

PLC based Home Automation System

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Abstract— Programmable Logic Controller (PLC) is utilized extensively for automation of electromechanical processes. In this study, a home automation system is designed using PLC. The proposed control module will consist of software simulation and hardware implementation. The control module provides multiple components fault detection, tolerance and switch on or off in critical areas. The system is easy to build, service, modify and it provides reliable communication of home automation with reduced cost. In this paper, we propose the idea of designing a smart home with optimized energy consumption. The system is programmable to meet demands, adding different home appliances in short time by optimizing the entire hardware assembly and software algorithms. The PLC is easy to understand and the system provides multiple solutions by using a single component. Although new but more efficient than previous systems, the PLC can become the epicenter to many new applications. Once the system is designed and implemented; the only cost is that of maintenance. It is also possible to combine PLC model with other devices such as GSM. Such kind of an application will be extremely beneficial for the aged and disabled people by offering voice control and safety items.

Keywords— Programmable Logic Controller, Fault detection, Software Algorithms, GSM.

I. INTRODUCTION

PLC can help in achieving complete automation e.g. an air conditioning system can be switched on before the owner reaches his home especially in summer. A PLC based security system will detect smoke, excessive electrical power usage, burglar attempts and unauthorized movements in the house and send alert messages. This is the idea behind designing home automation system using PLC and there is no end to its applications. Advanced and more reliable PLCs are now being developed that can maintain a record of household items, record their usage through RFID (Radio Frequency Identification), automatically order replacements etc. Home automation is a key term when we refer a smart home, a home that can detect and distinguish, automatically adjust the lighting as per user's requirement, open doors automatically when combined with proper sensors, switch on the security lights at night and switch them off in morning without any interference in the user's schedule, heat water for bathing and tea making, accessing anywhere in the world via internet, a live video of what is happening in your surroundings [1]. This is possible via one centrally controlled system. Nowadays, it has become essential to have an automated home which can range from remote, set burglar alarm and hi-tech security gates.

II. LITERATURE SURVEY

Various home automation systems have been designed and the system coding depends on number of applications to be controlled. The reason for its tremendous growth has been attributed to various informal research and designs. The types of home automation systems based on their control systems are:

A. Individual Control System-

This type of control system is considered to be the predecessor of modern day control systems. Here each device like heater or air conditioner will have an independent control dedicated to it. Following are the various individual control systems:

- Wired remote controller
- High-spec wired remote controller
- Timer remote controller
- Wireless remote controller
- Simplified remote controller
- Remote sensor

B. Distributed Control System-

A distributed control system is a computerized control system. In this, the control systems are distributed throughout the system, but there is a central operator supervisory control. The main feature of this type of system is emergency shut-down. This system can be pre-set or the control parameters of several similar devices can be varied as per requirement. For example, controlling the thermostats of several air conditioners and their ON/OFF timings [3].

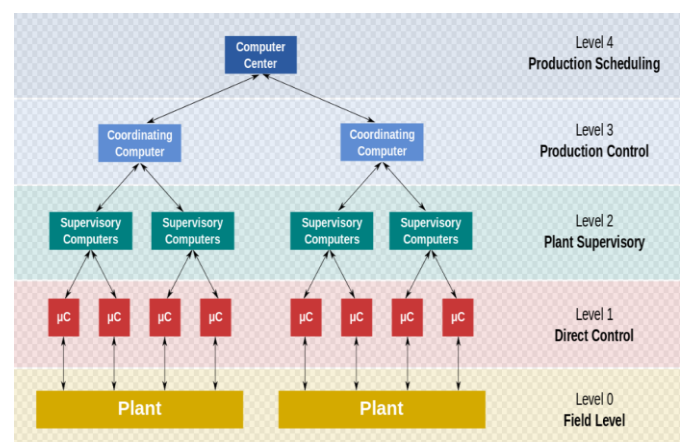


Figure 1: Distributed control system (Source: Wikipedia)

C. Central Control System-

These systems are programmed to handle various functions of multiple utilities like home entertainment, windows, refrigerators and cooking systems all at the same time in home. The operator can connect to the control system through telephone or internet from anywhere in the world.

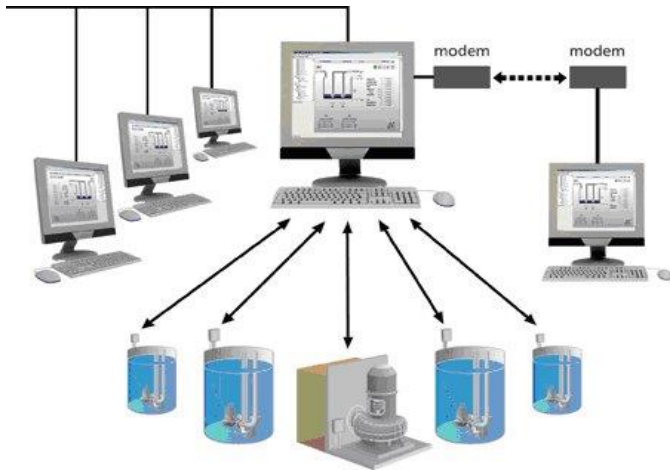


Figure 2: Central control system (Source: Xylem solutions)

The different types of home automation systems using PLC but based on the carrier mode are as follows:

A. Power line carrier System-

It is the least expensive type of home automation system which operates over the home's existing wiring or power line carrier. These can range from X10-based lamp timers, to more complex and intricate systems that require installation by a trained professional [4].

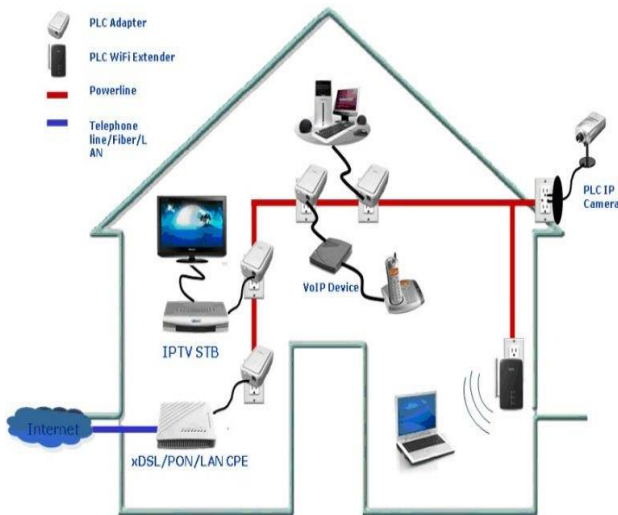


Figure 3: Power line carrier system [5]

B. Wireless system-

Along with power line carrier systems, the wireless systems are also available those utilize radio-frequency technology. They can be used for operating lights, sometimes in concurrence with a hardwired lighting control system.



Figure 4: Wireless system (Source: Zygbee Home Automation)

C. Hardwired system-

Hardwired home control systems are the most reliable but expensive. Hard wired systems are considered an ideal choice for larger homes where there is a requirement for multiple actions operating simultaneously [6]. The major applications of hardwired systems may include integrating more systems in the home, effectively combining the indoor and outdoor lighting, audio and video equipment's and security system, even the heating and cooling system into one control package that will be easy and not time consuming.

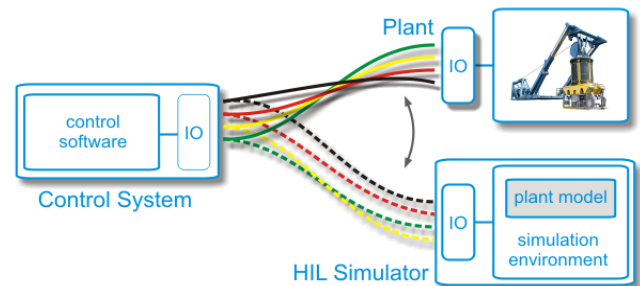


Figure 5: Hardwired system [7]

D. Internet Protocol control system-

Internet Protocol (IP) control automation system provides control using internet. Each device under its control is given a particular and specific Internet Protocol address and they can be monitored using a local area network (LAN) in home. Hence, the system is interactive using internet with the possibility of live video streaming and real-time control.

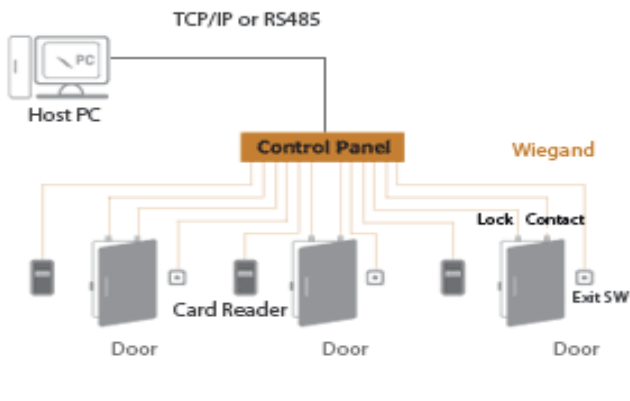


Figure 6: Internet protocol control system [8]

E. Comparison of Home Automation System using PLC and microcontroller

- PLC uses programmable memory for functions such as timing, counting etc. whereas a microcontroller is a microprocessor with internal input and output and memory i.e. RAM, ROM, PORTS.
- PLC has more number of input and output terminals as compared to microcontroller.
- PLC can be used easily for Industrial/Home automation whereas in microcontroller certain difficulties arise as per change in operation.
- For PLCs, development time is less as compared to microcontrollers.
- Troubleshooting a PLC is much more technician friendly but in microcontrollers troubleshooting is much more complex.
- Interfacing in PLC is much simpler than in microcontrollers where the user requires developing his own signal interface.
- PLCs are highly reliable, fast and flexible as compared to microcontrollers.
- Microcontrollers are developed for dedicated equipment's but PLCs can control many devices simultaneously.

Today's smart home focuses on comfortable living with optimum power usage and security of the house. They helps in reducing the wastage of energy. The system also tracks the unoperational devices in the house). Current trends in smart home and home automation include the following [9]-

- Lightening control.
 - Automated thermostat adjustment
 - Remote video surveillance
 - Remote mobile control
 - Automated control of doors
- In this work we are going to automate the following tasks:
- Automation of the lightening systems to turn on or off depending upon certain conditions in various areas of house.
 - Automation of home appliances for e.g. controlling the temperature of oven etc.
 - Controlling the AC to save energy.
 - Control of garden irrigation system depending upon the signals received from the humidity and precipitation sensors.

- Home security system: It will monitor the house and in case of any unwanted activity, it will take actions according to the logic.
- Movie Theater at your home: By controlling your TV, tuners, stereo, DVD players etc. you can create your own home theater.
- Waking up in your favorite environment: Instead of waking to a harsh alarm sound, you can set the control system to create your favorite environment at your wake-up time.

III. METHODOLOGY

In this project, some specific and deliberate choices were made on the type of platforms, the hardware components to be used and the mode of operation of home automation system. Before the actual design of the project work, it is extremely necessary to make specific deliberate choices in selection of appropriate implementation platforms. Priority was given to low cost yet reliable components, availability, flexibility and simplicity in all these selections. Some of the available platforms are- Power line, RS232, Ethernet, Infrared, GSM, PLC and Microcontroller; RS232. Many permutations and combinations were considered for this project and among them; GSM and PLC were found most appropriate due to reliability and simplicity when used for an individual control home automation system which our project work deals with. Using Power line and Ethernet seemed expensive and complex for this kind of home automation system while Bluetooth and Infrared are found to be unreliable [10].

A. Hardware Requirements:

- Programmable Logic Controller (PLC)
- RS 232 To 485 Converter
- Line Filter-single phase 0-230V
- Miniature Circuit Breaker (MCB)- single pole 230V AC 2Amp
- Switched Mode Power Supply (SMPS) 0-25V DC
- Voltage Regulators- IC7805, IC7812
- Opto-Coupler
- MOSFET
- Relay
- Centre Tapped Transformer -input 230V AC, output-12-0-12V
- Fuse 0.5mA
- BLDC Motor 12V DC
- Lamp Load 230V 12W
- GSM Module
- SIM
- Mobile phone

B. Software Requirements:

- SCADA software
- Communication protocol- MODBUS
- Programming software- ABB AC31GRAF
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IV. IMPLEMENTATION

A small PLC could have a fixed range of connections constructed in for inputs and outputs. The processor and choice of I/O modules are customized for precise application. Numerous racks may be administered through a single processor and can have number of inputs and outputs. Consumer Interface is required for the purpose of configuration, alarm reporting or regular control. A human-gadget interface (HMI) is employed for this purpose. Textual content displays are available in addition to graphical contact screens. PLC's have built in communication ports, typically 9-pin RS-232, however optionally EIA-485 or Ethernet.

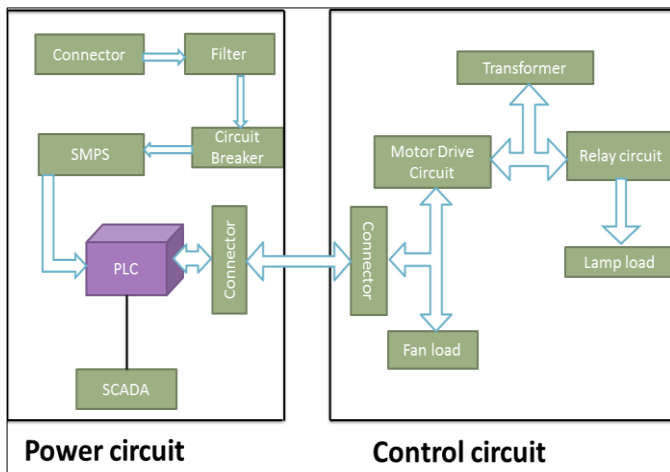


Figure 7: Block diagram of proposed system

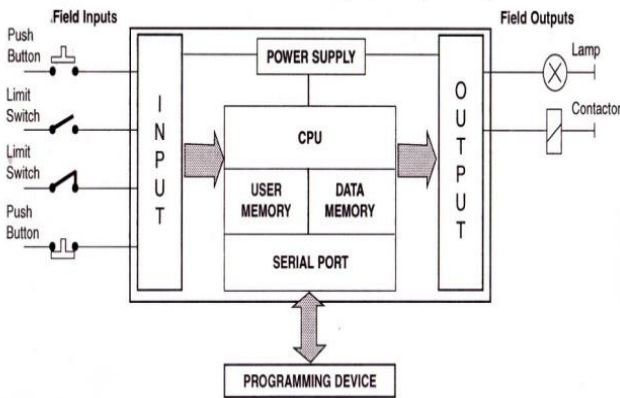


Figure 8: Block diagram of PLC [11]

The central processing unit (CPU) is the heart of the PLC system. It replaces central relays, counters, timers and sequencers. One bit processors can deal with logic operations. PLCs with word processors are used when processing text and numerical data, calculations, gauging, controlling and recording as well as the simple processing of signals in binary code are required. The operating principle of CPU can be briefly described as follows:

- The CPU accepts input from various sensing devices, executes the user program stored in the memory and sends appropriate output signal to control devices.
- A DC power source is required to produce low-level voltage used by processor and I/O modules [12]. The CPU contains various electrical parts and operational key switches.

In our system we are using PLC from ABB [13].



Figure 9: ABB 07KR51 PLC

Following are some of the specifications of the PLC:

- Binary inputs: 8
- Binary outputs: 6
- Analog potentiometers: 2
- Maximum number of extension units per central unit: 6
- Maximum number of remote units on the CS 31 bus: 13

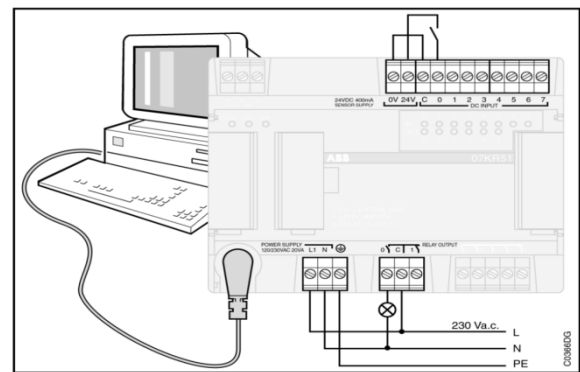


Figure 10: Cabling of a 07KR51 230 V a.c. central unit [13]

In latest years, "protection" PLC has started to end up popular. These are different from traditional PLCs as being appropriate for use in safety-essential packages for which PLC have traditionally been supplemented with difficult-stressed protection relays.

V. CONCLUSION

PLC is much better and advanced when compared to relay based automation. PLC uses simple program using ladder logic. The major advantages of using PLC are as follows:

1. It consumes less power.
2. Low maintenance cost and can be easily programmed.
3. Also, it has self-diagnostic functions which enables easy and fast troubleshooting of the system.
4. The machine cycle time is improved tremendously due to the speed of PLC operation being a matter of milliseconds.
5. Modification of control sequence can easily be done by programming without changing the I/O wiring.

ACKNOWLEDGMENT

We would like to express our sincere thanks to Mrs. Neha Bansal and Mrs. Garima Gurjar for taking time from their busy schedule to provide us with great deal of help, support and encouraged us to work diligently at every aspects of our project. Their constructive suggestions helped us to successfully do the project. We have benefited a lot from their immense knowledge and experience. We would also like to thank the faculty of Department of Electrical Engineering who greatly assisted our research and for their valuable help.

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