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PLC and SCADA Based Secured and Sustainable Living

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ABSTRACT: In this paper, we propose a few automated processes for a partial automation of the apartment which can be mostly used in residential areas and industries. It is developed using PLC and SCADA. SCADA stands for Supervisory Control and Data Acquisition system. The main intent of the paper is to treat the waste water which can be in turn used for many other purposes and a fire alarm system. The necessity of standalone autonomous smoke detection systems, which render the work for quick detection, alarm notification and sometimes turning on the extinguishers, is very necessary for a secured living. In order to supervise the entire process manually SCADA system is used. A smoke sensor is used in order to detect any outbreak of fire. The status of each and every process is monitored using SCADA system in the control room.

KEY WORDS: PLC, SCADA, Data Acquisition system, Smoke sensor, Water treatment.

I.INTRODUCTION

Automation is basically the delegation of human control function to technical equipment. It uses controlled systems such as computers, PLCs, Microcontrollers to control machinery and processes to reduce the necessity of human involvement and mental requirements. Different types of controllers can be used to operate and control the equipment such as machinery, processes in factories, heat treating ovens and boilers, and other applications with minimal or reduced human intervention. Food/ Beverage, Chemical industries, Power, Machine Manufacturing, etc are the few examples where we see the mechanization today. Most of the automation has been existing in industries from decades. But the shift for automation in home and apartments has popped in very recently. One can employ this kind of a system which enables an individual to supervise devices such as Lighting, Heating and ventilation, water pumping, gardening system, Overhead water flow control remotely or from any centralized location. Automatic systems are being preferred over manual system because they reduce individual's effort. Similarly talking about apartment automation, by use of PLCs everything seems to be more accurate, reliable and more efficient than the existing controllers. RS VIEW32 SCADA software is a powerful SCADA for industrial automation, process control and supervisory monitoring.

II. LITERATURE SURVEY

The existing system that is used for the automation is Building Automation System (BMS). A Building Management System (BMS) or a (more recent terminology) Building Automation System (BAS) is a computer-based control system installed in buildings to control and monitor the building's mechanical and electrical equipment such as ventilation, lighting, power systems, fire systems, and security systems, waste water treatment system and water overflow alarm system. Building Management Systems are most commonly implemented in large projects with extensive mechanical, HVAC, electrical, and plumbing systems.

As our paper mainly aims at automation thus both microcontroller and PLC can be used to achieve. The microcontroller has to be programmed by using one of the programming languages like C or Basic for which programmer should be well trained in that particular language. Microcontroller also cannot work as a standalone controller. Thus comparing both of them, we found that there are more advantages of PLC than microcontroller except one fact that PLCs are costly. But on a long run, it works efficiently and its reliability is high. This is one of the factor due to which the cost can be neglected.

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Fire detectors can be of different types with various specific features depending upon the areas of application and demands. These can be heat or thermal type detectors, fixed temperature heat detectors, rate-of-rise heat detector, smoke detectors [8].

II.BLOCK DIAGRAM

Fig. 1 represents the block diagram of our project titled: PLC and SCADA Based Secured and Sustainable Living.

- Number of inputs: 4, Electrode system of the reservoir, Electrode system of tank 1, Master ON/OFF switch, Output of smoke sensor.
- Number of outputs: 9
  Number of control valves: 6, Buzzer, Relay, DC Motor.

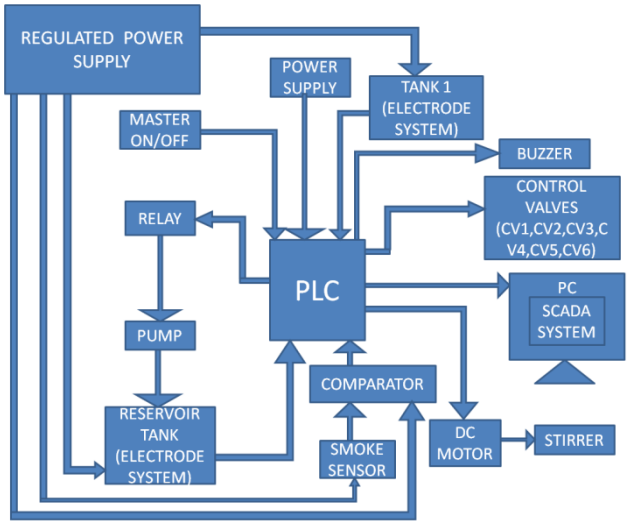

Fig. 1: Block Diagram

PROGAMMABLE LOGIC CONTROLLERS: In this paper, our major focus is about apartment automation. Thus, by the use of PLCs all the input and output field devices can be controlled automatically with the proper programming. This will reduce the manual manpower too. Everything seems to be more accurate, reliable and more efficient due to the PLCs. It is a combination of electrical, electronic and mechanical section where the software used is Ladder Logic language programming. A Programmable Logic Controller as shown in fig. 2 (PLC) or Programmable Controller is a digital computer used for automation of electromechanical processes, such as control of machinery in factories, control of amusement rides, or control of different processes used for manufacturing. Programs to control machine operation are typically stored in battery-backed or non-volatile memory [2]. A PLC is an example of a real time system because output results must be produced in response to input conditions applied within a delimited time, otherwise that will lead to unintended operations.

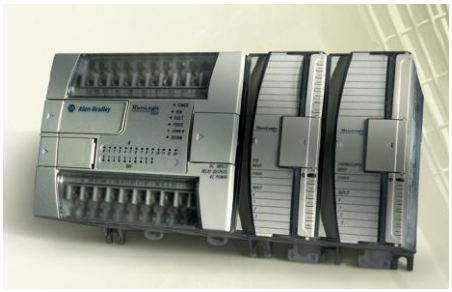

Fig. 2: Allen Bradley PLC

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WORKING OF PLC: The primary task of a PLC is to acquire the input signals and store this data into the memory of the processor and based on the specified program the output devices are activated [4].Boolean algebra forms the mathematical basis for this operation, which recognizes precisely two defined statuses of one variable: "0" and "1". Accordingly, an output can only assume these two statuses. For instance, a connected motor could therefore be either switched on or off, i.e. controlled.
This function has coined the name PLC: Programmable logic controller, i.e. the input/output behaviour is similar to that of an electromagnetic relay or pneumatic switching valve controller; the program is stored in an electronic memory [5]. However, the tasks of a PLC have rapidly multiplied: Timer and counter functions, memory setting and resetting, mathematical computing operations all represent functions, which can be executed practically by any of today's PLCs.

SCADA (SUPERVISORY CONTROL AND DATA ACQUISITION): SCADA stands for Supervisory Control And Data Acquisition. In this paper, the visualization of the current status of the apartment elements is made possible with the use of SCADA screen which is interfaced to the PLC through various communication protocols. RS VIEW32 SCADA software is a powerful SCADA for industrial automation, process control and supervisory monitoring.
As such, it is a purely software package that is positioned on top of hardware to which it is interfaced, in general via Programmable Logic Controllers (PLCs), or other commercial hardware modules [6]. Any application that gets data about a system in order to control that system is a SCADA application. SCADA is not a specific technology, but a type of application. SCADA refers to a system that collects data from various sensors at a factory, plant or in other remote locations and then sends this data to a central computer which then manages and controls the data.
A typical SCADA system comprises of I/O signal hardware, controllers, software, networks and communication. SCADA system is normally used to monitor and control a remote site or a distribution that is spread out for a long distance. An RTU (Remote Terminal Unit) or a PLC (Programmable Logic Controller) is usually used to control a site automatically [7]. The SCADA system also provides a host control functions for the supervisor to control and define settings.

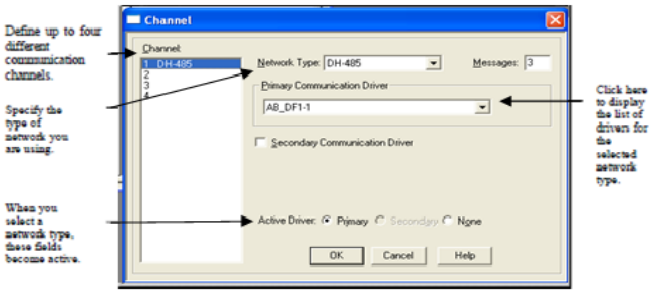

Fig. 3: Configuring Channel for Direct Driver Communication

The communication channel is the connection from the RS View32 station to the network to which the programmable controllers are attached to and this is shown in Fig. 3. The node is a programmable controller attached to a data highway or network. Once the RSView32 station is set up, it must periodically update its value table. This is done by scanning its nodes which is shown in Fig. 4.

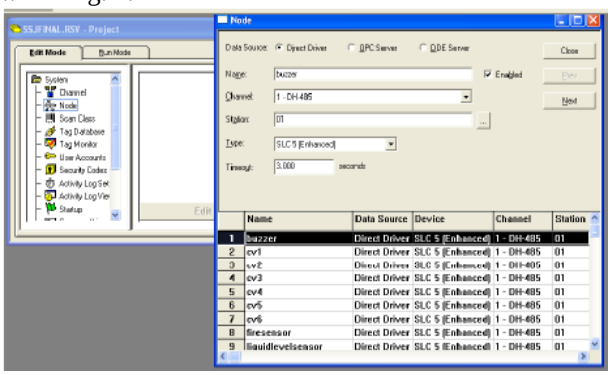

Fig. 4: Creating Nodes for Direct Driver Communication

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All graphic objects can have animation attached to them. Groups of objects can also have animation attached. We can attach as many types of animation to an object as we like by going to animations and linking the corresponding tags. This is shown in Fig. 5.

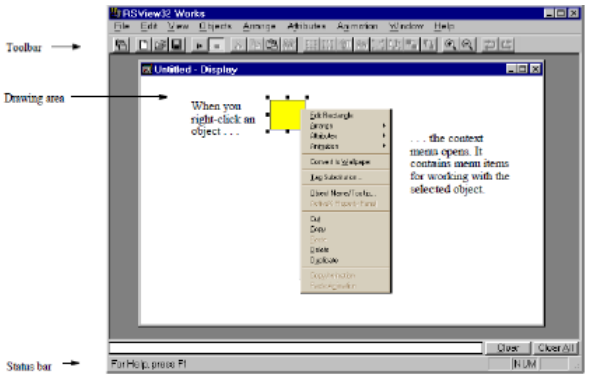

Fig. 5: Placing Animations for the Graphical Objects

Thus, Fig. 3, Fig. 4 and Fig. 5 represent the Link up of PLC (Allenbradly) 1200 Micrologix and RS view32 i.e. SCADA respectively.

SMOKE SENSOR: MQ - 2 is a combustible gas and smoke sensor that detects the concentrations of combustible gas in the air and furnishes the output in terms of respective analog voltage. MQ-2 gas/smoke sensor (fig. 6) has high sensitivity to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam [8]. This sensor is very economical and is appropriate for an extensive wide range of applications.

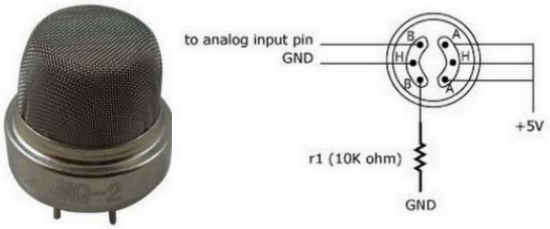

Fig. 6: MQ-2 Smoke Sensor

SOLENOID CONTROL VALVE: A control valve is an electromechanically operated valve. The valve is controlled by an electric current through a solenoid. These are used to stop, release, dose, mix or distribute fluids.. These valves provide fast and safe switching, high reliability, long service life, good medium compatibility of the materials used, low control power and compact design. Fig. 7 shows the solenoid control valve we have used.

Fig. 7: Solenoid control Valve

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III.IMPLEMENTATION

Ladder logic program for the process with brief explanation:

Initially, as soon as the master switch is switched ON the process starts as shown in Fig. 8. Water from the reservoir is pumped into tank 1. As soon as the particular level of water is reached in tank 1, the solenoid valve is turned ON i.e. it is opened and water from tank 1 flows into tank 2, filtering process is employed in tank 2.

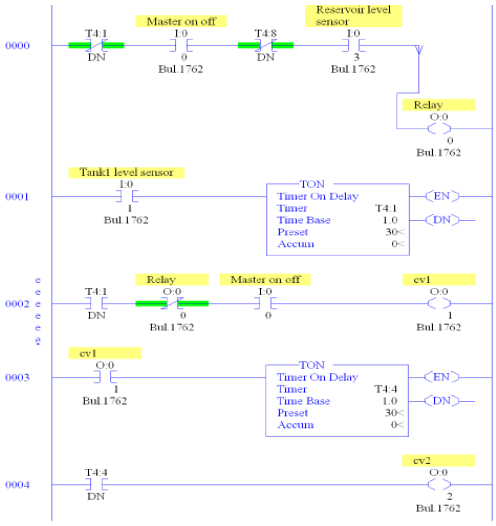

Fig. 8: Ladder Logic Program part 1

After the filtering is complete water from tank 2 flows into tank 3 when another solenoid valve connected to tank 2 opens. In tank 3, chlorine is added to water. This is depicted in the ladder logic in Fig. 9.

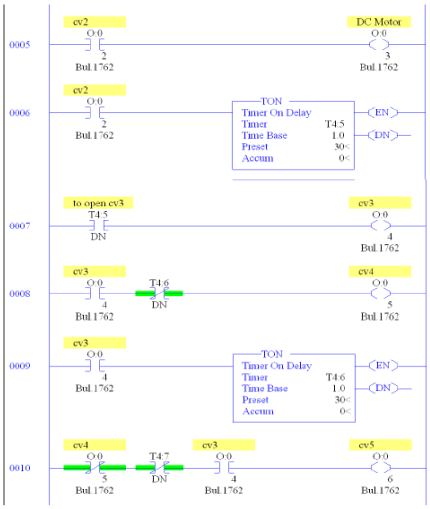

Fig. 9: Ladder Logic Program part 2

After a process of chlorination this treated water is sent to residential areas and can also be used for gardening. This water is passed to the residential areas one by one for some specified duration of time and so we have employed timer functions to do the operation. The Ladder logic program for this end process is shown in fig. 10.

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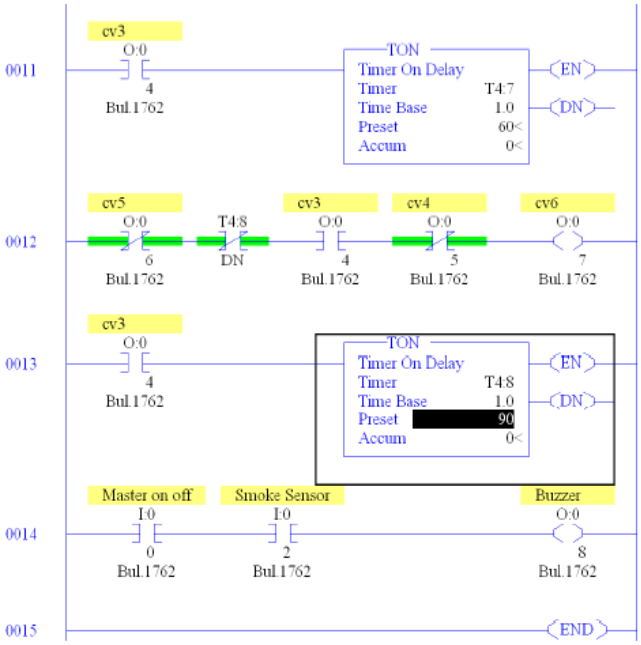

Fig. 10: Ladder logic program part 3

IV.RESULTS

The objective of our paper is accomplished by designing the automated water treatment plant and fire alarming system in and around the residences by programming using RSLOGIX 500 through PLC and the entire process is monitored using SCADA screen using RS View 32. Initially, to achieve this, the block diagram was shown in Fig.1 which was followed by the PLC used in our paper in Fig. 2. The linking up of SCADA with PLC was shown in Fig. 3, 4 and 5. The smoke sensor and the solenoid valve employed are shown in Fig. 6 and Fig. 7 which are followed by the ladder logic for the process in Fig. 8,9 and 10.

The photographs of our entire setup and the final SCADA screen of the process are shown.
Fig. 11 shows the complete hardware setup of the process. The whole setup mainly consists of a reservoir and three storage tanks in which filtration and chlorination process takes place. At the end, it is passed through three lanes appropriately. At the back side, there is PLC setup through which field devices are connected. There is a PC at the right to monitor the process through SCADA. There is smoke detection system in the bread board kept behind the process tank 1.

Fig. 11: Hardware implementation of the process

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Next the SCADA screenshots which we created to monitor the waste water treatment plant and the smoke detection system will be shown.

WELCOME SCREEN 1:

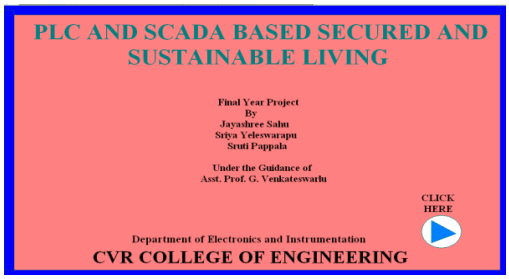

Fig. 12: SCADA screen 1 displaying the details of the project

As we see here, this is the first welcome screen (fig. 12) as we run the project. If we click next button then we are directed to the next screen where we have to choose either of waste water plant or fire alarm system.

SCREEN 2:

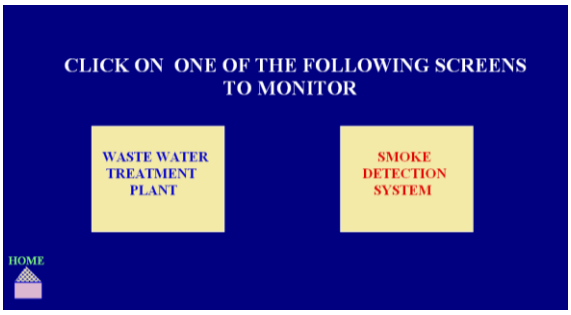

Fig. 13: SCADA screen 2 displaying the options

We see that there are options (fig. 13). If we click on waste water treatment plant we get Fig. 14 and if we click on fire alarm system we get Fig. 15. At any point of time, we can go back to the home screen.

SCREEN 3:

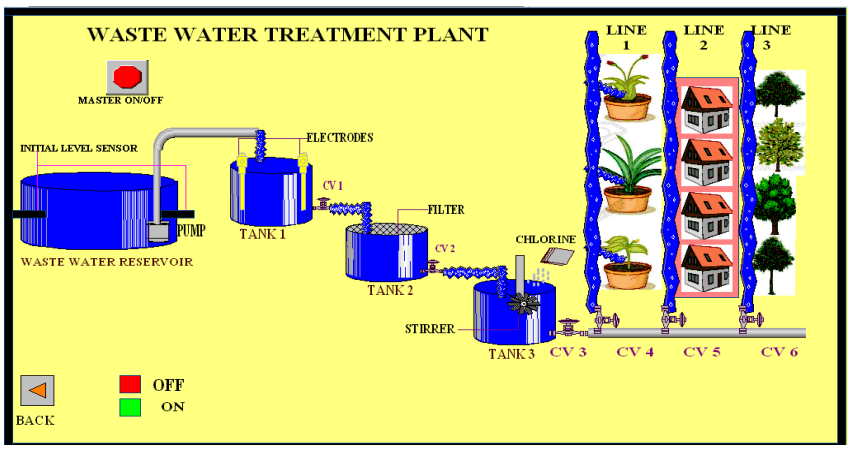

Fig. 14: SCADA screen 3 displaying whole waste water treatment plant

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The fig. 14 shown above shows the waste water treatment plant which is one of the applications implemented in our project. As any of the field devices get ON due to the ladder logic written, then the level in the tanks decreases or increases appropriately. Simultaneously, the control valves also glow red or green depending on its true or false states.

SCREEN 4:

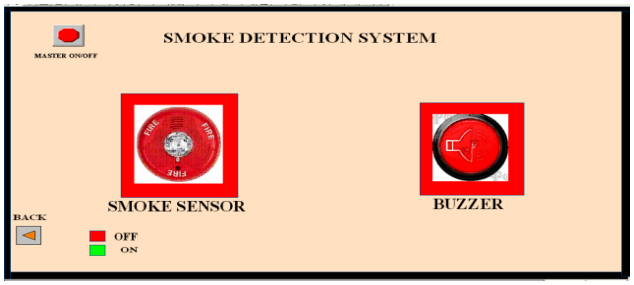

Fig. 15: SCADA screen 4 displaying the fire alarm system

As we see in the fig. 15, there shown is the smoke sensor and the buzzer. As the smoke is detected, the smoke sensor turns green and at the same time the buzzer too starts glowing. Thus, using the SCADA system the whole process can be monitored.

V.CONCLUSION AND FUTURE SCOPE

By using PLC and SCADA the cost effective automation system for residences can be developed and it is very user friendly for the operator or control engineer to trouble shoot the process if any errors occurs and can also be kept track of what is happening in the process.

This kind of implementation has many advantages. Some of them are:

- Increased level of comfort and time saving.
- Time and money saving during maintenance.
- Effective monitoring of the processes.
- Improved plant Reliability and life.
- Flexibility on change of building use.
- Remote monitoring of plants like water treatment plant or electrical supply, etc.
- Ease of storing reports of the systems.

By using PLC and SCADA based automation in and around residences or apartments, we can lead to a better, comfortable life by reducing costs and improve the quality of life.

- It helps in obtaining certifications like LEED(Leadership in Energy & Environmental Design) certification.
- Helps in creating Smart cities, the future of the globalised world.
- Part of Green Buildings, which people prefer now to reduce the carbon foot print.

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BIOGRAPHY

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