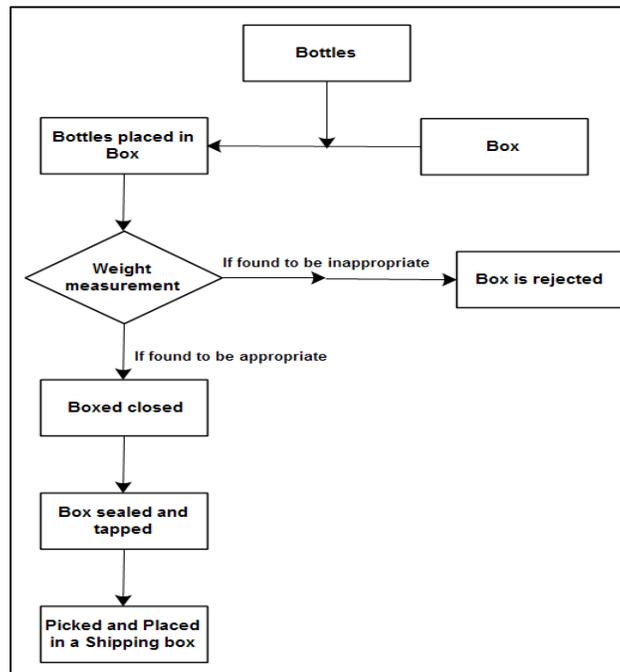


Fig. 2: Flowchart

IV. COMPONENTS

A. Hardware Section

1) PLC



Fig. 3: PLC

A programmable logic controller is a digital computer used for automation of typical industrial electro-mechanical processes such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many machines in industries. PLCs are designed for multiple arrangements of digital and analog inputs and outputs, extended temperature ranges, immunity to electrical noise and resistance to vibration and impact. Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory. A PLC is an example of a “hard” real-time system since output results must be produced in response to input conditions within a limited time, otherwise unintended operation will result. Early PLCs were designed to replace relay logic systems. These PLCs were programmed in ladder logic which strongly resembles a schematic diagram of relay logic. This program notation was chosen to reduce training demands for the existing technicians. Other early PLCs used a form of instruction list programming, based on a stack based logic solver. Modern PLCs can be programmed in a variety of ways, from the relay-derived ladder logic to programming languages such as specially adapted dialects of BASIC and C.

2) Conveyor Belt

The dc motor is one the output. It is driven by the instructions given through the PLC. A 12V, 5A power supply is used to drive the motor .The motor conveyor belt is fitted to a metallic stand with rollers and bearings.

3) RS-232 cable

RS-232 is standard for serial communication transmission data. It formally defines the signal connecting between a DTE (data terminal equipment) such as a computer terminal, and DCE (data circuit-terminating equipment, originally defined as data communication equipment) such as a modem. The RS-232 standard is commonly used in computer serial ports. The standard defines the electrical characteristics and timing of signals, the meaning of signals, and the physical size and pinout of connectors.

4) SMPS

Like a linear power supply, the switch mode power supply too converts the available unregulated ac or dc input voltage to a regulated dc output voltage. However in case of SMPS with input supply drawn from the ac mains, the input voltage is first rectified and filtered using a capacitor at the rectifier output. The unregulated dc voltage across the capacitor is then fed to high frequency dc to dc converter. The switch employed is turned ON and OFF at high frequency.

5) Push Button

A toggle switch works by a lever to open or close an electrical and electronic circuit. Toggle switches are available in two types: Maintained contact and momentary contact. Maintained switches stay in the position in which they are switched to, and momentary switch does not.

Electrical & electronic circuits have 2 modes ON & OFF. Pole of the switch closes or opens the electrical connection & is electrically insulated from all other contact points in order to control a device, the toggle switch must be connected to the positive electrical input of the device.

6) Relay Cards

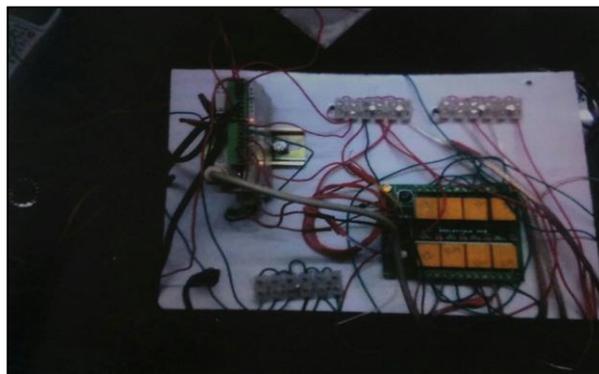


Fig. 4: Relay Cards

A relay card is a device that consists of a number of relays that are mounted on a PCB. A relay is a switch that utilizes an armature powered by an electromagnet in order to complete an electrical circuit. Relays are commonly used to operate the circuits that provide power to motors and lights. Relays are simple devices that are comprised of 4 basic components. Relays make use of an electromagnet, a spring and a set of electrical contacts which are connected to an armature. Without power to operate the electromagnet, the armature is held in position by the spring, which keeps it from making contact with the second electrical circuit that it is designed to operate.

7) Photo Transistor

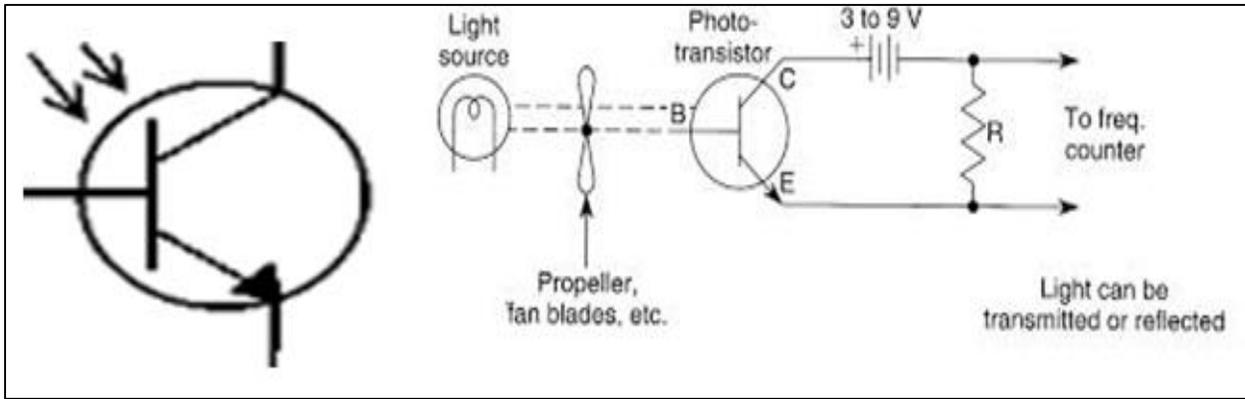


Fig. 6: Photo Transistor

A phototransistor is a light-sensitive transistor. A common type of phototransistor, called a photo bipolar transistor, is in essence a bipolar transistor encased in a transparent case so that light can reach the base–collector junction.

B. Software Section

1) Ladder Diagram

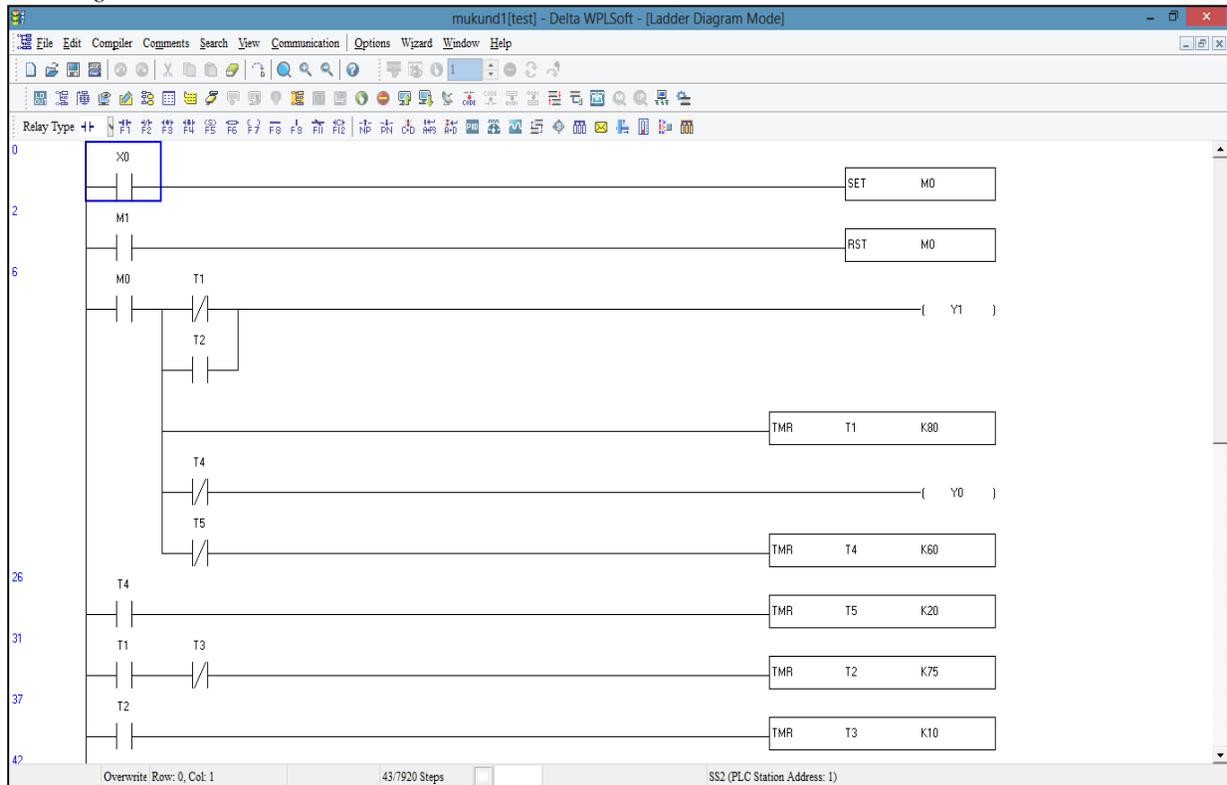


Fig. 6: Ladder diagram

2) Infrared Sensors for Sensing the Bottles

An Infrared (IR) sensor is used to detect obstacles in front of the car or to differentiate between colors depending on the configuration of the sensor. In IR sensor circuit, there is basically IR LED (Light Emitting Diode) and IR photodiode, IR LED emits infrared light and detector (photodiode) which is sensitive to IR light of the same wavelength as that emitted by the IR LED.

The principle working of IR sensor is that, when IR light falls on the surface of photodiode the resistance of the photodiode decreases proportionally with the increasing magnitude of the IR light, as the magnitude of the resistance decreases output voltage also decreases with respect to time.

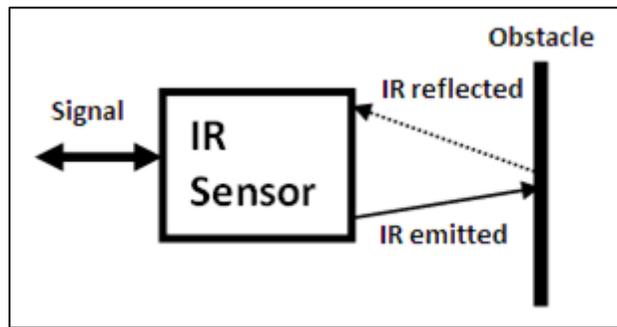


Fig. 7: Infrared Sensors for Sensing the Bottles

IR sensor reflects efficiently on white surface, since white surface reflects all types of light whereas black surface absorbs the light and hence IR sensors operation is dispersed.

Operational amplifier (Op-amp) is a high gain voltage controlled amplifier with differential inputs and single stable output. Op-amp produces an output potential (relative to circuit ground) that is typically hundreds of thousands of times larger than the potential difference between its input terminals. The amplifier's differential inputs consist of a non-inverting input (+) with voltage V_+ and an inverting input (-) with voltage V_- ; ideally the op-amp amplifies only the difference in voltage between the two, which is called the differential input voltage. The output voltage of the op-amp V_{out} is given by the equation:

$$V_{out} = A_{OL} (V_+ - V_-)$$

Where A_{OL} is the open-loop gain of the amplifier (the term "open-loop" refers to the absence of a feedback loop from the output to the input).

Op-amp is classified into 3 configurations; open loop and closed loop. In this case the circuit is closed loop with positive feedback. Along with Op-amp AND gate is used to differentiate the input of 3 IR sensors. AND gate basically plays a role of multiplier, where in when 3 inputs are high the output is given to the Op-amp which indicates the presence of object. The truth table of AND gate is displayed below which gives clear picture of working of AND gate.

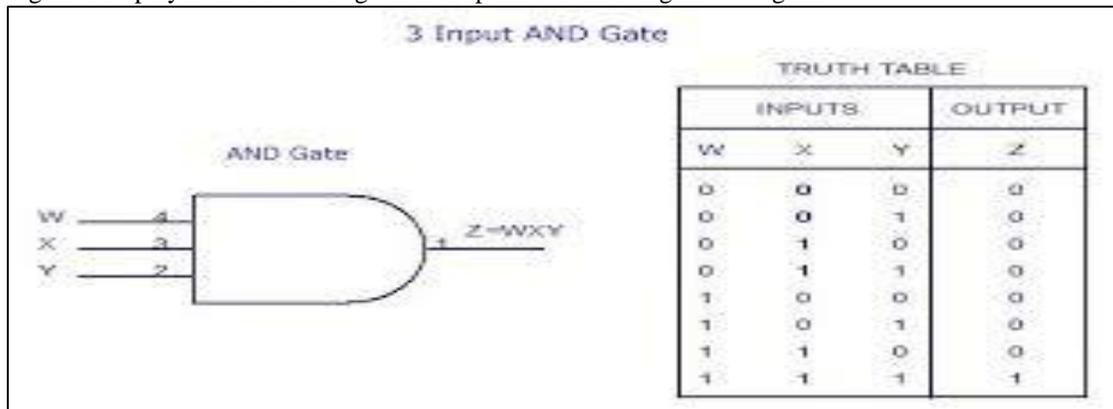


Fig. 8:

3) Object Counter

Various types of counting circuits using TTL ICs such as 7490 and 7447 with common anode type of 7 segment LED displays are available and have appeared in different counting application. The input circuit consists of phototransistor T1 with a high speed switching transistor amplifier built around T2. A 6.3v, 60 mA lamps is used as light source. A beam of light from lamp is focused on the base of phototransistor. The property of phototransistor is that whenever the light focused on its base is obstructed it gives a pulse. So object to be counted are arranged in a row to move one by one in between light source and the phototransistor. The pulse output from phototransistor is amplified by T2 and output of T2 is fed to IC1. IC1 is a CMOS QUAD 2 input NAND SCHMITT TRIGGER (CD 4093) which converts these pulses into perfect square wave. The output of the Schmitt trigger is fed to a counter chain for counting and displaying the counts digitally.

The counter chain consist of 2 dual BCD UP COUNTERS (IC2 and IC3) the clock input of all the counters are grounded. The cascading of counters can be done by connecting D output of the previous stage to the ENABLE PIN input of the next stage of the counters, keeping clock input of the latter at ground potential the output of IC1 is fed to enable input of the counter IC2, keeping its clock input low. The D-C-B-A the outputs of these counters are decoded using CMOS BCD to 7 segment latch decoder driver consisting of IC4, IC5, IC6 & IC7.

Advantages of CMOS ICs over TTL circuits:

- Very low power consumption.
- Wide supply voltage range.

- Good noise immunity.
- High package density.
- High fan-out capability

4) DC Servo Motors

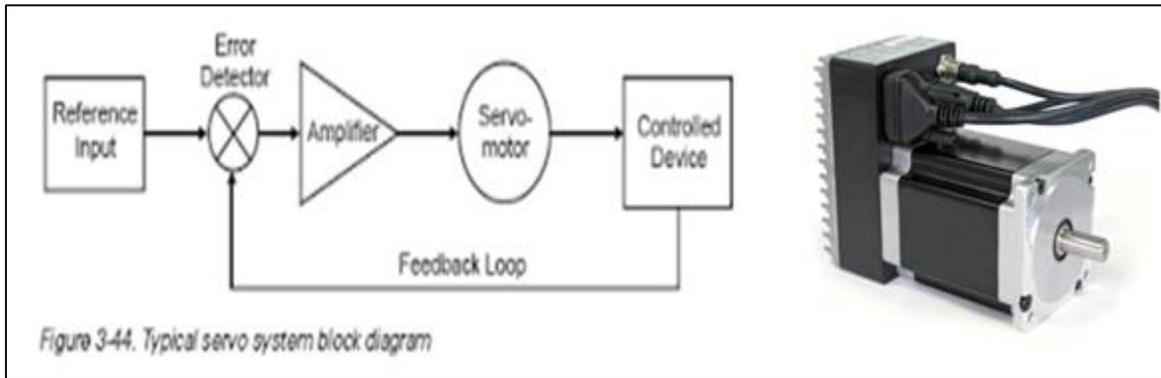


Fig. 9: DC Servo Motors

Under Electrical Motor, as we know that any electrical motor can be utilized as servo motor if it is controlled by servomechanism. Likewise, if we control a DC motor by means of servomechanism, it would be referred as DC servo motor. There are different types of DC motor, such shunt wound DC motor, series DC motor, Separately excited DC motor, permanent magnet DC motor, Brushless DC motor etc. Among all mainly separately excited DC motor, permanent magnet DC motor and brush less DC motor are used as servo.

V. APPLICATION

- Packing of bottles in pharmaceutical industries.
- Packing of beverage bottles.
- Packing of medical bottles.

VI. CONCLUSION

The automation can be on the same machine level on a production line, or in a whole department where the workers task is monitoring, inspection and maintenance.

This paper presented the automation of material handling and packaging in a production line of which this processor is done manually in different companies. PLC today are advancing in terms of applicability and capability. The experimental prototype uses a programmable logic controller specifically the digital DELTA (DvP2) and the electro mechanical devices Called relay cards.

The system works during normal operation and greatly improved the automation processes with the use of the PLC ladder diagram. The wiring an 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 automation system.

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