iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH
IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 12 Issue: VI Month of publication: June 2024

DOI: https://doi.org/10.22214/ijraset.2024.63012

PLC Based Automatic Bottle Filling System

M. D. Balsaraf [1],Wabale Akash Uttam[2],Madhe Pratiksha Laxman[3]
[1]*Assistant Professor,* [2,3]*Final year Student, Department of Instrumentation and Control Engineering, Pravara RuralEngineering College, Loni Tal. Rahata, Dist. Ahmednagar, 413736, Maharashtra*

Abstract: Introducing a cutting-edge solution for beverage industries, our paper unveils a revolutionary bottle filling machine employing state-of-the-art Programmable Logic Controller (PLC) technology. Crafted with simplicity and efficiency in mind, this compact system seamlessly integrates a conveyor belt for bottle transportation and a precision DC pump to regulate water flow with unparalleled accuracy Operating with finesse, an infrared sensor precisely detects bottle positions, triggering the pump to commence filling precisely at the opportune moment. Once the bottle is detected, a secondary sensor halts the conveyor, initiating a 15-second pump operation optimized for filling up to 800ml bottles swiftly and flawlessly. Upon completion, the pump gracefully ceases, and the conveyor resumes its smooth operation Notably, our system is designed with user convenience at its core. A dedicated stop button empowers operators to halt operations instantly, ensuring safety and control. With each component meticulously optimized for performance and reliability, our cost-effective filling machine stands as a beacon of innovation, poised to revolutionize small-scale beverage enterprises, from cozy coffee shops to bustling juice bars and beyond.
Keywords: Automation, Easy technology, PLC, conveyor, DC motor, inductive sensor, water pump, Relay, etc

I. INTRODUCTION

In today's fast-paced manufacturing landscape, automation plays a crucial role across various industries, not just in manufacturing. With advancements in technology, production levels have surged. However, production managers face the challenge of reducing costs while maintaining product quality within tight deadlines. Moreover, the rising consumer demand intensifies competition among manufacturing companies, where factors like cost, accuracy, time, and quality are paramount. To address these challenges, integrated processes in the industry are key. One essential component of industrial automation is the Programmable Logic Controller (PLC). Acting as the brain of industrial applications, PLCs are extensively utilized to control processes, enhancing performance, accuracy, and efficiency, ultimately leading to increased production.This paper focuses on the design and implementation of a water filling machine as a practical example of PLC application in the industry.

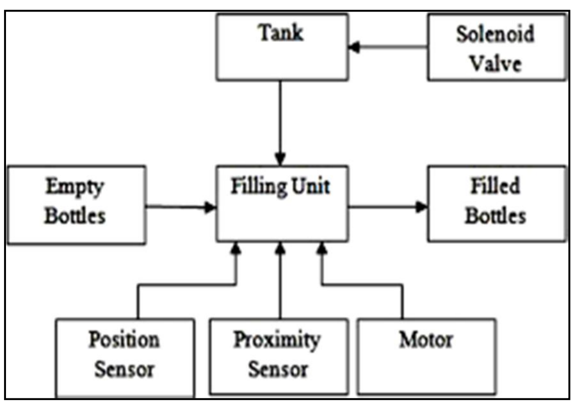


Fig.1. Block Diagram of Automatic Bottle Filling and Capping System.

II. SYSTEM DESCRIPTION

In this fully automated system for filling and capping, both hardware and software components are meticulously developed. On the hardware side, there's the mechanical structure providing the framework, the electrical system powered by DC motors, the pneumatic system for air-driven actions, and the essential PLC (Programmable Logic Controller) acting as the central control unit. For software, the focus is on programming the Delta PLC, renowned for its high performance and versatile features. With efficient program editing tools, the Delta PLC ensures streamlined software development, facilitating the seamless automation of the filling and capping processes.The block diagram of this system is shown in Fig. 1

III. HARDWARE DESCRIPTION

A. *Programmable Logic Controller (PLC)*

A programmable logic controller (PLC) is a digital electronic device that uses a programmable memory to store instructions and to implement functions such as logic, sequencing, counting, and arithmetic in order to control machines, process, and has been specifically designed to make programming easily.

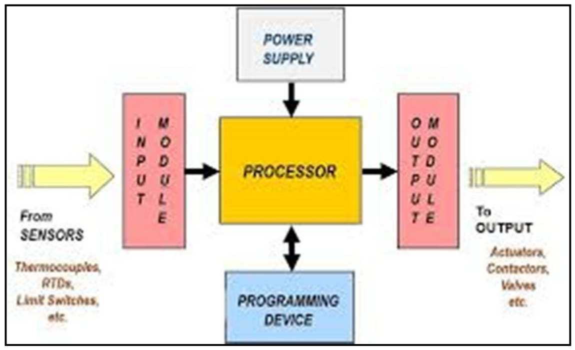


Fig.2. PLC Process Diagram

PLC consist of input modules or points, a Central Processing Unit (CPU), and output modules or points. An input accepts a variety of digital or analog signals from various field devices (sensors) and converts them into a logic signal that can be used by the CPU. The CPU makes decisions and executes control instructions based on program instructions in memory. Output modules convert control instructions from the CPU into a digital or analog signal that can be used to control various field devices (actuators). A programming device is used to input the desired instructions. These instructions determine what the PLC will do for a specific input. An operator interface device allows process information to be displayed and new control parameters to be entered.


Fig. 3. PLC Unit (DELTA)

B. *DC Motor*

In this system, a DC motor is like a power converter—it transforms electrical energy into mechanical energy. Its primary job is to drive the conveyor system, moving bottles from one spot to another using a belt. Operating on a 12V DC power supply, the motor keeps the conveyor rolling smoothly.

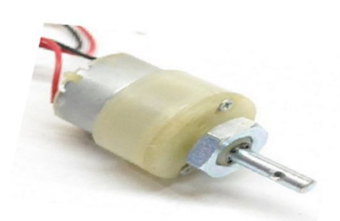


Fig.4. DC Motor

C. Proximity Sensor

In our system, we use proximity sensors to spot objects using different methods like electromagnetic fields, light, or sound. Specifically, we employ inductive and capacitive sensors. Inductive sensors help us know if there are bottles in the holder. Depending on what the sensors tell us, we decide when to start the filling and capping operations.

Fig.5. Proximity Sensor

D. Water Pump

A water pump is like an underwater motor that helps move water around. It's sealed to work underwater and can-do tasks like driving a filter or just keeping water flowing in an aquarium. In our water filling system, we use a water pump instead of a solenoid valve to make filling bottles easier. It's a simple, cost-effective way to get the job done.

Fig.9. Water Pump

E. Conveyer Belt

On a belt conveyor system, a conveyor belt is a means of moving items (usually shortened to a conveyor belt). Conveyor systems come in a variety of shapes and sizes, and the belt conveyor system is one of them. The belt conveyor system is composed of two or even more pulleys (also known as drums) with a rotating conveyor belt as a permanent indicator of intermediate bearing. The belt as well as the material in front strap are moved by either or both of the pulleys, which are strong.

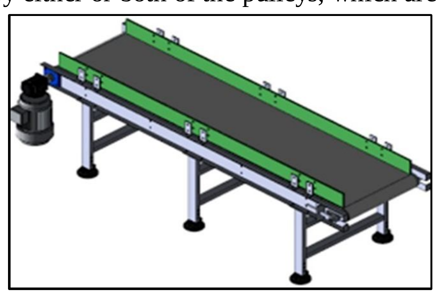


Fig.10. Conveyer Belt

IV. SOFTWARE DESCRIPTION

WPL Software Version 2.38 is the main programming software which is used to program the PLC. Five distinct forms of programming language for PLC are:

- Ladder Diagram (LD)
- Structured Text (ST)

of the various languages one can use to program a PLC, ladder logic is the only one directly modeled after electromechanical relay systems. It uses long rungs laid out between two vertical bars representing system power. Along the rungs are contacts and coils, modeled after the contacts and coils found on mechanical relays. The contacts act as inputs and often represent switches or push-buttons; the coils behave as outputs such as a light or a motor. Table 1 shows the operation of Input/ Output Module and Timer of the system.

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 12 Issue VI June 2024- Available at www.ijraset.com

Table1. Input/ Output Module and Timer

Input Module	Output Module	Timer
X0	Y0	T0
X1	Y1	T1
X2	Y2	
X3	Y3	
X4	M0	
X5		

Input Modules: X0 - Start
X1 - Fill Sensor
X2-Cap Sensor
X3-Stop
X4-Position
X5-Bottle Out

Output Modules: Y0 – Conveyor
Y1-Filling System
Y2 – Rotate
Y3 - Capping System
M0 - Stop Capping

Timers: T0 – For Filling
T1-For Capping

V. IMPLEMENTATION OF BOTTLE FILLING SYSTEM

Bottle Detection Using Sensor

In this innovative bottle filling and capping system, the process is meticulously orchestrated for seamless operation. As bottles are positioned in their holders on the conveyor's input side, smart inductive sensors spring into action, detecting their presence. These sensors communicate with the PLC, setting the stage for the filling and capping operations. Each bottle's status is carefully noted: if present, a corresponding signal is relayed to the PLC, activating the pumps for filling. Should a bottle be absent, the system gracefully skips over it, ensuring efficiency.Once all bottles are accounted for, the conveyor kicks into gear, propelling them forward for filling. A precisely timed relay orchestrates the filling process, ensuring each bottle receives the perfect amount of water. With this timer set, the pump springs to life, then gracefully shuts off when the task is complete. As the conveyor resumes its journey, the bottles arrive at the capping station, guided by yet more sensors. These sensors halt the conveyor at just the right moment, ensuring flawless capping. Here, an ingenious actuator arrangement takes over, securing each bottle's cap with precision.This system represents the marriage of cutting-edge technology and meticulous design, ensuring a smooth and efficient journey from empty bottle to securely capped product.

VI. RESULT

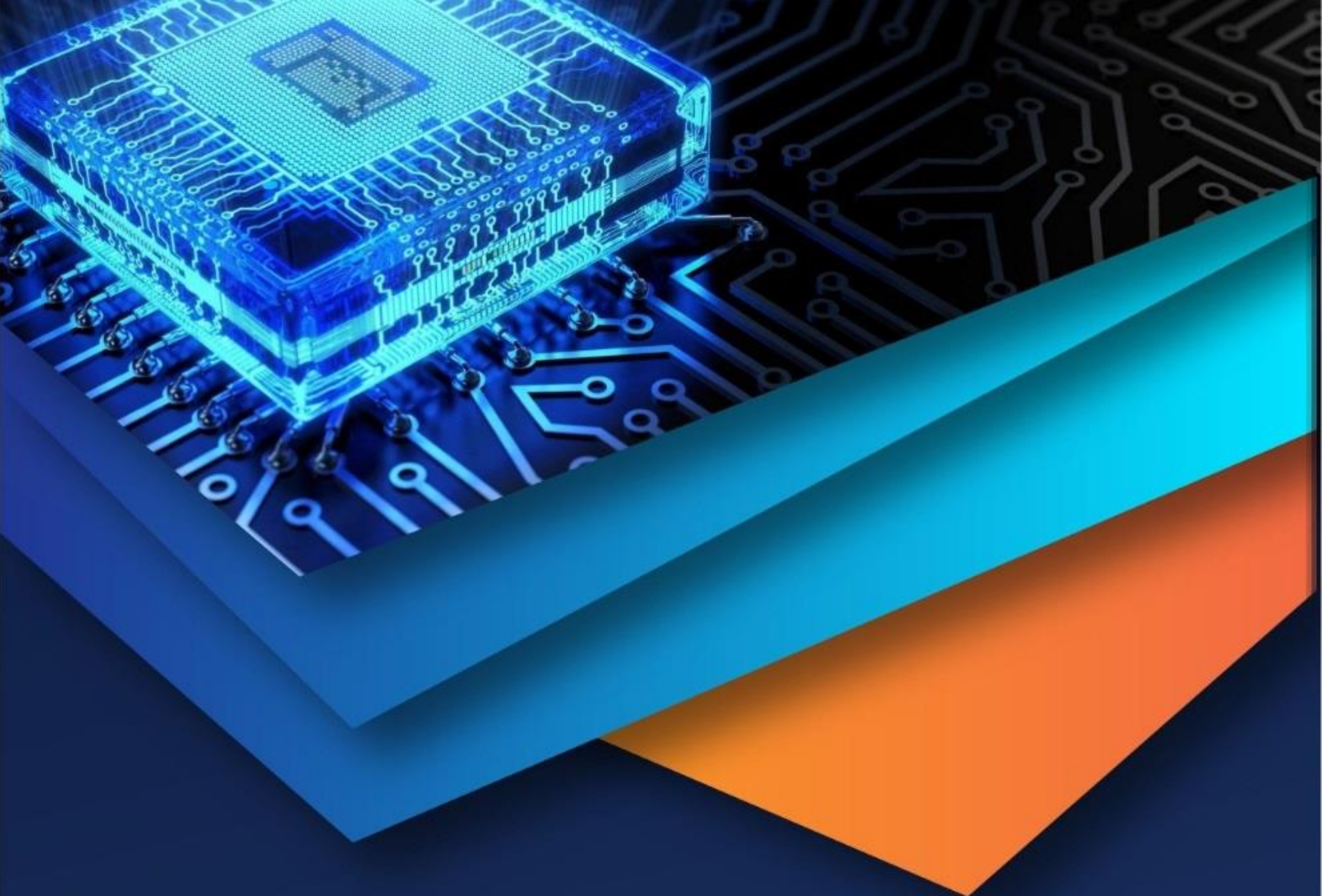
We have successfully developed our project and tested it takes about 1-2 min for the bottle of 500 ml to be filled simultaneously adding a second bottle on the conveyor after the first filled bottle exits the rotary disk. No error was detected while filling the bottle.

VII. CONCLUSION

This paper explores the efficient use of conveyor systems for moving objects, focusing on the flat belt type for bottle transportation in packaging processes. Conveyors prove particularly beneficial for handling heavy or large materials, streamlining tasks and saving time and effort. The system operates on time-based controls, initiating pulses through sensors for filling and capping processes. Its practical applications extend to various commercial settings like coffee shops, juice bars, and cold drink outlets, relieving human labor. The research findings underscore the effectiveness of conveyor systems and highlight the importance of PLC in industrial automation, emphasizing the need for further study in this area.

REFERENCES

[1] Frank Petruzella, "Programmable Logic Controllers", Fifth Edition, Mc Grawhill Education, (2017).
[2] T. Kalaiselvi, R. Praveena, Aakansha. R, Dhanya, ‘‘PLC Based Automatic Water Bottle Filling Capping System with User Defined Volume Selection’’, IJETAE, vol. 2, Issue8, (August 2012).
[3] Kevin Collins, "PLC Programming for Industrial Automation".
[4] Daniel Kandray, "Programmable Automation Technologies", Industrial Press, (2010 ISBN 978-0- 8311-3346-7).
[5] Prof.Anup G. Dakre, Junaid G. Sayed, Ekata A. Thorat, Md. Aousaf Md. A. Choudhary, "PLC Based Automatic Bottle Filling and Capping with Metal Can Ejector
[6] Ms. Diptee Patil “Automatic Bottle Filling, Capping And Labelling System Using PLC Based Controller” 2021; Vol 20 (Issue 1)
[7] Md. Liton Ahmed, Shantonu Kundu, Md. Rafiquzzaman “Journal of Advancement in Mechanics” MAT Journals 2019 Volume 4 Issue.
[8] Dr. Pankaj Prajapati, International Research Journal of Engineering and Technology (IRJET) “AUTOMATIC BOTTLE FILLING AND CAPPING SYSTEM USING PLC” e-ISSN: 2395-0056 Volume-1, Issue-1, 2019.



10.22214/IJRASET

45.98

IMPACT FACTOR: 7.129

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY