Implementation and Performance Analysis of Bottle Filling Plant Using Ladder Language

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Abstract: *PLCs are used in many real world applications. In any industry to achieve automation PLC is the first choice. Traditional methods of bottle filling is time consuming and expensive. This method involved placing of bottles onto a conveyor belt and filling only one bottle at a time. Filling is a task that carried out by a machine which packages liquid products such as cold drinks, water or milk etc. In this paper mainly focuses on programmable logic controller used for bottle filling system as well as user-defined volume selection simultaneously. It also includes counting of number of filled bottles. The filling and counting operation takes place in a synchronised manner. The filling and counting can be done on the conveyor belt. We can decide that how much water we want to fill in the bottle and same quantity of water will be come out from the tank. It also includes user-defined filling time selection menu through which we can input desired time for filling a bottle up to a desired volume. We control the entire system by programming the PLC (Programmable logic controller). Here an Allen Bradley (AB) PLC is used to control the virtual model of bottle filling system module.*

Keywords: Integer, Ladder Logic, PLC, TIMER, SENSOR, Counter, move, Automation, RS Logix500 etc.

1. Introduction

A small PLC will have a fixed number of connections built in for inputs and outputs. Typically, expansions are available if the base model has insufficient I/O. Modular PLCs have a chassis (also called a rack) into which are placed modules with different functions. The processor and selection of I/O modules are customized for the particular application. Several racks can be administered by a single processor, and may have thousands of inputs and outputs. Bottle filling system is an application of automation where we developed a bottle filling and counting system. A bottle filling system with PLC used for user defined selection volume in percentage which uses the ladder language. Here the ladder logic used is RSLOGIX500ENGLISH and help in calculate the number of filled bottles. Here we use a start/stop control of the motor when we on the switch then motor will be on. Bottles are kept over a conveyor belt which will be attached with the motor. When we on the motor conveyor belt will be start. When bottle come under the tank then a sensor sense the bottle and give the value to the counter which count the number of filled bottles. Depending on the output of the sensor the corresponding tank switch on and filling operation takes place. The filling operation is based on user-defined volume through which user can choose the volume of liquid to be filled [4]. If the particular bottle is not present then the tank in that position is switched off, thereby avoiding wastage of the liquid. Here we also provide a timer in which we give a time value for filling a bottle. Depending on the preset value of the timer the tank is switched on for that particular period of time and the filling is done. We also use a limit block due to this if we want to count a limited value of bottle than a clear block will reset the system after a limited value of bottles. Here we used two output in which first show for bottle is filling and another one show bottle has been filled.Filling system has been designed with the help of hardware devices. It uses dc gear motor drivers, sensing devices, Limit switch, Programmable Logic Controller (PLC) device.

A. Programmable Logic Controller

PLC is an assembly of solid state digital logic elements design to make logical decisions and provide outputs. . PLC is an electronic device to be used in the field of industry that controls the system with the help of counters, timers and with other arithmetic operation.PLC is a digital computer usedfor automation of electromechanical processes. The first PLC, designated the 084 because it was Bedford Associates' eighty-fourth project, was the result [1]. One of the people who worked on that project was Dick Morley, who is considered to be the "father" of the PLC [2]. In 1968 GM Hydra-Matic(the automatic transmission division of General Motors) issued a request for proposals for an electronic replacement for hard-wired relay systems based on a white paper written by engineer Edward R. Clark. Some drawbacks found in traditional system:

- A basic machine might need a wall covered in relays to control all of its functions. And with these type of relay control some limitations like relay fail, delay when relay turns on/off is obtained.
- PLC's are free from several conditions such as dust, heat, cold and have the facility for input/output arrangements. Because of these few reasons PLC is preferred.

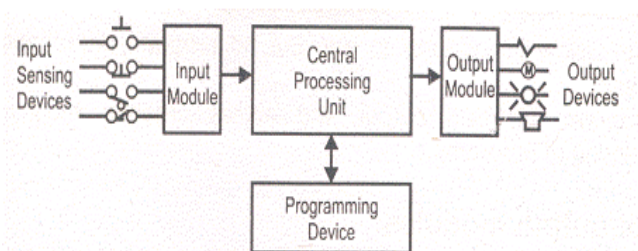What does a PLC look like? The illustration below in fig 1 shows the block diagram of PLC:

Figure 1: Block Diagram of PLC

As shown in above figure all the input devices attached with the input module and output devices attached with output module which performed according to the program installed in PLC. The illustration below (Figure 2) shows the typical internal parts of a PLC just used for bottle filling system. Where PLC connected to PC and then to the output device. Indicator lamps, solenoid valves, and motor contactors (starters) are all examples of discrete control devices. In a manner similar to discrete inputs, a PLC connects to any number of different discrete final control devices through a discrete output channel. Discrete output modules typically use the same form of opto-isolation to allow the PLC's computer circuitry to send electrical power to loads: the internal PLC circuitry driving an LED which then activates some form of photosensitive switching device [9]. Alternatively, small electromechanical relays may be used to interface the PLC's output bits to real-world electrical control devices. Here whole of the procedure to be performed will be explained through programming. Under the IEC 61131-3 standard, PLCs can be programmed using standards-based programming languages.In PLC based automatic bottle filling and capping system with user defined volume selection filling of bottles can be done by using PLC.
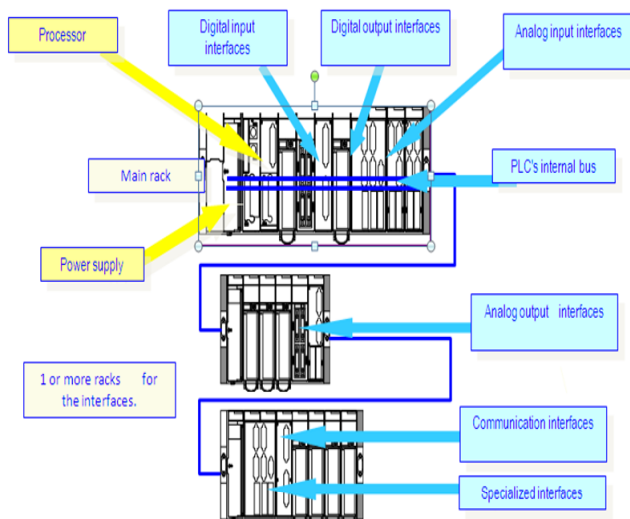

Figure 2: PLC internal architecture

All control operations (filling and counting) are done using the PLC. The entire bottling process is automated by feeding the necessary conditions into the PLC using ladder logic. Ladder logic is one of the methods of programming in PLC . PLCs are used in many industries and machines. Unlike general-purpose computers, the PLC is designed for multiple inputs and output arrangements, extended temperature ranges, immunity to electrical noise, and resistance to vibration and impact [5].Programs to control machine operation are typically stored in battery-backed-up or non-volatile memory [8]. A PLC is an example of a hard real-time system. Early PLCs were designed to replace relay logic systems. More recently, PLCs are programmed using application software on personal computers, which now represent the logic in graphic form instead of character symbols. As PLCs became more advanced, methods were developed to change the sequence of ladder execution, and subroutines were implemented.

2. Programming Software

RS LOGIX 500 is main programming software in which programming of our filling plant is done. RS LINX is communication software which communicates between our PC and PLC. PLC based on many instruction, timer and counter.RSLOGIX500 supports four programming language.

- FBD(Function Block Diagram)
- ST(Statement list)
- STL(Sequential text list)
- IL(Instruction List)
- Ladder

A PLC program is generally executed repeatedly as long as the controlled system is running. The status of physical input points is copied to an area of memory accessible to the processor, sometimes called the "I/O Image Table" [3]. The program is then run from its first instruction rung down to the last rung. It takes some time for the processor of the PLC to evaluate all the rungs and update the I/O image table with the status of outputs. This scan time may be a few milliseconds for a small program or on a fast processor, but older PLCs running very large programs could take much longer (say, up to 100 ms) to execute the program. If the scan time were too long, the response of the PLC to process conditions would be too slow to be useful. As PLCs became more advanced, methods were developed to change the sequence of ladder execution, and subroutines were implemented [5].But in this filling plant RSLOGIX500 supports ladder language. Because it is easy to use and operator can easily understand this language. Ladder language make easy all the controlling with less wiring and there is another advantage we can reload the program because it have all the controlling in program and we can easily change the program. Ladder language have two vertical lines one is positive and another is negetive and these lines called power rails,There are some horizontal line which are connected with these vertiical lines called rungs.We design all the program on these rungs with the help of some instruction. Ladder have many instruction for different types of application XIC, XIO, Timer, Counter, Compare, Latch/Unlatch, Scaling, limit and others. In this program we use XIC, XIO, Counter,Timer.
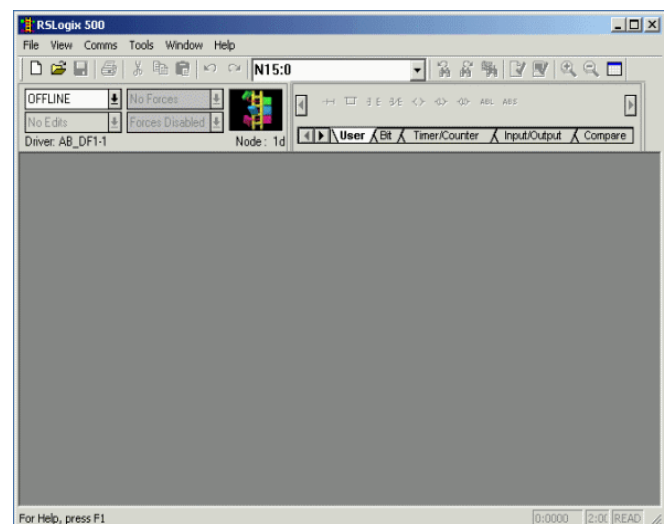

Figure 2: RS logix screen

RS emulator 500 tests our work by running a virtual PLC. We will be able to download our program to it and run it in a very similar fashion to a real PLC [6]. Start the emulater with the START > All Programs > Rockwell Software >RSLogix Emulate 500 >RSLogix Emulate 500 shortcut.

3. Output Implementation

As PLCs became more advanced, methods were developed to change the sequence of ladder execution, and subroutines were implemented [4]. A primary reason for this is that PLCs solve the logic in a predictable and repeating sequence, and ladder logic allows the programmer (the person writing the logic) to see any issues with the timing of the logic sequence more easily than would be possible in other formats. Here in above figure the screen of RS LOGIX shown with whom we will proceed our programme. And whole of the processing related to our work will be done on it.

An important concept to master when working with DC discrete I/O is the distinction between current-sourcing and current-sinking devices. The terms "sourcing" and "sinking" refer to the direction of current (as denoted by conventional flow notation) into or out of a device's control wire. A device sending (conventional flow) current out of its control terminal to some other device(s) is said to be sourcing current, while a device accepting (conventional flow) current into its control terminal is said to be sinking current [7] .

PLC contains real time operating system and exploits for these system exit much as they do for dekstopcomputer In case of implementation we implement the programming in RS logix. PLC programs are typically written in a special application on a personal computer, then downloaded by a direct- connection cable or over a network to the PLC. The program is stored in the PLC either in battery-backed-up RAM or some other non-volatile flash memory [8]. PLC can be programmed to replace thousands of relays. The flexibility that such systems offer has resulted in rapid growth of demand for these controllers .ladder language is easier than others [6]. Prior to the discovery of the Stuxet Computer Virus in june 2010, PLC received attention. Timer is used to provide time delay in any process. There are three types of timer, T-ON,T-OFF,RTO. Here we use T-ON timer which provide time delay when timer is enabled.The addressing of timer is given: T4:0,T4:1………T4:255.

In diffferent types of PLC different type of counter is used but here we use up counter for counting the number of filled bottles The advantage of using PLC tools such as PLC LOGIX are that they save time in design of automated control applications and they also increase the level of safety associate with equipment PLC contains real time operating system.

Following steps are followed by our program: In first step when we on the switch then motor will be on. Bottles are kept over a conveyor belt which will be attached with the motor. When we on the motor conveyor belt will be start. When bottle come under the tank then a sensor sense the bottle. As sensor sens the bottle Timer get enabled and provide time delay. Depending on the preset value of the

timer the pump is switched on for that particular period of time.
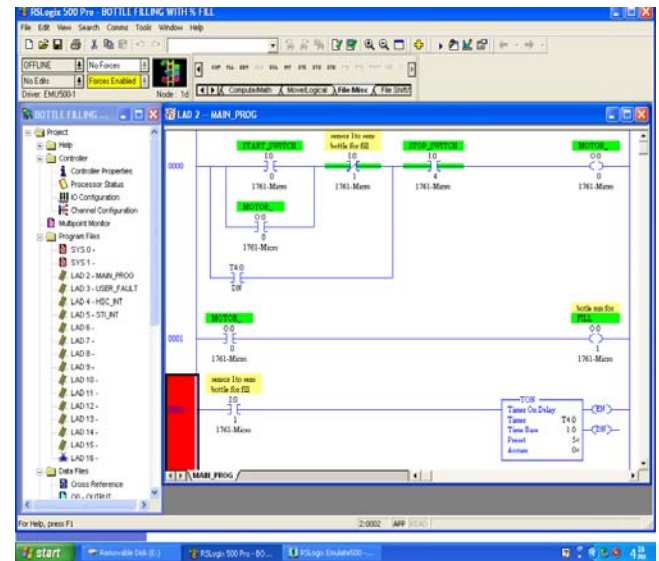
Figure 3: Sensor for Bottles

In second step filling and counting operation takes place. Timer bit is used to count the fill time of bottle. Starting of timing shows that bottle is filling and tank start to empty. The filling operation is accompanied with a user defined volume selection menu and depending on the volume which is informed of percentage; the filling of liquid takes place. The filling is done using timing operations. Once the filling process is done the conveyor starts moving again. In Fig. 4 FLL (fill file) shows % fill of user-defined volume in bottle. In this source N7:1 shows how much % user wants to fill a bottle and Dest N7:2 shows how much bottle is to be filled in once time.
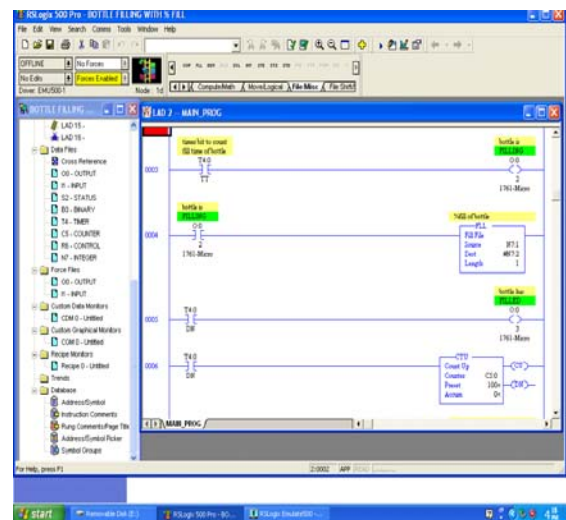
Figure 4: Filling of bottles

Last step of RS LOGIX screen showing display of total number of filled bottle. In this project pump remains on for the preset value of the timer and switches off once time is out. As Accumulator value is equal to the preset value then DN bit of timer will be high which shows filling process is complete and counter starts counting of number of filled bottles. Here move instruction used for display the total number of bottle filled.CLR is used for resetting.

Figure 5: Display board

4. Conclusion and Future Scope

The conclusion of all is that ladder language is very easy to program any type of operation which we want to operate automatically. This language is very useful to run all types of industrial application. In our thesis we calculate the number of filled bottle with user defined volume selection in percentage using PLC. A lot of additional features like user defined volume specification etc. is added in the different stages in our work and the desired results are obtained. PLC is used to control the various operations. Another advantage of this system is that wiring of the input and output devices are very easy. Easy to repairable and we can change program as per our need again and again. This system also use very low power consumption because PLC use only 24v dc to operate their input and output module and only 5v dc is used to operate their CPU. PLC based Bottle filling system will provides a great deal of applications in the field of automation, especially in mass production industries where there are large number of components to be processed and handled in a short period of time and there's need for increased production. The programming of this system is flexible, quickly and easily done. This will increase the total production output; this increase in production can yield significant financial benefits and savings.

This system is very useful for future with the help of this system; 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. Capping operation can also be implemented. This concept can be used in food industries, milk industries, medicine industries, mineral water, mineral water, chemical product industries and manufacturing industries.

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