



AUTOMATIC COFFEE MAKING MACHINE USING PLC

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Abstract—Automation is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heat-treating ovens, switching on telephone networks, steering and stabilization of ships, aircraft and other applications with minimal or reduced human intervention. Some processes have been completely automated. With automation through put or productivity can be increased, Improved quality or increased predictability of quality, increased consistency of output can be obtained. Automation can be achieved with some controllers one is programmable logic controller (PLC). The PLC is an industrial computer. The PLC controls the industrial machines and processes. PLCs have more advantages compared to microcontrollers and personal computers. In different areas of the industry PLC are being applied, e.g.: materials handling, packaging, palletizing, milling, boring, grinding, filling, sorting, weighing. Hence now a day's all industries are preferring PLCs over other controlling equipment.

Keywords- Programmable Logic Controller, Automation, Control Systems.

I. INTRODUCTION

A PLC is a computer specially designed to operate reliably under harsh industrial environments – such as extreme temperatures, wet, dry, and/or dusty conditions. It is used to automate industrial processes such as a manufacturing plant's assembly line, an ore processing plant, or a wastewater treatment plant. PLCs share many features of the personal computer you have at home. They both have a power supply, a CPU (Central Processing Unit), inputs and outputs (I/O), memory, and operating software (although it's a different operating software). The biggest differences are that a PLC can perform discrete and continuous functions which a PC cannot do, and a PLC is much better suited to rough industrial environments. A PLC can be thought of as a 'ruggedized' digital computer which manages the electromechanical processes of an industrial environment. PLCs plays a crucial role in the field of automation, using forming part of a larger SCADA system. A PLC can be programmed according to the

operational requirement of the process. In the manufacturing industry, there will be a need for reprogramming due to the change in the nature of production. To overcome this difficulty, PLC based control systems were introduced[3].

PLC BLOCK DIAGRAM

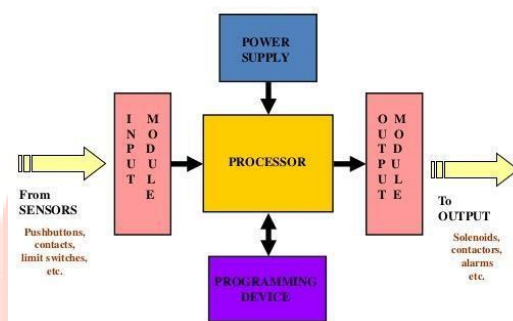


Figure 1 Block Diagram of PLC

Programmable Logic Controllers continuously monitors the input values from various input sensing devices (e.g. accelerometer, weight scale, hardwired signals, etc.) and produces corresponding output depending on the nature of production and industry [3]. A typical block diagram of PLC consists of four parts namely:

- Power Supply Module
- Central Processing Unit (CPU) and memory
- Input & Output Module
- Communication Interface Module

II. LITERATURE SURVEY

PLC (Programmable Logic Controller) is used to develop an automated coffee/tea machine using PLC programming languages. Programmable Logic Controllers developed to date, continues to be perceived as a model basis of a modern-day automation platform, garnering recognition for its robust quality and high-end capabilities, including improved performance, compliance with the latest networking standards, and operational cost efficiency. Designed for a wide range of process and machine management, it finds perfectly his place in numerous segments such as the Food & Beverage etc. [1] In many industries (such as pharmaceuticals, beverage industries, etc.), bottles are required to be filled up with a pre- determined amount of liquid. Implementing systems using relay logic control can

cause them to be inflexible. Programmable Logic Controllers – PLCs – are more flexible in automating various processes, since the behavior of the system can be changed without changing the electrical connections, as well as being able to monitor the system undergoing its operation. [2]

III. METHODOLOGY

Automation is the technology by which a process or procedure is performed with minimal human assistance. Automation or automatic control is the use of various control systems for operating equipment such as machinery, processes in factories, boilers and heating ovens, switching on telephone networks, steering and stabilization of ships, aircraft and other applications and vehicles with minimal or reduced human intervention. Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually in combination. Complicated systems, such as modern factories, airplanes and ships typically use all these combined techniques. The benefit of automation includes labor savings, savings in electricity costs, savings in material costs, and improvements to quality, accuracy, and precision. The coffee machine discussed here contains 2 containers with valves. One container has decoction and the other has milk. There are two steps involved in our coffee making process namely adding decoction and adding milk. A cup is made to move on the conveyer belt which stops at decoction container. The decoction is filled to the cup for the duration specified by the timer. Then the cup moves on the conveyer belt and stops at the milk container and milk is filled for the specified timer duration. We can operate and control automatically the coffee preparation by using PLC.

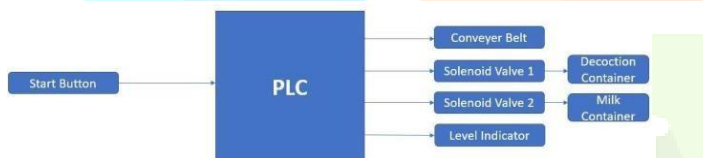


Figure 2 Block Diagram Of an Automatic Coffee Making Machine

A. PARTS OF BLOCK DIAGRAM

The main parts used in the block diagram of Automatic level controller are given below:

- Programmable logic controller (PLC) Version L20
- Two containers fitted with solenoid valves.
- Conveyer belt for cups to pass

B. Level indicator circuit.

C. PLC-INDRALOGIC L20 DP

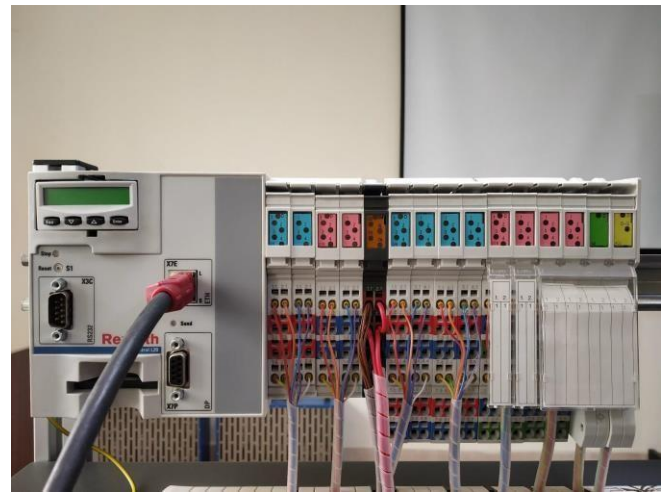


Figure 3 INDRALOGIC L20 DP

- Processor – STM ST40
- Supply voltage – 24V DC
- Bandwidth – 166MHz
- Digital inputs – 16
- Digital outputs – 16
- Analog inputs – 2
- Analog outputs – 2
- Communication interface – Ethernet TCP/IP
- Permissible temperature – +5 °C ... +55 °C
- Firmware used – 03V09.1

D. TWO CONTAINERS FITTED WITH SOLENOID VALVES

There are two containers, one contains decoction and other contains milk. These are the filling containers from which decoction and milk at different levels are to be filled in the cup. In order to automatically control the flow of liquid from the containers into the cups, solenoid valves are required. Cups are filled with decoction and milk levels set with the help of timer in PLC logic.

The containers consist of solenoid valves which operates at 24V DC which is fixed to it. The solenoid valve is thus directly connected to the PLC. Conveyer system is arranged below the main container. The conveyer belt is designed using 24V DC motor.



Figure 4 Two containers which contains decoction and milk

CONVEYER BELT

A conveyer belt is the carrying medium of a belt conveyor system (often shortened to belt conveyor). A belt conveyor system is one of many types of conveyor systems. A belt conveyor system consists of two or more pulleys (sometimes referred to as drums), with an endless loop of carrying medium the conveyer belt that rotates about them. 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. There are two main industrial classes of belt conveyors; Those in general material handling such as those moving boxes along inside a factory and bulk material handling such as those used to transport large volumes of resources and agricultural materials, such as grain, salt, coal, ore, sand, overburden and more. A conveyor belt uses a wide belt and pulleys and is supported by rollers or a flat pan along its path. 24V DC motor is used to run the conveyor belt.

E. LEVEL INDICATOR CIRCUIT

Four LEDs are used for level indication. A light-emitting diode (LED) is a two-lead semiconductor light source. It is a p-n junction diode that emits light when activated. When a suitable voltage is applied to the leads, electrons are able to recombine with holes within the device, releasing energy in the form of photons. This effect is called electroluminescence. LEDs are typically small (less than 1 mm²) and integrated optical components may be used to shape the radiation pattern. In this prototype the LEDs are used to indicate the different levels namely- decoction addition, milk addition, cycle complete.

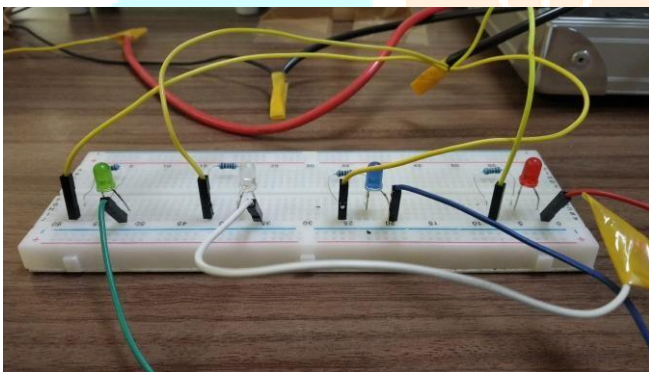


Figure 5 Level Indication Using Four LEDs

IV. EXPERIMENTAL SETUP

A. HARDWARE

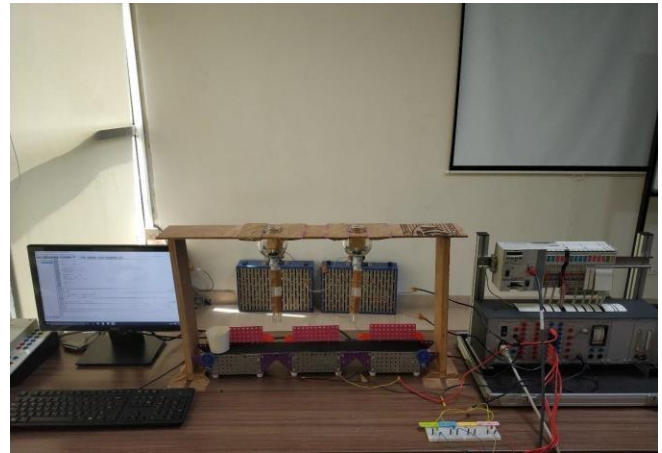


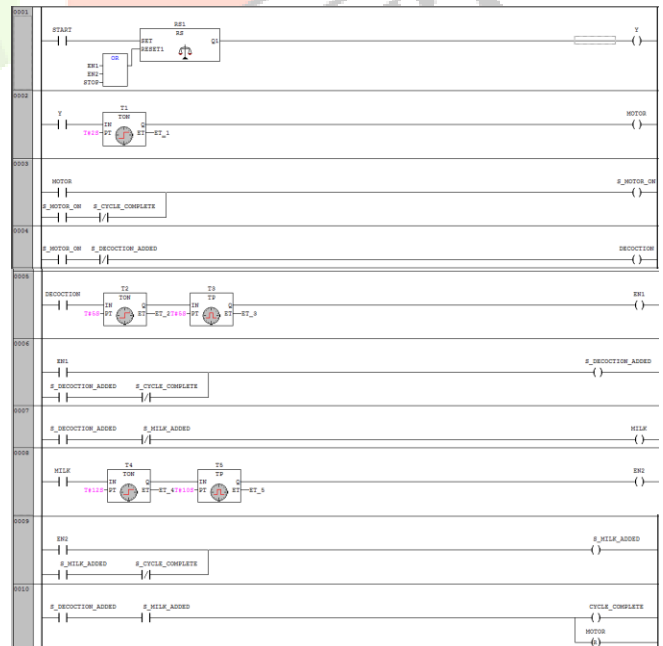
Figure 6 Hardware Setup

B. SOFTWARE

- Indra works: A firmware environment
- Indra Logic language: A programming language developed by Bosch Rexroth.
- Ladder diagram as the source code to the PLC.

V. LADDER DIAGRAM

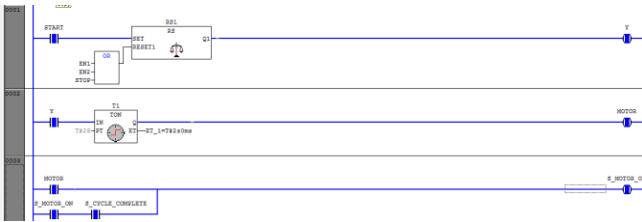
Ladder diagram is the industrial standard for writing control logic [5]. Ladder diagram for “Automatic Coffee Making Machine” is as shown below.



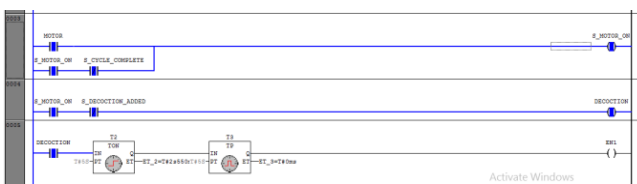
VI. RESULTS

The whole system of “Automatic coffee making machine” is turned on by start process button. There are different cases which indicate how the control flows in the ladder diagram. The cases are:

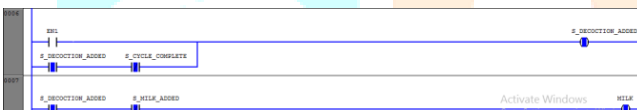
CASE 1: MOTOR IS ON



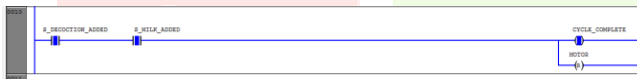
CASE 2: COFFEE DECOCTION IS ADDED.



CASE 3: MILK IS ADDED.



CASE 4: CYCLE COMPLETE



VII. CONCLUSION

PLC is a multiloop control system which reduces man power and increases the smoothness of the operation. It also improves the quality of the product and controls the process parameters with better accuracy. The automation of any system or any industry is necessary in the present comparative ward for the better performance of the system or industry. The main and most important part of an automatic system is a PLC. By the use of PLC, we can change any system as according to our requirements without changing in the hardware. The many other benefits are also by them it is used like it's required less space and less power to operate, it has long life, the changing in logic is easy etc. For the use of a plc the programming is a must. For the different PLCs of all the companies the method of programming and the logic remain same but the addressing is changed, the addressing is also available from the software. So, the most important part is programming the plc according to the requirements.

The project provides a great deal of application in the field of automation and in the field of mass production where units need to be processed and monitored in a short period of time which leads to increase in production. For the setup of an automated machine like this using PLC, the initial cost maybe high but it offers many advantages that overcomes this cost.

It leads to high production rate, use of less manpower, saves the operational time in plants etc.

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