Energy Optimization using Smart Monitoring and Control for the Sustainable Home

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Abstract—In the present condition, we control the lights, Geysers, other home appliances manually. Many times, we forget to switch off the buttons which increases the electricity bill. In the home automation sector, intelligent household gadgets have been a research focus for how to make televisions, refrigerators, lighting, alarm sensors, and other home devices work efficiently and easily. Under such conditions, home appliances should not only function alone, but also in conjunction with other devices, i.e., they should be networked for easier management. The smart automated building concept entails a home/building automation system that is more energy efficient and has higher power quality [4].

A home automation system connects all of the electrical gadgets in a house. So, we are automating it based on simulation software using PLC and SCADA. This paper focus on Simulation based Home automation solution, with automation we can turn on/off AC or geysers by controlling and monitoring the temperature of these equipment's, similarly we control lighting and other equipment's which saves us the electricity bill and provides comfort. The programming of the various devices to be controlled is done on the PLC and then interfaced with the help of SCADA software.

The paper objective is to fulfill all the levels of Home Automation such that; Monitoring is done by the SCADA software, Control of the devices can be done on the field as well as the SCADA software and the PLC programming module, Automation is achieved by simulation of the programmed devices, Data is recorded to observe the load consumption, This monitoring and controlling helps us save energy (electricity and water), and smart usage of electrical appliances are hence termed as smart home automation system

Keywords: PLC, SCADA, Home Automation, Building Monitoring system, Load Monitoring, Smart Automated buildings.

I. INTRODUCTION

In the present condition, we control the lights, Geysers, AC and other home appliances manually. Many times, we forget to switch off the buttons which increases the electricity bill. With automation we can turn on/off AC or geysers by controlling and monitoring the temperature of these equipment's, similarly we control lighting and other equipment's which saves us the electricity bill and provides comfort.

SMART Home Automation is achieved using Programmable Logic Control (PLC) & Supervisory Control & Data Acquisition (SCADA) on a software simulation level.

The programming of the various loads to be controlled is done on the PLC and then interfaced with the help of SCADA software.

The project fulfills all the levels of Home Automation such that:

- Automation is achieved by PLC and SCADA.
- Control of the loads is done by PLC program.
- Operation can be done from both field and SCADA.
- Monitoring is done in SCADA.
- Data is recorded for load analysis.

II. BACKGROUND THEORY & LITERATURE REVIEW

The rapid advancement of information technology has resulted in significant changes in the structure of the automation system, causing individuals to place greater emphasis on home security, comfort, and efficiency. In the home automation sector, intelligent household gadgets have been a research focus for how to make televisions, refrigerators, lighting, alarm sensors, and other household devices work efficiently and easily [4].

Under such conditions, home appliances should not only function alone, but also in conjunction with other devices, i.e., they should be networked for easier management. The smart automated building concept entails a home/building automation system that is more energy efficient and has higher power quality. A home automation system connects all of the electrical equipment in a home [4].

As a result, we're utilizing simulation-based software with PLC and SCADA to achieve Home Automation.

Aims & Objective:

To design a SMART HOME AUTOMATION project where different loads are monitored and controlled using PLC and SCADA (Software Simulation Mode).

Writing PLC program logic in Ladder language to control the load as per customer requirements.

Creating the animation in SCADA for monitoring and controlling the different loads.

We can reduce costs and time as well as increase productivity, reduce mistakes,

III. METHODOLOGY

Smart Home Automation is implemented using simulation software for PLC and SCADA for 2 BHK at Ground floor and Studio apartment on 1st floor.

2 BHK: (2 Bedroom, Hall, Kitchen)

Bedroom Loads: Lights, AC, Fire sensor & Sprinkler

Hall Loads:Lights (normal & Chandelier), AC, TV,

Fire sensor-Sprinkler & Earth Detector

Kitchen Loads:Microwave Oven & Refrigerator.

Washroom Loads: Light, Geyser & Washing Machine.

Studio Apartment:

Studio Loads: Lights, AC, TV Fire sensor & Sprinkler,Earth Detector, Microwave Oven & Refrigerator.

Washroom Loads:Light, Geyser & Washing Machine.

Figure 1: Smart Home Automation at glance [7]

PLC Programming shall be done based on requirements and then it shall be interfaced with SCADA. A PLC program is written to control the loads of home on different conditions. For e.g., Controlling Air conditioners based on the temperature set point. Likewise, other loads shall be programmed in PLC as required. Monitoring of these loads can be done by means of SCADA screen where animations are created Alarms and Trends are implemented for different loads. Log-sheets shall be recorded in excel sheet. This monitoring and controlling helps us to save energy (electricity and water), and smart usage of electrical appliances are hence termed as Smart Home Automation system.

The programming of the various loads to be controlled is done on the PLC (Programming Language - Ladder Logic/Diagram) and the monitoring is done in SCADA by creating animation (Simulation based)

- The Software used for PLC Programming & SCADA animation is TIA Portal V15.
- We are simulating the PLC program to control the various loads of home in different conditions.

Like for example, for AC if the temperature of the room exceeds 35 degrees C then the AC should turn ON and set the room temperature to a certain level say 20 deg C and it will turn OFF automatically after that. The same AC can be controlled manually as per our requirement if needed.

Similarly, we can set the temperature of geyser as per our requirement & the operation of the light loads will depend on number of people present in the room.

- We will communicate PLC to SCADA using suitable (PROFINET for Siemens) connection.
- In SCADA we create animations of different loads and we assign specific tags from the PLC program.
- The PLC tags are also used for data logs which is stored in excel sheet.
- Alarms and Trends.
- This is a smart way for energy management and effective utilization.

IV. SOFTWARE REQUIREMENTS

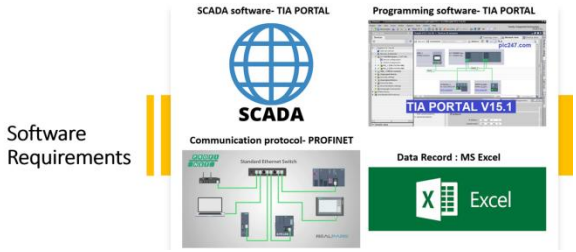


Figure 2: Software Requirements for Home Automation

Selection of PLC in Software

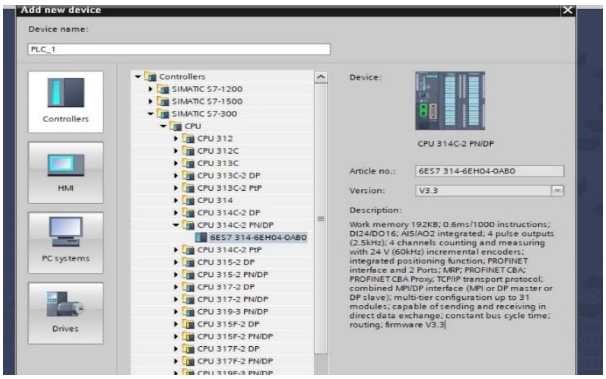


Figure 3: Selection of PLC HW in SW

Selection of SCADA in Software

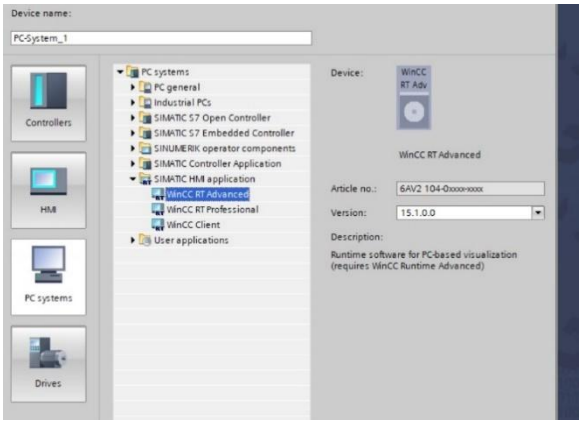


Figure 4: Selection of SCADA in SW

V. ESTIMATED RESULTS

Monitoring and control of different loads for smart home automation using PLC & SCADA.

Data storage of the loads operating is recorded and saved for further requirements in report format from PLC to excel sheet.

We can configure Alarms and Trends for critical loads

A. SCADA SCREENS

Figure 5: 2BHK Floor plan/Layout [7]

Figure 6: Studio Floor plan/Layout [7]

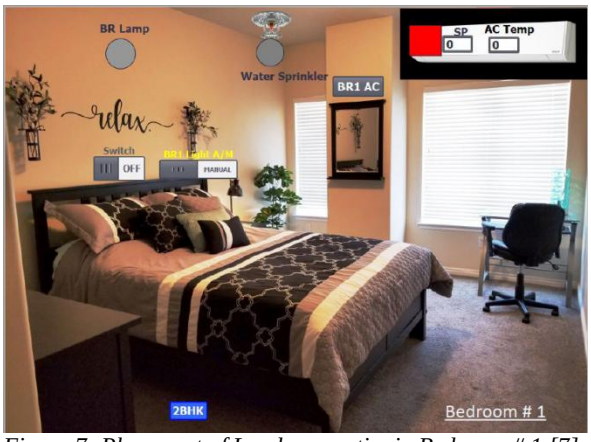


Figure 7: Placement of Load connectionin Bedroom # 1 [7]

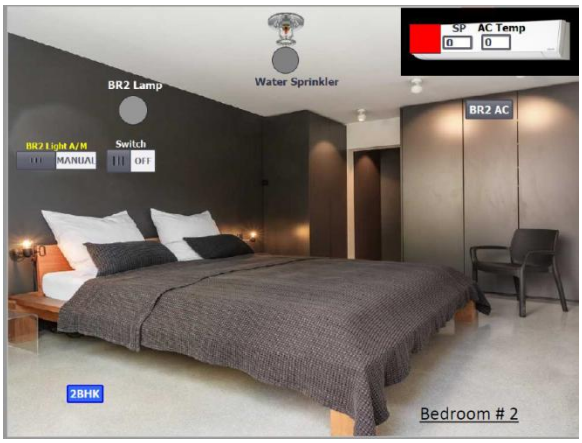


Figure 8: Placement of Load connection in Bedroom # 2 [7]

Figure 9: Layout of load connection in Hall [7]

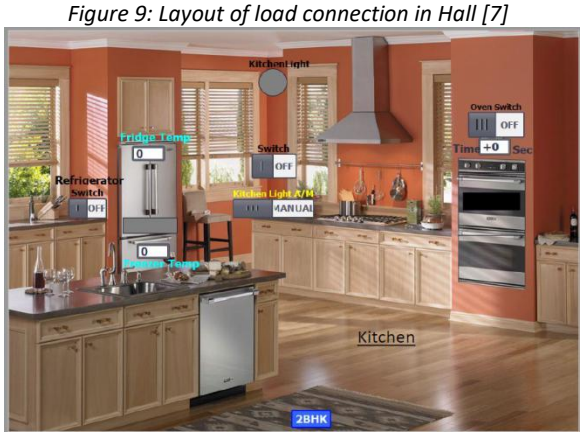


Figure 10: Layout of load connection in Kitchen [7]

Figure 11: Load connection in Washroom [7]

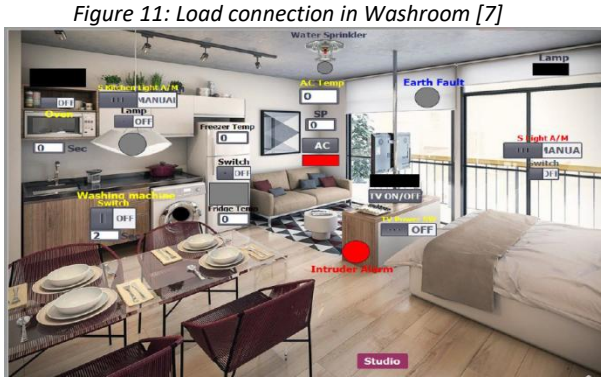


Figure 12: Load schematic in Studio [7]

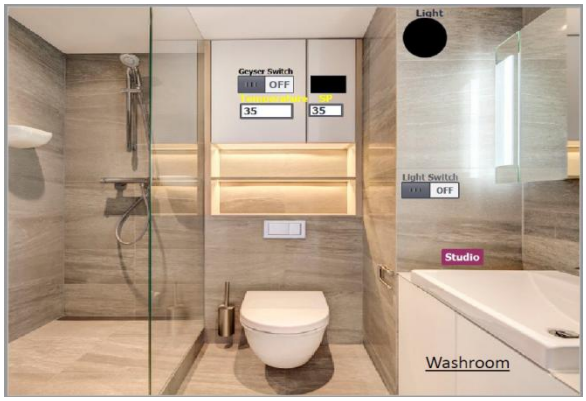


Figure 13: Load details of Studio Washroom [7]

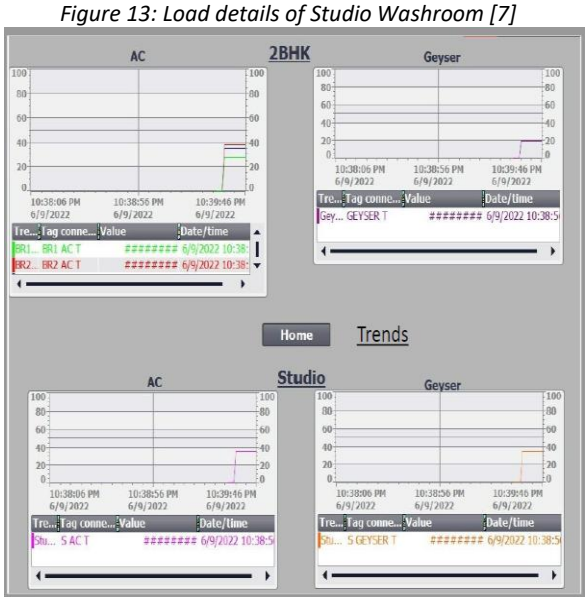


Figure 14: Trends of Various parameter under control (Temp)

	A	B	C
1	VarName	TimeString	VarValue
2	BR1 AC T	10-06-2022 08:13	32
3	BR2 AC T	10-06-2022 08:13	35
4	HALL AC T	10-06-2022 08:13	38
5	S AC T	10-06-2022 08:13	36
6	GEYSER T	10-06-2022 08:13	24
7	S GEYSER T	10-06-2022 08:13	28
8	BR1 AC T	10-06-2022 08:13	30
9	BR2 AC T	10-06-2022 08:13	33
10	HALL AC T	10-06-2022 08:13	38
11	S AC T	10-06-2022 08:13	36
12	GEYSER T	10-06-2022 08:13	24
13	S GEYSER T	10-06-2022 08:13	28
14	BR1 AC T	10-06-2022 08:13	30
15	BR2 AC T	10-06-2022 08:13	33
16	HALL AC T	10-06-2022 08:13	36
17	S AC T	10-06-2022 08:13	36
18	GEYSER T	10-06-2022 08:13	24
19	S GEYSER T	10-06-2022 08:13	28
20	BR1 AC T	10-06-2022 08:13	30
21	BR2 AC T	10-06-2022 08:13	33
22	HALL AC T	10-06-2022 08:13	36
23	S AC T	10-06-2022 08:13	36
24	GEYSER T	10-06-2022 08:13	26
25	S GEYSER T	10-06-2022 08:13	28
26	BR1 AC T	10-06-2022 08:14	30
27	BR2 AC T	10-06-2022 08:14	33

Home Automation Loads

REPORTS

	A	B	C
1	VarName	TimeString	VarValue
28	HALL AC T	10-06-2022 08:14	36
29	S AC T	10-06-2022 08:14	34
30	GEYSER T	10-06-2022 08:14	26
31	S GEYSER T	10-06-2022 08:14	30
32	BR1 AC T	10-06-2022 08:14	27
33	BR2 AC T	10-06-2022 08:14	33
34	HALL AC T	10-06-2022 08:14	36
35	S AC T	10-06-2022 08:14	34
36	GEYSER T	10-06-2022 08:14	26
37	S GEYSER T	10-06-2022 08:14	30
38	BR1 AC T	10-06-2022 08:14	27
39	BR2 AC T	10-06-2022 08:14	30
40	HALL AC T	10-06-2022 08:14	36
41	S AC T	10-06-2022 08:14	34
42	GEYSER T	10-06-2022 08:14	26
43	S GEYSER T	10-06-2022 08:14	30
44	BR1 AC T	10-06-2022 08:14	27
45	BR2 AC T	10-06-2022 08:14	30
46	HALL AC T	10-06-2022 08:14	33
47	S AC T	10-06-2022 08:14	34
48	GEYSER T	10-06-2022 08:14	29
49	S GEYSER T	10-06-2022 08:14	30
50	BR1 AC T	10-06-2022 08:14	27
51	BR2 AC T	10-06-2022 08:14	30
52	HALL AC T	10-06-2022 08:14	33
53	S AC T	10-06-2022 08:14	31
54	GEYSER T	10-06-2022 08:14	29
55	S GEYSER T	10-06-2022 08:14	30

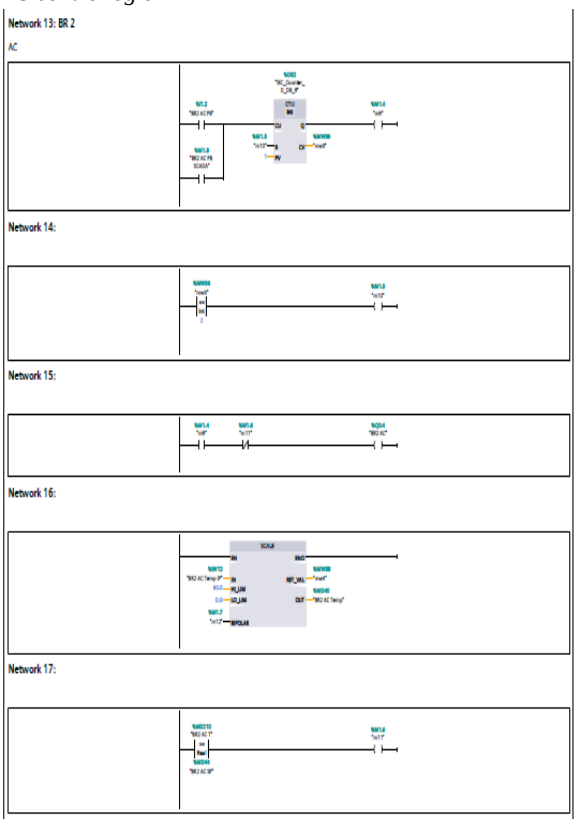
Home Automation Loads

Figure 15: Reports of Various parameter under control (Temp)

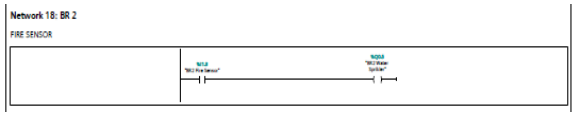
B. LADDER LOGIC

Ladder program is developed for Home automation to control various parameters like AC, Geyser Temp, Fire Alarm, Intruder Alarm, TV Control, Chandelier, Washing M/C, Oven control etc. The sample ladder program for few of the applications are given below:

AC controllogic

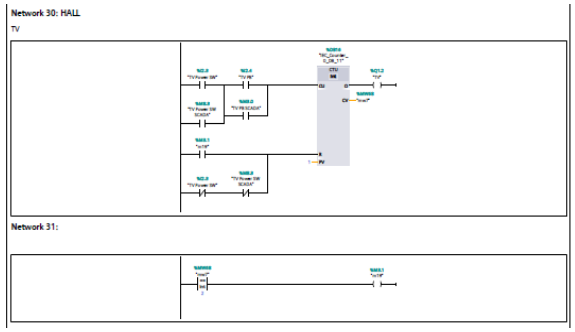


Fire Alarm

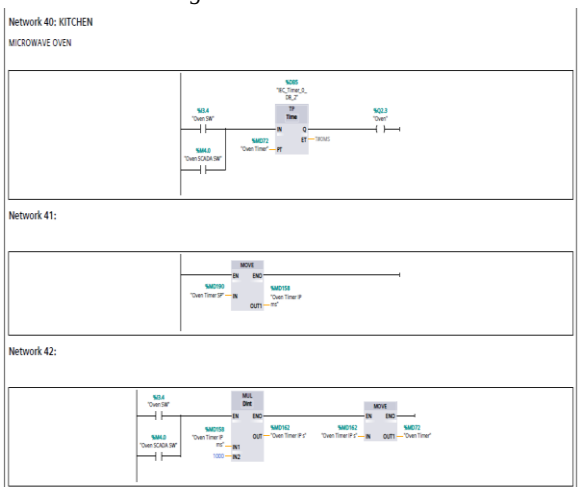


Intruder / Security Alarm

TV Control logic:



Microwave Oven logic:



Geyser control logic:

VI. FUTURE OF HOME AUTOMATION

Figure 16: Future of Home Automation Global [6]

Figure 17: Future of Home Automation India [6]

VII. CONCLUSION

By doing smart home automation by PLC and SCADA, wherein we can implement Advanced latest technology. It is reliable and robust; It is secured, we can do load analysis through Trends and data logging, we will be informed for different load fault conditions through Alarms. A PLC's expandability and capacity are demonstrated by its connection to a variety of input-output modules. The new extension modules have a wide range of applications. either digital or analogue, both are utilized in this project. The device gets a good user-friendliness rating. A single PLC is capable of a great deal. govern the entire industry because it easily replaces the earlier, antiquated and inconvenient Relay logics. As a consequence. For the electrical sector, engineers, and designers, the current work is vital [9].

The automized system will help to reduce the electricity bills, it will have lower Maintenance cost, Automation of many flats can be done in One single programmable logic controller, it gives us more flexibility. Fire Alarm Control Panel (FACP) systems and other 3rd party systems can be connected to PLC over serial, Modbus TCP, Ethernet IP and OPC protocols, so it gives us more flexibility to design the system as per requirements.

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