Smart Energy Saving Classroom using PLC

Pulkit Mathur[1] Somya Singh[2] Lalit Mohan[3] Shobhit Saxena[4] Ritu Rajan[5]
[1,2,3,4]U.G. Student [5]Assistant Professor
[1,2,3,4,5]Department of Electrical Engineering
[1,2,3,4,5]MIT Moradabad, India

Abstract— *This paper demonstrates a live implementation of the smart energy saving classroom using Programmable Logic Controller (PLC). PLC is one of the mostly used controllers as it is easy to operate and controls task according to the program which is already fixed. In this modern era when the young generation is transforming and getting smart, the campus premises should be smart too. So here is a classroom where there's no need to operate the appliances through switches, you enter the premises and appliances get switched on and get off when you leave the premises. The fans operate automatically according to temperature and lights get turned ON according to the intensity.*

Keywords— PLC, Relay (DPDT), SMPS, Infra-Red through Beam Sensors, LED Indicator, Temperature Sensor, Light Intensity Sensor

I. INTRODUCTION

In this project we have automated a room with the help of PLC. This is the technique which not only reduces the human effort but also saves time. In this project the main aim was to reduce the electricity consumption [1]. The working is such that when a person will reach the entry gate of the room the lights get automatically turned ON while the fan gets turned on as per the room temperature. If it is hot, the sensor will detect the requirement and the fans will also get turned ON. Thus in this busy schedule we don't need to put any efforts in switching ON/OFF the lights and fans. Thus it is saving valuable time and is economical by saving the bill of electricity.

This automated room will lead to reduction of human movement as the human does not need to move for switching on the appliances such as lights, fans etc.

Motivation of this project is that it's making the working of equipment happen automatically thus it not only reduces the human efforts but also saves our precious time.

We have implemented the hardware in the room. In this modern time PLC is also used even in our transmission system. By using PLC we can easily automate any device and in this project we are automating the room. Thus, this technique becomes time efficient.

In this room, there are two fans and two lights. These all four appliances are automated. There is a single gate for entry and exit both. So there are two through beam sensors installed at the gate for sensing the entry and exit. A temperature sensor and light intensity sensor is also installed in the room. The working of our room is in two modes. First one is manual mode, in which all the appliances get turned on/off through switches. The other mode is automatic mode i.e. PLC mode. In PLC mode, all the appliances of the room get turned ON/OFF automatically through PLC switching.

There is a control panel in the room and all the controls are established here. A changeover is installed for switching between PLC mode and manual mode. There are two LED indicators present indicating that which mode is in use. Other controlling consists of four toggle switches. These switches are for presetting the appliances to control in PLC mode.

Besides these features, energy is also used efficiently in this project. All the appliances are in use only when there is a need by any user. At the idol state, these components remain off. So energy consumption reduces.

We have used PLC of Allen Bradley, Micrologix 1000 of 10 I/Os. For converting 220V AC to 24V DC, switched mode power supply is used.

II. BASIC APPROACH FOR SMART ROOM

The main objectives of our project can be summarized as follows:

- To design and develop smart room which is user friendly.
- To understand the energy consumption associated with room and to reduce it.
- To make a program, which should be easy to understand by an electrical engineer.
- To use the most appropriate hardware components that would make the room more efficient and reliable.
- To develop a user friendly interface of control panel.

This room is fully automated. There is no need of any kind of human efforts. This is associated with user friendly environment for the users. It is energy efficient and economical. PLC is used of 10 I/Os.

A. PLC:

Fig. 1: PLC used for project

A programmable logic controller, PLC is a digital computer used for automation of typically industrial electromechanical processes, such as control of machinery on factory assembly lines etc. It is a solid state user programmable control system with functions to control logic, sequencing, timing, arithmetic data manipulation and counting capabilities. It can be viewed as an industrial computer that has a central processor unit, memory, input output interface and a programming device [2]. The central processing unit provides the intelligence of the controller. It accepts data, status information from various sensing devices like limit switches, proximity switches, executes the

user control program stored in the memory and gives appropriate output commands to devices such as solenoid valves, switches etc.

In this project we have used PLC with 10 I/Os as shown in Fig. 1. It contains 6 Input terminals and 4 output terminals. 4 input terminals and 2 output terminals are in use.

B. Power Supply:

We are using Switch mode power supply. This supply converts the 220V AC into 24V DC with the current rating of 2 Amperes. There is a regulator also, by using which we can control the output value of SMPS [4].

A switched-mode power supply is an electronic power supply that incorporates a switching regulator to convert electrical power efficiently. SMPS transfers power from a source, like mains power, to a load, such as a personal computer, while converting voltage and current characteristics. Unlike a linear power supply, the pass transistor of a switching-mode supply continually switches between low-dissipation, full-on and full-off states, and spends very little time in the high dissipation transitions, which minimizes wasted energy. Ideally, a switched-mode power supply dissipates no power.

Voltage regulation is achieved by varying the ratio of on-to-off time. In contrast, a linear power supply regulates the output voltage by continually dissipating power in the pass transistor. This higher power conversion efficiency is an important advantage of a switched-mode power supply.

Switched-mode power supplies may also be substantially smaller and lighter than a linear supply due to the smaller transformer size and weight.

C. Relay:

In electrical engineering, relay is an electrical component that can break an electrical circuit, by interrupting the current or diverting it from one conductor to another. The most familiar form of relay is a manually operated electromechanical device with one or more sets of electrical contacts, which are connected to external circuits. Each set of contacts can be in one of two states: either "closed" meaning the contacts are touching and electricity can flow between them, or "open", meaning the contacts are separated and the switch is non-conducting. Relay we used is DPDT *(double pole double throw)* relay [3]. It operate on 24V DC supply which is controlled by PLC. Fig. 2 shows the connection diagram of a DPDT relay.

1) Working of Relay:

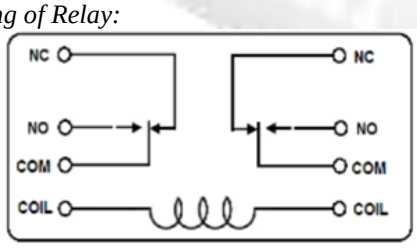

Fig. 2: Connection Diagram of Relay

In this project, 6 DPDT Relays are used to provide switching action to the components installed. The first 2 relays are used for the lights and fans operation in automatic i.e. PLC mode. Likewise, other 2 relays are used for operation in manual mode with the help of switches. The through beam sensors installed on the gate for entry and exit are also switched with the help of relays, one relay for the entry purpose and the other for exit.

D. LED:

We've used 3 LED indicators in the project. The first indicator is installed with the reset switch to signify the user if he/she resets the system. The other two indicators are used with the changeover on the control box to indicate which mode he/she is using i.e. manual mode or automatic mode.

E. Through Beam Sensors:

In this project, we are using through beam sensors which are installed at the gate sensing entry & exit. It is a sensor able to detect the presence of nearby objects without any physical contact. A through beam sensor often emits a beam of electromagnetic radiation (infrared), and looks for changes in the field or return signal. The object being sensed is often referred to as the sensor's target. A sensor consists of an emitter and a receiver. An infrared beam is emitted by emitter and received by the receiver. If any obstacle comes in between them, the receiver senses obstacle and gives the signal. These sensors work on the supply of 24V DC. These sensors are of NPN type [8].

F. Temperature Sensor:

Temperature Sensor is used for sensing the temperature in the room. There is a controller which is associated with the sensor [6]. Fig. 3 shows the temperature controller along with the sensor. The temperature is getting measured by sensor and the output is transferred to the controller. Controller decides the action of output relay according to the temperature which is preset by the user.

Fig. 3: Temperature sensing unit

G. Light Intensity Sensor:

A light dependent resistance is used for the whole set up of light intensity measurement [7]. LDR is a light-controlled variable resistor. The resistance of an LDR varies with increasing incident light intensity.

A light dependent resistor works on the principle of photo conductivity. Photo conductivity is an optical phenomenon in which the material's conductivity gets increased when light is absorbed by the material. So the whole setup is light dependent device. The Fig. 4 shows the diagram of the LDR used in the project. This device is associated with measuring device and analyzes the light in the room. If the light intensity is more than 30 Lux in the room then it keeps the output value (0), but as the light

intensity gets decreased then a proper output get produced as true (1) condition.

Fig. 4: Light Intensity Sensing Unit

H. PLC Programming:

Ladder logic is the most common programming language used to program a PLC.

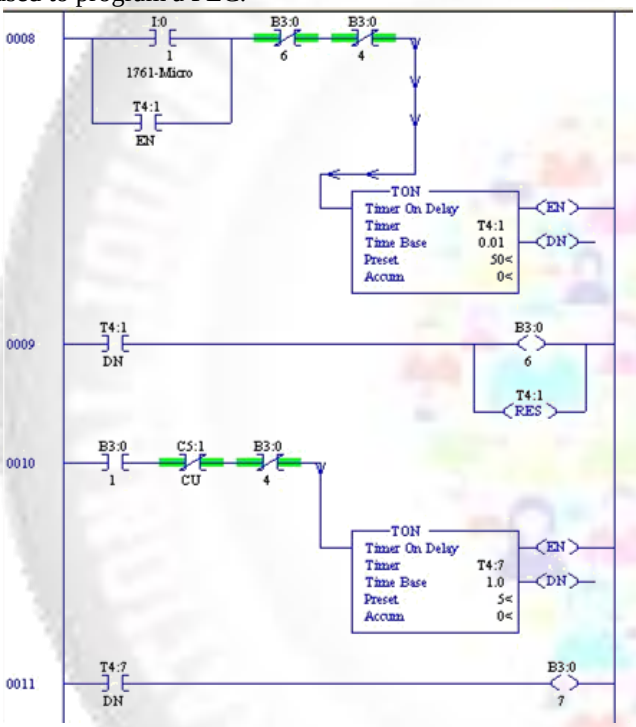

Fig. 5: PLC program in Ladder Logic

Ladder logic was one of the first programming approaches used in PLCs because it borrowed heavily from the relay diagrams that plant engineers already knew. It is similar to a schematic for a set of relay circuits [5]. Fig. 5 shows the glimpse of the program used to complete the aim of the project.

The program is made such that when the person passes through both the sensors then only the supply will get switched ON/OFF. In case, he/she passes through one sensor and step back, the preset value of timer given to the particular sensor resets it and the sensors come back to the initial stage resulting to less chance of errors.

Also, reset switch is provided to initialize the whole program which includes the resetting of the accumulator bit in counters and timers used.

III. OVERALL BLOCK DIAGRAM AND SNAP SHOT OF OUR MODEL

The figures given below shows the block diagram of the system and the snapshots of the real time project. Fig. 6 shows the overall block diagram of the smart energy saving classroom.

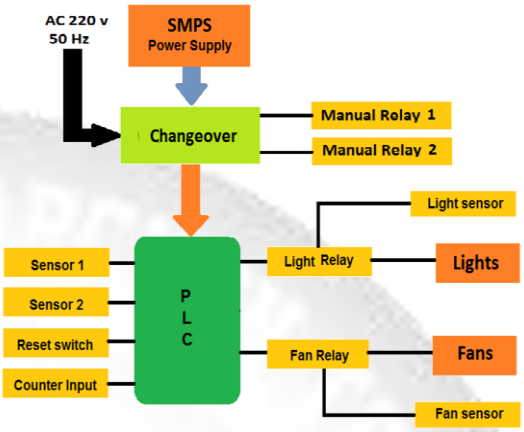

Fig. 6: Block Diagram of Smart Energy saving room

It is describing briefly about each and every appliance connected to the components. Fig. 7 shows the internal view of the control box and the automatic mode is shown in Fig. 8. The automatic mode i.e. PLC mode is set upwards and hence the above LED indicator is glowing. The temperature controller is showing the current room temperature.

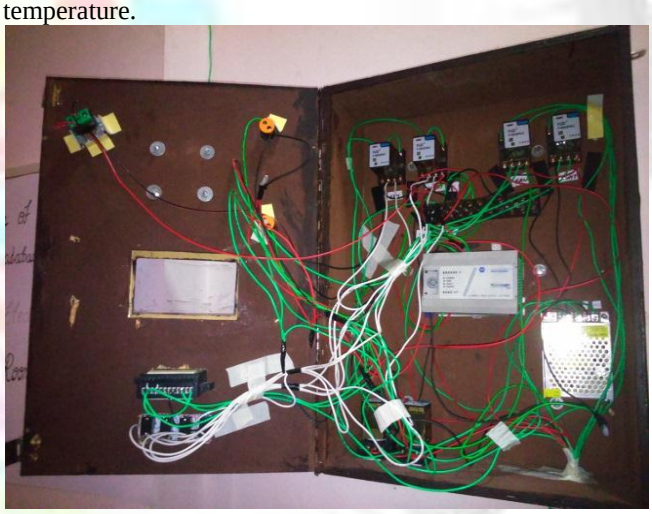

Fig. 7: Connection view of control box

Fig. 8: Control box running in PLC mode

IV. RESULTS AND DISCUSSION

Smart Energy Saving Classroom completes the demands of Smart India very efficiently. It provides smart work, energy consumption control and ease at the same time. Thus it is completely smart and fully automated energy saving classroom.

V. FUTURE WORK AND CONCLUSION

We have initialized this phenomenon. But this can be updated further. Some features can be added as;

Currently the room is running through PLC but we can also add a voice recognition system which will work according to the voice commands of user without affecting the frequency of voice.

Some other sensors like motion sensors can also be implemented. Through these type of sensors, we can recognize the presence of user in particular section of the room and thus only the needed appliances will get turned on automatically.

This paper presented a new method for making the classrooms smart. The project Smart Energy Saving room using PLC has the advantages associated with PLC like reliability, roughness. PLC is used for automation in industries. This project ensures less maintenance and reduces risk factor and also increases the efficiency. In our project we have utilized the application of PLC effectively.

REFERENCES

[1] Z.B. May, Y.A.A.B. Mohd. Yaseen, "Smart Energy Saving Classroom System Using Programmable Logical Controller", Advanced Materials Research, Vol. 660, pp. 158-162, 2013.
[2] Sheila Mahapatra, Aman Jain, Divyanshu Singh, "PLC Based Home Automation System", IJITEE, Vol. 4, Issue 5, October 2014.
[3] http://www.electroschematics.com/9601/dpdt-switch-relay/
[4] https://www.wikipedia.org./wiki/Switchedmode_power_supply
[5] http://library.automationdirect.com/history-of-the-plc/
[6] http://www.selec.com/Content/DownlodableFiles/Operating%20Manuals/Temperature%20series/Cooling%20controller/OP_CH403_OP161-V03B_02.pdf
[7] Sharath Patil G.S, Rudresh S.M, Kallendrachari. K, M Kiran Kumar, Vani H.V, Design and Implementation of Automatic Street Light Control Using Sensors and Solar Panel, IJERA, Vol. 5, Issue 6, (Part-1) June 2015
[8] http://www.softnoze.com/downloads/Sensor%20Basics%204.pdf