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Implementation of Hybrid Automatic Controlling Mechanism of Liquid Dispensing System

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Abstract

In today's competitive world of industrialization, it necessitates a great demand of industrial control systems and automation in order to streamline operations in terms of speed, reliability and high output. Automation act as an important part of the world economy and its development. With numerous advantages and benefits PLC aims to be a solution that could bring radical development in every required aspect. PLC aims to be a vital tool in industries, here an automatic controlling mechanism of liquid dispensing system, is proposed specially for pharmaceutical industries. This proposed system includes mixing of liquids in desired proportion. The aim of this project is to design and develop the real time implementation liquid dispensing system based on PLC by saving operational time. The present work defines automatic dispensing of liquid at different levels with additional features of packaging and dispatch section. The complete sequence of operations is performed by ladder diagram and PLC. The safety measure of the working personnel is also taken into account that warns the operator and working personnel in the event of any fault.

Keywords: PLC, Automation, Ladder logic diagram, Counter, Sensor.

Introduction

In accordance to present revolutionized scenario, the industrialization and globalization has made its notable mark towards world economy and development. So, in order to compete with the enhancing era of technology, automation has proved to be a boon and its influence continues across the globe. PLC aims to be solution in almost every aspect and could bring radical development in its field due to numerous advantages like future expandability, high efficiency, greater production in less time, reliable and safe. Basically, PLC is designed towards continuous automation solutions focusing on a step beyond mechanization which greatly decreases the need of manual operations. The application of PLC is widely used in industrial sector day by day. One of the important applications is in pharmaceutical industries, oil refineries, food processing, chemical industries where PLC proves to be a vital tool for the dispensing of the liquid. In this present work, to understand and study the process of automation in industries, a prototype of liquid dispensing system is proposed and implemented. This project aims to address the design and briefly describes the sequence of functional operation of the liquid dispensing in order to understand the complete process of automation. In this proposed system, major features and fundamental capabilities of PLC are studied reducing the need of human intervention. This prototype carries out the mixing of different liquids at the desired proportion. The filling of liquid takes place at different levels simultaneously at their respective position. The sensors act as an important tool to detect the position of bottles placed on the conveyor belt during the accurate dispensing of liquid at both position. The counter is provided at both sections of packaging section and dispatch section so that counted number of filled bottles could be verified. This design of hybrid prototype also includes protection and alert system as a purposeful safety measure for the operators and working personnel present at this particular department.

Finally, this proposed system reduces complexity, increases safety; low cost and not only guarantees reduced production time but also a higher productivity both in terms of quantity and quality meeting the goal of PLC implementation and applicability.

Objective

In this project, a hardware model regarding the objective of project has been proposed which serves following main purposes: The first purpose is to design, develop and testing of real time implementation of PLC based automatic liquid dispensing system to different sized component by one machine. The second purpose is to detect accuracy of the system with respect to desired volume selection of liquid and its filling by saving operational time in pharmaceutical industry. The theft of missing filled bottles must be controlled at the dispatch section and packaging section.

Safety of the operators and working personnel is a major issue for an industry regarding its growth and purpose.

Programmable logic controller: A Programmable Logic

Controller (PLC) is an industrial computer which is widely used for monitoring numerous automation based electromechanical processes regarding the control of machinery.

A PLC is basically an example of a real-time system and solid state device that are well adapted to control all operations and automation tasks. It is user – friendly, microprocessor based specialized computer that carries out control functions of many types and levels of complexity. The purpose of PLC is to monitor crucial process parameters during industrial operations and adjust them accordingly. It is extensively used in industries because it can be programmed, controlled and operated even by a person who is unskilled in operating computers. Ladder logic is one of the fundamental methods used for programming of a PLC.

PLC is a digital electronic device; consisting of five major hardware components an I/O unit, central processing unit, memory unit. The input and output components are accessible to PLC and the control program is loaded in its memory. All kinds of logic and control operations, data transfer and data manipulation operations performed by the central processing unit. The results and outputs are stored in the memory of the PLC.

The processor or CPU is the brain of the PLC. Its function is similar to that of a CPU in a personal computer that carries out mathematical and logical operations. Memory is the area of CPU in which data and information is stored. The electrical power supply converts alternating current to direct current by using filters and regulators. An input and output modules act as an interface between the processor and the devices attached to the PLC. It supports, accepts and converts the incoming signals that are used by the processor. Simultaneously, the output module converts the signals to be used by the actual devices.

The block diagram of PLC is shown in Figure-1 consisting basic components as input module, CPU and output module and a monitor for loading of program.

PLC consists of an input/output (I/O) unit, central processing unit (CPU) and memory. The I/O unit acts as the interface between PLC and real time systems. All logic and control operations, data transfer and manipulation work is done by CPU. PLCs provide the advantages of high reliability in operation, flexibility in control techniques, small space and computing requirements, expandability, high power handling, reduced human efforts and complete programming and reprogramming in a plant. The PLC is designed to operate in the industrial environment with wide ranges of ambient temperature, vibration, and humidity and is not usually affected by the electrical noise that is inherent in most industrial locations. It also provides the cost effective solution for controlling complex systems.

Methodology

The proposed methodology of the project is discussed briefly. The implementation of this project is in two sections: Hardware and Software Implementation.

Hardware Implementation: The hardware implementation of this proposed project consists of different sections which are following as below. Mixing Section, Liquid Level Section, Liquid Filling Section, Packaging Section, Dispatching section.

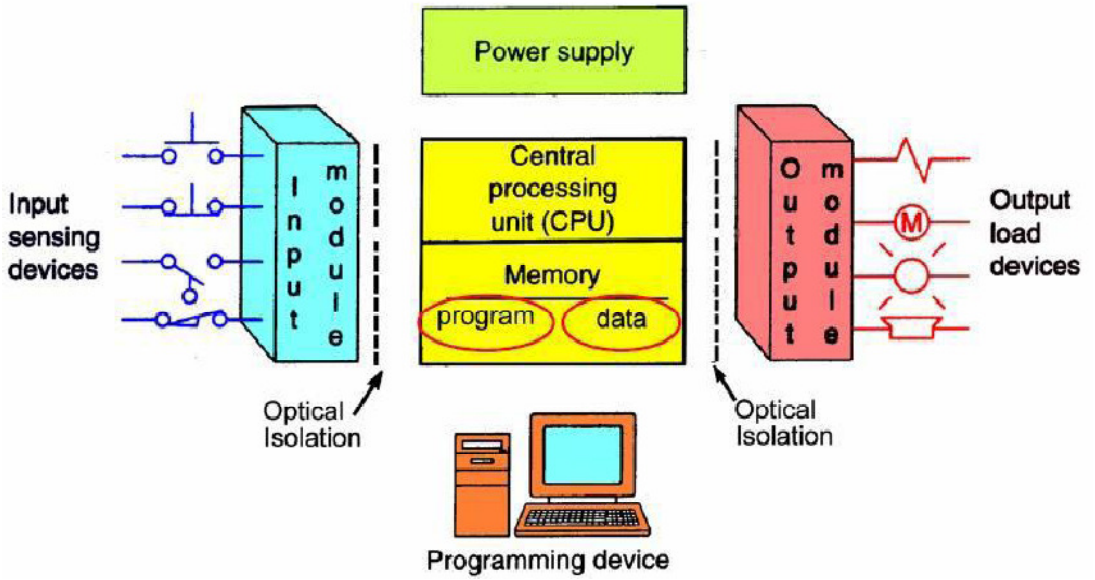

Figure-1
Block Diagram of PLC

This section of proposed project focuses on distribution of two different kind of chemical liquid into different tank to a main two buffer storage tank. This distribution takes place automatically using the Programmable Logic Controller (PLC). It commonly applied application of PLC where two different chemical liquids are mixed in required proportion to form a batch. Rate of the flow is already fixed. We only control the time of the flow. Level of the liquids in the tank is sensed by the level sensor. The ratio of two different liquids will decided as per the required mixed liquid that we needed in the bottle. Bottles are kept in position over the conveyor belt; that are sensed to detect their presence by using sensors.

Depending on the output of the sensor the corresponding valve switch on and filling operation takes place. If the particular bottle is not present then the valve in that position is switched off, thus avoiding wastage of the liquid. The filling process is done based on timing. Depending on the pre-set value of the timer the valve is switched on for that particular period of time and the filling is done. When sensor 2 senses the bottle, it also gives a high output to the PLC. The timer used is TON. It gives two outputs, Enable output and done output. The Enable output remains high while the timer is counting and the output goes high after the timer has finished counting. The Enable output of TON is given to the valve, and so the valve is open for the predefined value of time.

The Done output bit is used to turn ON the motor again in the running. And this all the process are repeat again and half the bottles fill again to in front of the second chemical tank and the bottles full filled and the done output bit is used to turn on the motor again. The process of liquid filling in the bottles will be a parallel process producing two different liquid output at the same time on the conveyor belt. After liquid filling section, the filled bottles will move towards the packaging section, where counting of bottles takes place. This counted number of filled bottles will be verified at the dispatching section in regarding to detect any theft of bottles.

Two Pushers are also attached in the dispatched section which dispatches selected number of the bottles in the carton placed. Thus, this process of liquid filling, packaging and dispatching takes place in a systematic manner.

Software Implementation: As per software purpose, there are basically five main programming languages for programmable control systems: Function block diagram (FBD), Ladder diagram (LD), Structured text (ST; similar to the Pascal programming language), Instruction list (IL; similar to assembly language) Sequential function chart (SFC).

These above mentioned techniques emphasizes on the logical organization of operations. In our proposed project Ladder Diagram (LD) is used which to interface the ON-OFF button with all the hard-ware parts with the PLC. Ladder logic is basically the main programming method used in PLC.

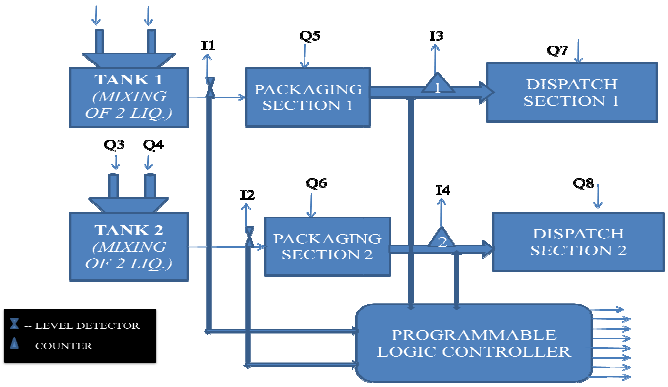

Figure-2
Schematic block diagram of the project

Conclusion

This paper presents an automatic controlling mechanism to fill bottles using PLC. The whole control is made in case of filling is achieved. The present system is a great deal in the field of automation, especially in pharmaceutical production industries where there are large number of medicinal liquids are to be filled and handled in an appropriate short span of time resulting an increased production. The programming to this proposed system is flexible, quick and easy. It will increase the total production output; can lead to yield significant financial benefits and savings. This concept is designed for pharmaceutical industries for filling medicinal liquid syrup in bottles. This present prototype is also useful for chemical product industries and manufacturing industries. The work is motivated to develop a system to monitor and control a hybrid method of automatically filling of the chemical liquid into the bottles using PLC controlling the major issues of theft and safety.

The proposed system is assumed to fill 2 or more bottles of maximum height of 6.6'' and maximum bottle diameter of 4.6" in 1 minute. It can be used commercially in various liquid filling processing industries reducing human effort and their dependency. So the proposed practical research result is much satisfactory to a great extent by helping us to understand the necessity of PLC and its controlling mechanism in industrial automation.

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