Automatic Bottle Packaging plant by using PLC

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ABSTRACT--Automation is the use of control systems and information technologies to reduce the need for human work in the Production of goods and services. Automation plays an increasingly important role in the world economy. Where PLC SCADA is widely used in industries. One of the important applications of automation is in the soft drink and other beverage industries, where a particular liquid has to be filled continuously. For these kinds of applications the trend is moving away from the individual device or machine toward continuous automation solutions. This project is an application of automation wherein we have developed a bottle filling system. By programming the Programmable Logic Controller using ladder logic we automate the whole process by means of controlling the ON and OFF status of field devices.

***Index Terms*—PLC, Arduino**

I. INTRODUCTION

Automation is used for all control systems and the technologies in PLC is use to reduce the human work and helps in increasing the production. PLC plays an important role in the world of automation industry. It acts a major function in the automation field which tends to reduce the complexity, increases safety and cost efficient. In this system we have applied a PLC based control system in an automatic bottle filling station.

The paper is divided into several sections where the first phase of the paper explains the description of the product. The second phase then gives the functional description of the product. PLC (Programmable Logic Controller) acts as a major function in automation fields where, small PLC have a fixed number of built-in connections for inputs and outputs. A bottle filling system with PLC allows the user defined selection volume in percentage which uses the ladder language. Ladder logic is used to control the process.The filling operation is based on the user-defined volume through which user can choose the volume of liquid to be filled. A sensor which is placed in the conveyor, is used to sense the bottle placed under the tank and the corresponding tank is switched on to fill the bottle.Filling is done by using various methods using motor, sensors, conveyor belt, PLC, solenoid valve. After filling packaging is done in our project.

II. SOFTWARE USED

2.1 LADDER LOGIC TECHNIQUE

Ladder logic is used to develop software for Programmable Logic Controllers (PLCs) used in industrial control applications. The name is based on the observation that programs in this language resemble ladders with two vertical rails and a series of horizontal rungs between them

Ladder logic has contacts that make or break circuits to control coils. Each coil or contact corresponds to the status of a single bit in the programmable controller's memory. Unlike electromechanical relays, a ladder program can refer any number of times to the status of a single bit, equivalent to a relay with an indefinitely large number of contacts.

So-called "contacts" may refer to physical ("hard") inputs to the programmable controller from physical devices such as pushbuttons and limit switches via an integrated or external input module, or may represent the status of internal storage bits which may be generated elsewhere in the program.

Each rung of ladder language typically has one coil at the far right. Some manufacturers may allow more than one output coil on a rung.

Rung Input: Checkers (contacts)

— [] — normally open contact, closed whenever its corresponding coil or an input which controls it is energized. (Open contact at rest)

— [\] — normally closed ("not") contact, closed whenever its corresponding coil or an input which controls it is not energized. (Closed contact at rest)

Rung Output: Actuators (coils)

— () — normally inactive coil, energized whenever its rung is closed. (Inactive at rest)

— (\) — normally active ("not") coil, energized whenever its rung is open. (Active at rest)

The "coil" (output of a rung) may represent a physical output which operates some device connected to the programmable

controller, or may represent an internal storage bit for use elsewhere in the program.

Logical AND

```
------[ ]--------------[ ]----------------( )
  Key Switch 1      Key Switch 2        Motor
```

The above realizes the function: Door Motor = Key Switch 1 AND Key Switch 2.This circuit shows two key switches that security guards might use to activate an electric motor on a bank vault door. When the normally open contacts of both switches close, electricity is able to flow to the motor which opens the door

Logical OR

```
--+-------[ ]-------+-----------------( )
  Switch 1                    Unlock

  +-------[ ]-------+
   Switch 2
```

The above realizes the function: Unlock = Interior Unlock OR Exterior Unlock. This circuit shows the two things that can trigger a car's power door locks. The remote receiver is always powered. The unlock solenoid gets power when either set of contacts is closed.

Basic Timers & Counters

Many times programs will call for action to be taken in a control program based on more than the states of discrete inputs and outputs. Sometimes, processes will need to turn on after a delay, or count the number of times a switch is hit.

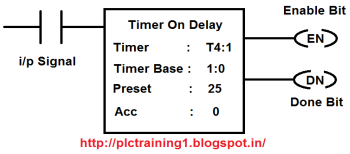


Fig.1. Timers and Counters

To do these simple tasks, Timers & Counters are utilized. On-Delay Timer (RTO) A timer is simply a control block that takes an input and changes an output based on time. There are two basic types of timers. There are other advanced timers, but they won't be discussed in this report. An On-Delay Timer takes an input, waits a specific amount of time, allows logic to flow after the delay. An Off-Delay Timer allows logic to flow to an output and keeps that output true until the set amount of time has passed, then turns it false, hence off-delay

A counter simply counts the number of events that occur on an input. There are two basic types of counters called up counters and down counters. As its name implies, whenever a triggering event occurs, an up counter increments the counter, while a down counter decrements the counter whenever a triggering event occurs. Figure shows the typical graphical representation of an Up Counter

2.2 Arduino

Fig.2. Arduino

Arduino is a tool for making computers that can sense and control more of the physical world than your desktop computer. Its an open source physical computing platform based on a simple microcontroller board, and a development environment for writing software for the board.

Arduino can be used to develop interactive objects, taking inputs from a variety of switches or sensors, and controlling a variety of lights, motors, and other physical outputs. Arduino projects can be stand-alone, or they can communicate with software running on your computer(for e.g. flash, processing, MaxMsp.). the board can be assembled by hand or purchased preassembled; the open-source IDE can be downloaded for free.

The Arduino programming language is an implementation of wiring, a similar physical computing platform, which is based on the Processing multimedia programming environment.

III. COMPONENTS

3.1 PLC

A **PROGRAMMABLE LOGIC CONTROLLER** (PLC) is an industrial computer control system that continuously monitors the state of input devices and makes decisions based upon a custom program to control the state of output devices.

Almost any production line, machine function, or process can be greatly enhanced using this type of control system. However, the biggest benefit in using a PLC is the ability to change and replicate the operation or process while collecting and communicating vital information.

Another advantage of a PLC system is that it is modular. That is, you can mix and match the types of Input and Output devices to best suit your application.

Fig.3. PLC Module

Features

Contains isolated RS-232/RS-485 combo port for serial and networked communication
Provides four latching or pulse-catch inputs and four interrupt inputs
Includes built-in independent 20 kHz high-speed counter
Offers Programmable Limit Switch function
Includes two built-in ¾-turn trim potentiometers with a digital output range of 0...250
Provides program data security
Supports floating point data files
Expands up to 136 I/O points
Compatible with \1762 MicroLogix Expansion I/O modules (up to six modules per controller)
Provides additional programming/HMI port for connectivity to a DF1 full-duplex compatible device (only on MicroLogix™ 1200R controllers)

3.2 ARDUINO BOARD

Specifications

SR. NO.	CONTENT	RATINGS
1	Microcontroller	ATmega328
2	Operating Voltage	5V
3	Input Voltage (recommended)	7-12V
4	Input Voltage (limits)	6-20V
5	Digital I/O Pins	14 (of which 6 provide PWM output)
6	Analog Input Pins	6
7	DC Current per I/O Pin	40 mA
8	DC Current for 3.3V Pin	50 mA
9	Flash Memory	32 KB of which 0.5 KB used by bootloader
10	SRAM	2 KB
11	EEPROM	1 KB
12	Clock Speed	16 MHz

Table No.1. Specification of Arduino

3.3 PROXIMITY SENSORS

Fig.4. Proximity Sensor

Photoelectric Sensors detect objects, changes in surface conditions, and other items through a variety of optical properties.

A Photoelectric Sensor consists primarily of an Emitter for emitting light and a Receiver for receiving light. When emitted light is interrupted or reflected by the sensing object, it changes the amount of light that arrives at the Receiver. The Receiver detects this change and converts it to an electrical output. The light source for the majority of Photoelectric Sensors is infrared or visible light (generally red, or green/blue for identifying colours).

Specifications:

Operating Range	50-300mm
Input voltage	10-35V
Output	PNP:NO/NC NPN:NO/NC
Maximum rating	200mA
Output diameter	M-18, M-20, flat

Table No.2. Specification of Proximity Sensor

Features

No beam alignment needed
Space saving
Wiring only on one side
Object with fluctuating position detectable
Wide sensing area

3.4 DC MOTOR

Fig.5. DC Motor

100RPM 12V DC geared motors for robotics applications. Very easy to use and available in standard size.Nut and threads on shaft to easily connect and internal threaded shaft for easily connecting it to wheel.

Features:

100RPM 12V DC motors with Gearbox
3000RPM base motor
6mm shaft diameter with internal hole
125gm weight
Same size motor available in various rpm
1.2kgcm torque
No-load current = 60 mA(Max), Load current = 300 mA(Max)

3.5 Conveyor belt

Fig.6. Conveyer belt

A conveyor belt is one of many types of conveyor systems. The belt is a loop of flexible material as shown in Figure 1(a) used to mechanically link two or more rotating shafts, most often parallel. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium that rotates about them as shown in Figure 1 (b). One or both of the pulleys are powered, moving the belt and the material on the belt forward. The powered pulley is called the drive pulley while the unpowered pulley is called the idler pulley.

3.6 USB to Serial 9 Pin Male adaptor

Fig.7. USB to Serial 9 Pin Male adaptor

- Used to connect serial devices such as modems to a PC or a laptop's USB port
- Consists of a USB A type plug on one end and a male 9-pin serial connector on the other
- Bi-directional cable
- Uses high quality cable, strain reliefs and moulded connectors
- Length of cable: 400mm
- Compliant with the USB 1.1 version and later specifications
  - Supports RS-232 serial Interface
  - Supports 500 kbps data transfer rate
  - USB suspend condition
  - Plug & Play compatible
  - USB host device drivers available
  - Draws its power from USB connection – no extra power adapter required
  - Supports Windows 2000/XP/7/8/10 and later and Mac OS 10.x and later

3.7 Relay

Fig.8. Relay

Relays are simple switches operated both electrically and mechanically . Relays consists of an electromagnet and set of contacts .There are also other operating principles for its working which differ according to their applications, relays used on the project as interface between the PLC outputs and DC motors inputs.

3.8 ULN2003

Fig.9. ULN2003

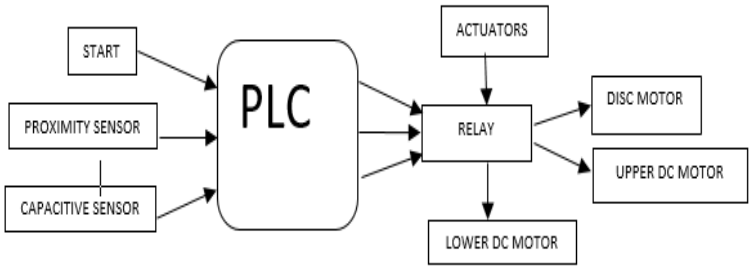
Features

The ULN2003 is known for its high-current, high-voltage capacity. The drivers can be paralleled for even higher current output. Even further, stacking one chip on top of another, both electrically and physically. Typical usage of the ULN2003A is in driver circuits for relays.

Main specifications:

- 500 mA rated collector current (single output)
- 50 V output (there is a version that supports 100 V output)
- Includes output flyback diodes
- Inputs compatible with TTL and 5-V CMOS logic

IV. BLOCK DIAGRAM



V. WORKING

Basic flowchart of bottle filling is implemented in the PLC Ladder logic diagram.

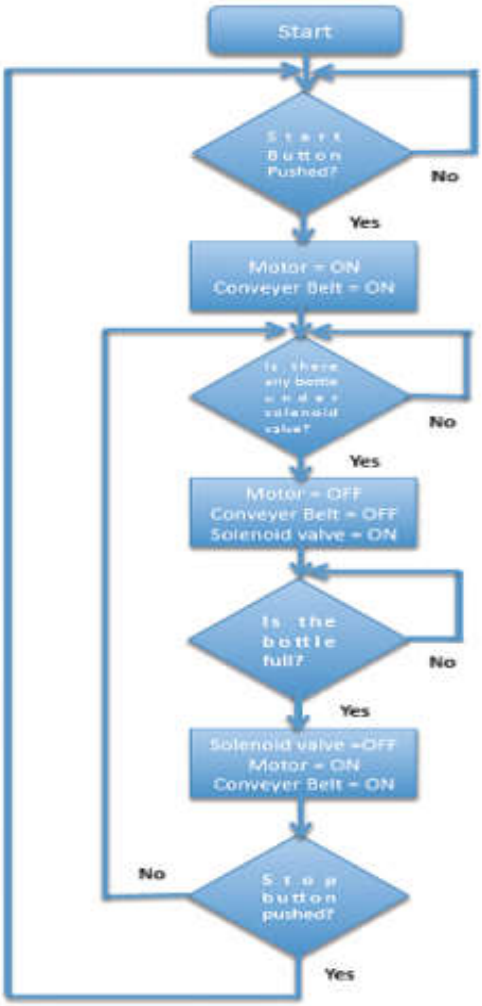


Fig.12. Flowchart

When the start button is pushed, the motor starts hence the conveyer belt starts moving. When the bottle is under the solenoid valve, the bottle is sensed and the motor stops hence the conveyer belt stops. Then the solenoid valve operates and the bottle starts filling the water. When the bottle completes filling process, the solenoid valve is closed and the motor starts, the conveyer belt starts moving and carries the bottle away from the solenoid valve. If another bottle is sensed then the above process will be repeated. When stop button is pressed or activated then the entire process will be stopped.

This operation is followed by the main task of the project is bottle packaging. The packaging process is done after fault detection and rejection of the bottle finally when the bottle is ready at that time we take the bottle on the next conveyer and bring the bottle to horizontal position and transfer it to the next conveyer directly into the box through the slope. The box is then closed by the flap and the bottle is packed completely.

VI. ESTIMATION OF THE PROJECT

Sr. No.	Material	Cost
1	Allen Bradley micrologix 1200 PLC	10000
2	Plywood	1070
3	Motors	2050
4	Actuator and sensors	1930
5	Conveyer belt	500
6	Flow sensors	500
7	Battery	750
8	Pulley	400
9	Others (transportations)	1925
	Total	19125

Table No.3. Estimation of project

VII. LITERATURE SURVEY

1) PLC Based Automatic Bottle Filling and Capping System With User Defined Volume Selection -8 th August 2012 In This Research Paper the researchers T.Kalaiselvi, R.Praveena at all.. Have develop an automatic bottle, filling and capping system with a mechanism using sensors. Automatic filling process for all the bottles simultaneously with a user defined selection for volume to be filled.

2) AN AUTOMATED BOTTLE FILLING AND CAPPING PROJECT FOR FRESHMAN ENGINEERING STUDENTS –June 2005 In this paper the researchers Kala Meah , Timothy Garrison , York College of Pennsylvania at all.. The students work in small teams and have roughly 12 weeks to design an automated electromechanical system that first transports three empty bottles, three tennis balls. The machine must fill each bottle. of water, cape each bottle by covering the top with a tennis ball, and then deliver the capped and filled bottles to an area outside of the operational zone.

3) PLC(Programmable Logic Controller) BASED AUTOMATIC BOTTLE FILLING -3 rd may 2015 In This Research Paper the researcher Jaymin Patel Department Of Physics and Electronics of Hemchandracharya North Gujarat University, Patan has develop a bottle filling system based on certain specifications. More features can be added to this system as follows: Depending on the size, shape and weight of the bottles, Filling operations can be implemented.

4) AUTOMATIC LIQUID FILLING TO BOTTLES OF DIFFERENTHEIGHT USING PROGRAMMABLE LOGIC CONTROLLER –14th July 2013 In This Research Paper the researcher MALLARADHYA H M, K R PRAKASH have Design and Develop an automated liquid filling to bottles of different height using PLC. A total control is made in a filling is achieved. The programming to this system developed is flexible, quickly and easily.

5) AUTOMATED MULTIPLE WATER FILLING (AMWF) MACHINE - April 2009 In This Research Paper the researcher RUHAIRI BIN ABDUL RAHIM from University Teknikal Malaysia Melaka has developed a project to apply filling system where this system can automatically filling 2 type of liquid into their bottle randomly by using PLC as a

controller. The filling system will be using the filling concept Time Gravity Filler Selection Guide.

6) PLC BASED AUTOMATIC LIQUID FILLING SYSTEM - March 2015 In This Research Paper the researcher S.Gowtham at all.. From INFO Institute of Engineering, Coimbatore has developed a bottle filling machine for filling of same size of bottles. The Entire system is reliable and time saving.

VIII. APPLICATIONS OF MODEL

1. Pharmaceutical companies
2. Paint Companies

IX. FUTURE WORK

By the installation of jet nozzle and strong solenoid valve can reduce the time to fill bottles and can efficiently increase productivity. A guide way could be used in case of vibration.

A capping section could also be introduced. The nozzle positioning must be given more care and concentration. The system could be redesigned for increased bottle size and productivity.

The number of boxes packed will be counted and it will be displayed on the LCD panel.

X. CONCLUSION

The PLC have in recent years experienced an unprecedented growth as universal element in industrial automation.

It can be effectively used in applications ranging from single control like replacing a small number of relays to complex automation problems

Today the PLCs are used for control &automation job in a single machine &it increases up to full automation of manufacturing/testing process in a factory.

An automated packaging machine prototype using PLC has been successfully design, constructed and implement based on control system concepts. ladder diagram applied for the programming and operation of the presented prototype, in which the operation is passes through two stages, carrying empty boxes to desired location, and packaging the samples into the boxes.

The experimental prototype tested to improve the automation processes with the use of the PLC ladder diagram. The packaging prototype was done to package four sample per a box in very short time.

XI. REFERENCES

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