ISSN (Online) 2278-1021
ISSN (Print) 2319-5940

International Journal of Advanced Research in Computer and Communication Engineering
Vol. 4, Issue 6, June 2015

The Concept of Programmable Logic Controllers and its role in Automation

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Abstract: In this paper, we discuss about Plc i.e. programmable logic Controllers. This paper explores the roles of PLC in automation engineering which is a cross sectional discipline that requires proportional knowledge in hardware and software development and their applications.Earlier in Industry, We used certain control devices which were controlled and wired directly with the system that leads to certain irregularity in the functioning of the whole system. To overcome the in-functionality of the system which was caused by large number of wires, we came cross towards Programmable logic controllers (PLC). The main reason in order to remove irregularity of relays and wiring issue, we prefer PLC to control and monitor the operation of devices in the industry.

Keywords: PLC, automatic control, Ladder Logic, Automation

I. INTRODUCTION

Every aspect of industry—from power generation to automobile painting to food packaging—uses programmable controllers to expand and enhance production. **Programmable logic controllers**, also called *programmable controllers* or *PLCs*, are **solid-state** members of the computer family, using integrated circuits instead of electromechanical devices to implement control functions. They are capable of storing instructions, such as sequencing, timing, counting, arithmetic, data manipulation, and communication, to control industrial machines and processes.

Programmable controllers have many definitions. However, PLCs can be thought of in simple terms as industrial computers with specially designed architecture in both their central units (the PLC itself) and their interfacing circuitry to field devices (input/output connections to the real world).The specifications required a solid-state system with computer flexibility able to (1) survive in an industrial environment, (2) be easily programmed and maintained by plant engineers and technicians, and (3) be reusable. Such a control system would reduce machine downtime and provide expandability for the future. Some of the initial specifications included the following:

• The new control system had to be price competitive with the use of relay systems.

• The system had to be capable of sustaining an industrial environment.

• The input and output interfaces had to be easily replaceable.

• The controller had to be designed in modular form, so that subassemblies could be removed easily for replacement or repair.

• The control system needed the capability to pass data collection to a central system.

• The system had to be reusable.

• The method used to program the controller had to be simple, so that it could be easily understood by plant personnel

PLC's were developed in the late 1960's to eliminate the large cost involved in changing complicated relay based machine control systems. These systems were inflexible. Their major rewiring or complete replacement was necessary every time when the production requirements changed and control sequences had to be modified. PLC is a small computer which is used for Automation and applications of Real -World Process, Such as a control of Machinery on assembly lines, Timers and Counter applications and other applications used the help of PLC. It is usually a Microprocessor. The Program which is to be written in ladder programming can use control complex sequencing and is written with the help of software by Engineers. The Program is stored in Battery-backed memory, Unlike General Purpose Computers, the PLC is packaged and designed for extended temperature ranges, dirty or dusty conditions, immunity to electrical noise, and

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is mechanically more rugged and resistant to vibration and impact. By implementing this project we decreases man power, thus increase in production of the industry [4].

II. DEFINITION OF PLC

PLC is a Digital Electronic Device that uses a Programmable memory to store instruction and to implement function such as Timing, Counting, Logic, Sequencing and arithmetic in order to control the machines and their processes. Input Devices such as switches, different types of sensors are used to control the input switching and output devices such as motors solenoids are used to control the output circuitry. Input devices e.g. switches, and output devices e.g. motors, being controlled are connected to the PLC and then the controller monitors the inputs and outputs according t this program stored in the PLC by the operator and so controls the machine or process[3].

Basically PLC was designed as a replacement for hard wired delay and other timer, counters and logic Functions. PLCs have certain advantages that make it possible to modify a control system without having to rewrite the connections to the input and output devices, the only requirement being that an operator has key in a different set of instruction. The result is a flexible system which can be used to control systems which vary quite widely in their nature and complexity.

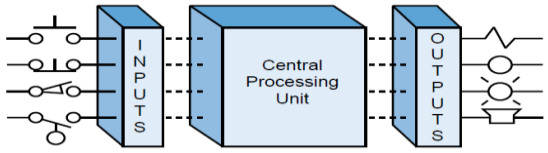

Figure 1:-PLC Architecture

III. PLC OPERATION

A PLC works by continually **scanning** a program. A PLC program is generally executed repeatedly as long as the controlled system is running. [1]. the status of physical input points is copied to an area of memory accessible to the processor, sometimes called the "I/O Image Table". 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. There are typically more than 3 but we can focus on the important parts and not worry about the others. Typically the others are checking the system and updating the current internal counter and timer values [6].A programmable controller, consists of two basic sections: the central processing unit and the input/output interface system.

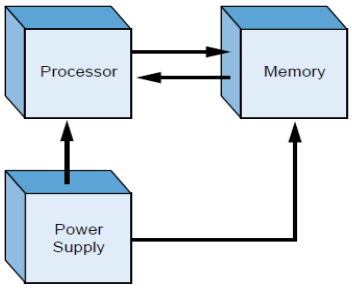

Figure 2:-PLC CPU Architecture

The operation of a programmable controller is relatively simple. The **input/output (I/O) system** is physically connected to the field devices that are encountered in the machine or that are used in the control of a process. These field devices may be discrete or analog input/output devices, such as limit

Switches, pressure transducers, push buttons, motor starters, solenoids, etc. The I/O interfaces provide the connection between the CPU and the information providers (inputs) and controllable devices (outputs).

During its operation, the CPU completes three processes: (1) it **reads**, or accepts, the input data from the field devices via the input interfaces, (2) it **executes**, or performs, the control program stored in the memory system, and (3) it **writes**, or updates, the output devices via the output interfaces. This process of sequentially reading the inputs, executing the program in memory, and updating the outputs is known as **scanning.**

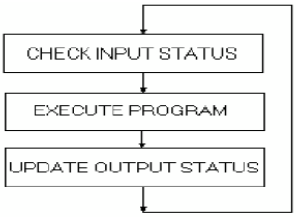

Figure 3:-PLC Scanning

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The input/output system forms the **interface** by which field devices are connected to the controller .The main purpose of the interface is to condition the various signals received from or sent to external field devices. Incoming signals from sensors (e.g., push buttons, limit switches, analog sensors, selector switches, and thumb wheel switches) are wired to terminals on the input interfaces. Devices that will be controlled, like motor starters, solenoid valves, pilot lights, and position valves, are connected to the terminals of the output interfaces [2]. The system **power supply** provides all the voltages required for the proper operation of the various central processing unit sections. Engineers can now have numerical control over automated devices. The result has been a rapidly expanding range of applications and human activities. Information technology, together with industrial machinery and processes, can assist in the design, implementation, and monitoring of control systems. One example of an industrial control system is a programmable logic controller (PLC). PLCs are specialized hardened computers which are frequently used to synchronize the flow of inputs from (physical) sensors and events with the flow of outputs to actuators and events.

IV. PLC FEATURES

The main difference from other computers is that PLCs are armored for severe conditions (such as dust, moisture, heat, cold) and have the facility for extensive input/output (I/O) arrangements. These connect the PLC to sensors and actuators.

Fig 4: Control panel with PLC (grey elements in the center). The unit consists of separate elements, from left to right; power supply, controller, relay units for in- and output.

V. PLC PROGRAMMING

PLCs are programmed using application software on personal computers. The computer is connected to the PLC through Ethernet, RS-232, RS-485 or RS-422 cabling. The programming software allows entry and editing of the ladderstyle logic. It is primarily 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.

The **ladder diagram** has and continues to be the traditional way of representing electrical sequences of operations. These diagrams represent the interconnection of field devices in such a way that the activation, or turning ON, of one device will turn ON another device according to a predetermined sequence of events. Programmable controllers can implement all of the “old” ladder diagram conditions and much more. Their purpose is to perform these control operations in a more reliable manner at a lower cost. A PLC implements, in its CPU, all of the old hardwired interconnections using its software instructions. This is accomplished using familiar ladder diagrams in a manner that is transparent to the engineer or programmer.

Let's compare a simple ladder diagram with its real world external physically connected relay circuit and see the differences.

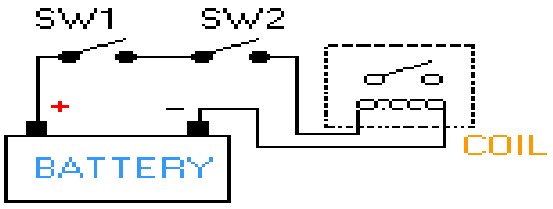

Figure 5:-Relay Circuit

In the above circuit, the coil will be energized when there is a closed loop between the + and - terminals of the battery. We can simulate this same circuit with a ladder diagram. A ladder diagram consists of individual rungs just like on a real ladder. Each rung must contain one or more inputs and one or more outputs. The first instruction on a rung must always be an input instruction and the last instruction on a rung should always be an output (or its equivalent).

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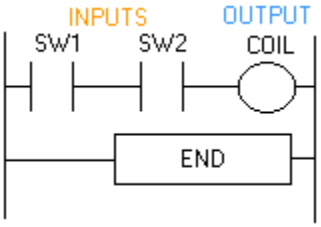

Figure 6:-Ladder Diagram

Notice in this simple one rung ladder diagram we have recreated the external circuit above with a ladder diagram. Here we used the Load and Out instructions. Some manufacturers require that every ladder diagram include an end instruction on the last rung. Some PLCs also require an end instruction on the rung after the end rung [5].

V1. PRESENT THEORIES & PRACTICES

Originally they were designed as a replacement for hard-wired relay and timer logic control systems. PLCs have the great advantage that it is possible to modify a control system without having to rewrite the connections to the input and output devices, the only requirement being that an operator has key in a different set of instruction. The result is a flexible system which can be used to control systems which vary quite widely in their nature and complexity.

PLCs are similar to computer but have certain features which are specific to their use as controllers.

These are:

1. They are rugged and designed to withstand vibrations, temperature, humidity and noise.
2. The interfacing for inputs and outputs is the controller.
3. They are easily programmed and have easily understood programming language.
4. It contains programmable functions.
5. It scans memory, inputs and outputs in predetermined manner.
6. It provides error checking diagnostics.
7. A PLC can provide some form of monitoring capabilities
8. A PLC can be effectively designed for a wide variety of control tasks.

VII. CONCLUSION

Programmable controllers are now mature control systems offering many more capabilities than were ever anticipated. They are capable of communicating with other control systems, providing production reports, scheduling production, and diagnosing their own failures and those of the machine or process. These enhancements have made programmable controllers important contributors in meeting today's demands for higher quality and productivity. Despite the fact that programmable controllers have

Become much more sophisticated, they still retain the simplicity and ease of operation that was intended in their original design. Programmable controllers can be considered newcomers when they are compared to their elder predecessors in traditional control equipment technology, such as old hardwired relay systems, analog instrumentation, and other types of early solid-state logic. Although PLC functions, such as speed of operation, types of interfaces, and data-processing capabilities, have improved throughout the years, their specifications still hold to the designers' original intentions—they are simple to use and maintain.

The soft wiring advantage provided by programmable controllers is Tremendous. In fact, it is one of the most important features of PLCs. Soft wiring makes changes in the control system easy and cheap. If it want a device in a PLC system to behave differently or to control a different process element, all have to do is change the control Program. In a traditional system, making this type of change would involve physically changing the wiring between the devices, a costly and time-consuming endeavor. In future definitely PLC is dominated on all other controlling methods.

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