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A Review: Embedded PLC

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***Abstract*— A programmable logic controller (PLC) is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. An Embedded PLC is a standard industrial device that provides a simple method of controlling processes. Designing of such Embedded PLC has the objective to provide easy and time effective solutions to industrial problems and make industrial automation at high level. Purpose of development of Embedded PLC is to meet all the advantages of embedded systems with the advantages of PLC. The proposed system has the combination of the LabVIEW software with ARM Microcontroller. Embedded PLC is an ARM microcontroller based system. The LabVIEW embedded module for the ARM controller is applicable for the Embedded PLC. The proposed PLC makes industrial automation easy and also applicable for the mechatronics students to learn the programming. The implementation of Embedded PLC is discussed and evaluated.**

***Index Terms*—ARM controller, Embedded system, LabVIEW software , Programmable logic controller**

I. INTRODUCTION

Programmable logic controllers (PLCs) are a specialized type of embedded systems used to control machines and processes. It uses programmable memory to store instructions and specific functions that include on off control, timing counting, sequencing, arithmetic and data handling. Originally, programmable logic controllers were specialized computers for the mapping of hardware relay logic to software in order to save costs and reduce necessary efforts for modification and maintenance of hardware logic. After this concept PLC's becomes one of the most commonly used types of automation components in industry. The graphical languages play a decisive role in high acceptance of PLC's. A Programmable Logic Controller (PLC) is a standard industrial control device that provides a simple, yet robust, method of controlling manufacturing and dynamic processes. As a result of their low cost, adaptability, and reliability, PLCs are by far the most common control mechanism used by manufacturing businesses of all sizes for environment control, food processing, motion control, and automated test equipment.

PLC's is preferred for the automation because of its advantages like consistency in manufacturing can be easily achieved, complete control of the manufacturing process can be achieved, accuracy and quality can be improved, Productivity can be improved, makes it easy to work in difficult or hazardous environment. The embedded system is designed to perform a specific task. An embedded system is one that has computer-hardware with software embedded in it as one of its most important component.

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II. LITERATURE SURVEY

Companies are always looking for ways to increase production. The elevated consumerism pushes factories to produce more in less time. Industry automation came as the solution to increase quality, production and decrease costs. Before PLCs came into existence; sequencing, safety interlock logic for manufacturing, and other controls were accomplished using physical relays, timers, and dedicated closed-loop controllers. But the control industries were looking forward to eliminate the high costs associated with inflexible, relay controlled systems [1]. The specifications required for a solid-state system that should be able to survive in an industrial environment, it can be easily programmed and reusable. Such a control system would reduce machine downtime and provide expandability for the future. To avoid such limitations control system has some features like easily replaceable, having long lifetime, reparable, methodology for programming should be simple reusable.

The early history of the PLC [2] goes back to the 1960's when control systems were still handled using relay control. Control systems implemented using relay controller which has lack of flexibility, complex troubleshooting. These problems were faced continuously by technician and control engineers. In 1968 Bill Stone part of the Hydramatic Division of General Motors Corporation presents "standard machine controller". The early model of this machine not only had to eliminate costly scrapping of assembly-line relays during model changeovers and replace unreliable electromechanical relays, but also it extends the advantages of static circuits to 90% of the machines in the plant, reduces machine downtime, includes full logic capabilities, except for data reduction functions.

Allen-Bradley develops first the PDQ-II or program data quantizier, was deemed too large, too complex and too hard to program. The second attempt, the PMC or programmable matrix controller, was smaller and easier to program, but still it was not able to fully serve customer needs for machine controls.By the time of the proposal, people at Bedford Associates, which included Richard Morley, Mike Greenberg, Jonas Landau, George Schwenk and Tom Boissevain, were already working on the design of a unit, which characteristics included a modular and rugged design, the use of no interrupts for processing, as well as direct mapping into memory. The Bedford team named this unit as the 084, since it was the 84th project for the company. The team at Modicon was finishing the design and build of the 084, that now they were calling the programmable controller (PC). Finally in 1969, Bedford Associates (Morley, Greenberg, Landau, Schwenk and Boissevain) already working from 1968 on the "084". They form Modicon and together in 1969 build the "Programmable

Controller 084" also known as the "Modicon 084" which wins the proposal.

By 1971, Odo Struger and Ernst Dummermuth engineers of Allen-Bradley, had begun to develop a new concept that included improvements based on the customer needs that could not be fulfilled by its second attempt, the PMC. This new concept was known as the Bulletin 1774 PLC.Allen-Bradley named this new device as the "Programmable Logic Controller" (PLC) over the then accepted term "Programmable Controller".In 1985 Rockwell Automation acquired Allen-Bradley. During this time Modicon was already gaining experiences through the Modicon 084. Based on this experience, the design cycle by Michael Greenberg, and the marketing ideas of Lee Rousseau, the Modicon 184 was born in 1973.In 1977 Modicon was sold to Gould Electronics, and later in 1997 to Schneider Electric, which still owns the brand today, and uses the Modicon name. In 1973, Modicon (Greenberg and Rousseau) develop the "Modicon 184", which produces the take off of Modicon. The evolutionary approach to help control engineers and maintenance people interface with Allen-Bradley PLCs improved acceptance and opened new possibilities for the use of PLCs. Zifferer's company merged with Rockwell Automation in 1993.

I. Recent PLC available in market

Sr. No.	PLC	Features
1	Micrologix 1000	Allen-Bradely develops Micrologix 1000 from Micro & Nano systems from Rockwell Automation. This controller fits a wide variety of applications upto 32 I/O points, while using a fraction of the space of a full-size controller. It contains embedded analog I/O, providing compact and cost-effective analog performance [3]
2	SIMATIC S7-200	The S7-200 Micro PLC from Siemens can be used as either a stand-alone Micro PLC solution or in conjunction with other controllers [4].
3	AC500 eCo PLC	AC500-eCo PLC is supplied by ABB. ABB is the supplier of choice for small equipmentcontrol applications to complex systems like web presses and distributed systems [5].
4	Modicon M340	Modicon M340 is a mid range PLC for industrial process and infrastructure from Schneider Electric. Modicon Programmable Automation Controllers (PACs) are built to suit the needs of the process industry and a wide range of demanding automation applications [6].

III. IMPLEMENTED AUTOMATION SYSTEM USING PLC

As the response to the feedback from academic and industry, the department of Agricultural Engineering, Faculty of Engineering and Architecture, University of Khartoum has successfully designed and developed a low cost programmable logic controller (PLC) workbench for educational purposes [7].

Fig.1. Overview of PLC Workbench

The purpose of the PLC workbench is to provide experience with PLC and related equipment commonly found in industry. The equipment installed on the PLC workbench includes: a personal computer (PC) and monitor, PLC unit, program software, power supply, relay, power source. Using such a workbench a packing system prototype is designed. Such a workbench is considered as a base for new Agricultural Automation and Robotic Laboratory. Human machine interface (HMI) will make the workbench a useful laboratory teaching principles of SCADA system [7].

The creation of a low-cost open source PLC, comparable to those already used in industry automation, with a modular and simplified architecture and expansion capabilities is discussed in [8]. The goal of this project is to create the first fully functional standardized open source PLC. The Open PLC was created to break these two barriers, as it is fully open source and open hardware. This kind of project helps spread technology and knowledge to places that need the most. Also, the Open PLC is made with inexpensive components to lower its costs, opening doors to automation where it wasn't ever possible before.

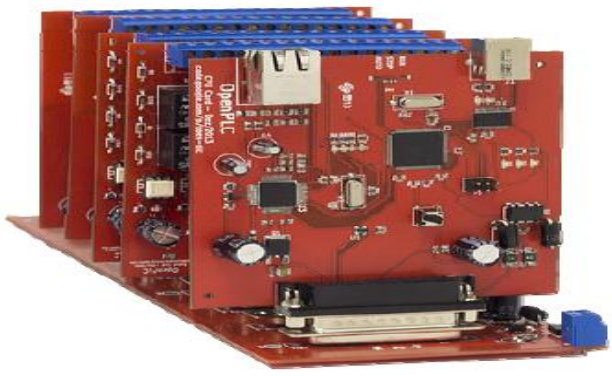

Fig.2.The Open PLC Prototype

The Open PLC was created based on the architecture of actual PLCs on the market. It is a modular system, with expansion capabilities; an RS-485 bus for communication between modules and hardware protections .By using Open PLC prototype The MODBUS-TCP communication was tested using SCADA software from different vendors. The

future step is to use Open PLC prototype in a field application, evaluating its robustness, versatility and ease of use for the user [8].

The design and implementation of a classical control system laboratory based on PLC control system is introduced in [9]. To design and implement the system, two parts must be produced. The first is software for PLC and the second is hardware for experiments related to the programs. This implementation has high performance, high accuracy and more speed response com-pared to the classical controller. The trainer presents practice simulation for many real systems; therefore it is very suitable for classical laboratory unit with undergraduate students.

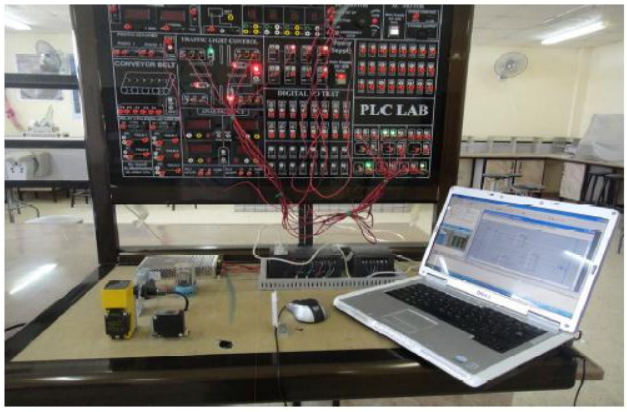

Fig.3. Classical control system laboratory based on PLC

A Programmable Logic Controller, PLC is a digital computer used for automation of electromechanical processes, such as control of machinery on factory assembly lines, amusement rides, or light fixtures. PLCs are used in many industries and machines. Continuous bottle filling system[10] is one of the important application of PLC in the bottle filling industry where we want our bottles, which are moving on the conveyor belt, to be automatically detected at the appropriate position and get it filled by any desired liquid and also after getting filled the queued bottle gets chance to be filled. If this whole process is carried out manually it will really take a long time and also the quantities will be quite lesser. So PLC becomes requisite controller for these types of industry.

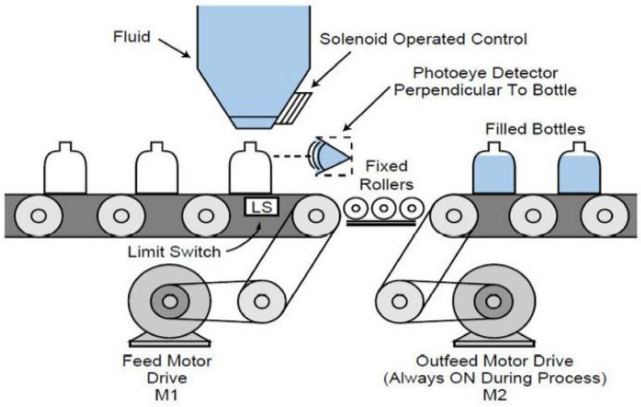

Fig.4. Bottle filling system using PLC

IV. CONCEPT OF EMBEDDED PLC

An Embedded PLC is a standard industrial control device that provides a simple, yet robust, method of controlling manufacturing and dynamic processes. As a result of their low cost, adaptability, and reliability, Embedded PLC can be used in manufacturing businesses of all sizes for environment control, food processing, motion control, and automated test equipment. Embedded PLC is nothing but the concept of combining advantages of embedded system together with the PLC.

Designing of such Embedded PLC for the providing advance solutions to industrial problems and make automation is easy. Such a Embedded PLC is designed for real time industrial monitoring. In this system PIC microcontroller with special web based software is used. This Embedded PLC will be very flexible in industrial sector. Embedded PLC can also be used for commercial application. E-PLC Soft logic software provides online support for Embedded as well as Conventional PLC Programming. But by using PIC controller there are some limitations for the PLC. PIC controller has some disadvantages like memory requirement is more, no more logic implementation is possible, no more external devices are interfaced by using PIC [11].

Fig.5. Interfacing of temperature Sensor to Embedded PLC

V. EXISTING SYSTEM

Early PLCs, up to 1980s, were programmed using programming panels. It can be also uses the special-purpose programming terminals, which having dedicated function keys for the representation of the logical elements of PLC programs [12]. Ladder Diagram (LD) is one of the important techniques for the PLC programming. When system architecture becomes more complex, LD implementation for the system becomes very hard. Therefore the performance of the PLC decreases in such a situation because PLC processor does not having capability to perform complex computations [13]. For understanding ladder logic, only experienced engineers are required for troubleshooting the problems. Fresher or inexperience person who does not having more knowledge about the ladder logic results in increase downtime of PLC. For the execution of complex ladder diagram dedicated processor is required which requires large memory to store this ladder diagram [14]. There are different manufacture provides different software for PLC, but the same programming software is not supported for other PLC [15]. Mostly for the PLC's I/O's are digital in nature,

therefore for the conversion ADC and DAC are used, and then I/O's are applied to the PLC. By adding such extra circuitry makes complications for PLC design [16]. PLC has limited transmission speed, it is normally in Kilobytes. That's why such a PLC not efficient for the high frequency application. This speed is not sufficient when your PLC is connected over the network or connected to internet. The most serious problem is attenuation of signal, distortion of transmitted signal & noise. Therefore by assuming all these limitations PLC's are limited to several area applications [17].

Therefore to avoid such limitations of the existing system an Embedded PLC is developed. Such a proposed system is ARM based System. It uses the LabVIEW software with FBD programming language.

VI. Conclusion

To avoid limitations of existing system Embedded PLC is implemented. Such a proposed system is an ARM microcontroller based system. For the programming of Embedded PLC LabVIEW software with LabVIEW Embedded Module is used. The prototype is developed as batch mixing system using Embedded PLC.

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