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Embedded PLC Development using ARM

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Abstract: *With the passage of time, the technologies used for automation enhanced in terms of accuracy and flexibility because of the use of semiconductor devices. PLCs (Programmable Logic controllers) is an industrial digital computer which has been ruggedized to provide the best way for controlling electromechanical processes, manufacturing processes, batch process, etc. They are highly robust, accurate, have reliable operation and can be easily programmed. But the major problem associated with PLCs is the cost. They are very expensive hence become an issue for small scale industry. Embedded PLC is an industrial device that provides a simple method of controlling process. Objective behind designing Embedded PLC is to exploit all the advantages of PLC & embedded systems at an economical level. In proposed system a combination of embedded PLC developed using ARM and embedded c is used to achieve the controlling of AC devices based on the signal provided by sensor.*

Keywords*: PLC, ARM, Embedded system, Automation, Embedded C.*

1. Introduction

Before the arrival of solid-state logic circuits, logical control systems were fabricated and built exclusively using electromechanical relays. Relays are far from obsolete in contemporary design, but have been replaced in many of their erstwhile roles as logic-level control devices, related most often to those applications demanding high current and/or high voltage switching. In late 1960's an American company released a computing device they called the MODICON (stands for Modular Digital Controller) which later became PLC. PLC is a micro-processor based industrial digital computer which is extensively employed for the automation and controlling of processes such as manufacturing, electromechanical, batch, etc. These controllers are specially designed to survive in harsh situations and shielded from heat, cold, dust, moisture etc. They found ample application in industries because of their ability of withstand noise, vibration and high temperature, reliable & precise operation and ease of programming. The issue with the use of PLC is the capital cost (ranges in lacs) which is very high. Thus implementation of PLC becomes less economical for small scale industries.

The embedded system is designed to perform a specific task whereas as per definition the general purpose computer is meant for general use. It can be used for playing games, watching movies, creating software, work on documents or spread sheets etc. Application specific requirements are key factor for the Embedded System.

Embedded PLC presented here is developed using ARM microcontroller (lpc2148) which meet all the features of PLC and embedded system. Embedded PLC has several numbers of I/O ports and communication module. ARM microcontroller is used because of its low price, low power consumption and high speed of operation.

2. Literature review

Embedded PLC can become a solution to various issues associated with PLC. Consider a case for Embedded PLC is an on-site diagnosis of industrial facilities based on the programming code for the technical device. Embedded PLC can perform reasoning on sensor data in the context of diagnostic background knowledge to detect a machine faulty behaviour to trace the causes. An example scenario is identification for steam and gas turbines in electrical power plants, where early detection of oddity in running a plant helps avoid exorbitant downtime and repair of turbine machinery [1]. 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 [2]. Ladder logic is most widely used technique for PLC programming. But as the architecture of system becomes more complex, LLD (Ladder Logic Diagram) implementation for system becomes very hard [3]. Only experienced engineers are capable of troubleshooting a ladder logic diagram. Fresher who does not have prior knowledge about ladder logic results in increased downtime of PLC [4]. Therefore to avoid such

limitation of existing system Embedded PLC is developed.

3. Block diagram of proposed system

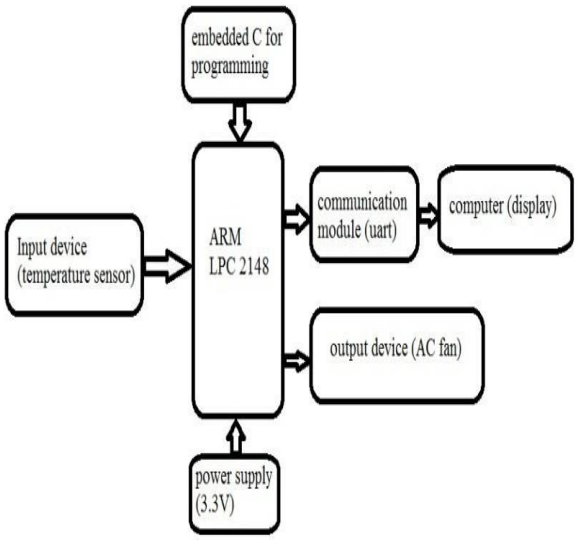

Figure 1 Block diagram of Embedded PLC

For the implementation of Embedded PLC, ARM microcontroller is used. It has several advantages over other microcontroller such as low power consumption, high speed of operation, low price and wide variety of peripherals. The block diagram presents the controlling of speed of AC fan on the basis of temperature sensor signal. As the temperature varies i.e. from 0°C to 30°C, the speed of the fan will be 25% of the max. speed, when temperature ranges from 30°C to 35°C, the speed of fan will be 50% of the max. speed and so on. The data will be displayed on the computer through communication module i.e. UART module. The UART module is a computer hardware for serial data communication in which data format and transmission speed is configurable. The code is written in embedded C. Since ARM controller is based on RISC (Reduced Instruction Set Computer) hence it is capable of execution instructions using less number of micro-controller cycle per instruction. Thus they can operate at higher speed, performing more millions of instruction per second. RISC architecture provide outstanding performance at a fraction of the power demand of the CISC (Complex Instruction Set Computer) devices.

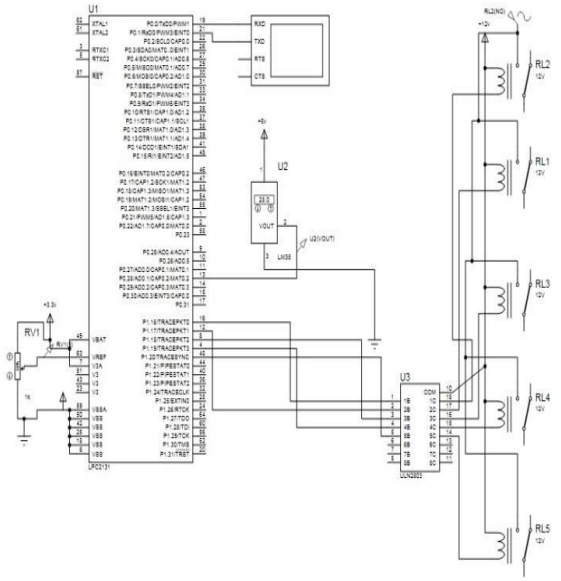

Figure 2 Circuit diagram of proposed model

4. Circuit Diagram of proposed model

ARM microcontroller LPC2148 requires 3.3V power supply which has been provided through a 3.3V voltage regulator (AMS 1117). The actual supply provided to the hardware is 12V which is then converted to 5V and then to 3.3V. Relay IC require 12V and MAX232 require 5V of supply. The controller is operated at 12MHz clock frequency which is provided by crystal circuit. The temperature sensor is connected at port P0.28 set as ADC (Analog to Digital conversion). Since the output of the temperature sensor is analog but input to the microcontroller is 3.3V digital hence analog to digital conversion is required. Temperature sensor input is calibrated using potentiometer. Port P0.16, P0.17, P1.18 and P1.19 of microcontroller is connected to relay through a relay driver IC (ULN 2803). Fan is connected to the relay through fan regulator. Fan speed is displayed on computer. The communication module include MAX232 IC for conversion of signal from RS232 serial port to signal suitable for use in TTL-compatible digital logic circuits.

5. Experimental setup

Hardware presented in the experimental setup is hard framed to protect it from any mechanical damage and provide robustness. Black covering is done to dissipate heat and keep the setup cool.

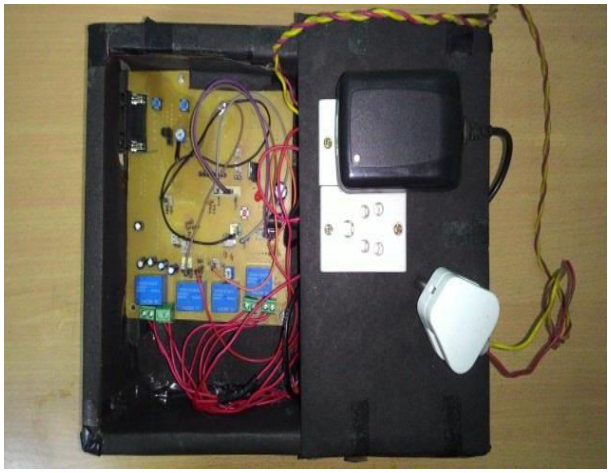

Figure 3 Experimental setup

6. Conclusion

Thus embedded PLC design provided above has reached the expectation of incorporating the traits of PLC and embedded systems. The experimental setup can be used for cooling of big machines and home purposes. By modifying the source code and increasing number of sensors more information can be obtained regarding the environment of the systems or the place for which it is implemented.

7. References

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