Advanced Fire Detection and Alarm System with Plc Program

Prof. Suraj S. Shinde[1], Mr. Chaukurte Shreeshail[2], Mr. Prakash Sagai[3]
[1]*Assistant Professor, SMSMPITR AKLUJ(MS)*
[2,3]*B Tech Students, SMSMPITR AKLUJ(MS)*

Abstract—**Fire accidents pose a significant threat to life, property, and industrial operations, making early detection and rapid response critically important. This project presents an Advanced Fire Detection and Alarm System using a Programmable Logic Controller (PLC), designed to enhance safety, reliability, and automation in fire monitoring systems. The system integrates multiple sensors, including temperature, smoke, and flame detectors, to identify fire hazards at an early stage. These sensors continuously transmit real-time data to the PLC, which processes the inputs based on a pre-programmed control logic. Upon detection of abnormal conditions indicating a potential fire, the PLC activates alarm mechanisms such as sirens, warning lights, and notification units to alert occupants and safety personnel. In addition to detection and alerting, the system can be configured to trigger automated responses such as sprinkler systems, ventilation control, and emergency shutdown procedures, thereby minimizing damage and ensuring rapid containment. The PLC-based architecture offers high reliability, flexibility, and ease of modification compared to conventional fire alarm systems.**

I. INTRODUCTION

More and more things are becoming automated nowadays. Automation is a step beyond mechanization, where humans are provided with machines to help them with their jobs, or simply replace them. Automation is a wide variety of systems in which there is a significant substitution of mechanical, electrical, or computerized action for human effort or intelligence. The technology exists from simple to complex ones. Automation process needs a logic controller to perform the sequenced task. A programmable logic controller (PLC) is an electronic device used in many industries to monitor and control building systems and production processes. PLC is designed to perform a single set of tasks, except under real-time constraints and with superior reliability and performance. This causes overheating, insulation damage, poor efficiency, and eventually failure. Another issue is earth leakage, which happens when insulation breaks
To meet the demands of harsh industrial environments, PLCs are designed to be extremely robust, often capable of withstanding extreme The input/output system forms the interface by which fields devices are connected to the controller. The main purpose of interfaces is to condition the various signals received from or sent to external field devices. Incoming signals from the sensor are wired to terminals on the input interfaces. Devices that will be controlled, like the motor starter, solenoid valves, pilot lights, and position valves, are connected to the terminals of the output interfaces. The system power supply provides all the voltages required for the proper operation of the various central processing unit sections.
Fire alarm systems provide notification of fire emergencies in an area or an entire building. Fire detectors are designed to detect fire, smoke, heat, and flame. Fire detection and alarm system is a key element for people to survive.

II. LITERATURE SURVEY

Fire detection and alarm systems have evolved significantly with advancements in automation and control technologies. Traditional fire detection systems primarily relied on standalone smoke detectors and manual alarm activation, which often resulted in delayed response times and limited reliability. Recent studies focus on integrating intelligent systems, sensors, and programmable automation to improve efficiency and early detection.
Several researchers have emphasized the importance

of multi-sensor-based fire detection systems. Conventional single-sensor systems (such as only smoke or heat detectors) are prone to false alarms due to environmental factors like dust, humidity, or temperature fluctuations. To overcome these issues, modern systems combine temperature, smoke, and flame sensors, improving detection accuracy and reducing false triggers. This multi-parameter approach has been widely accepted in industrial and commercial applications.

The introduction of Programmable Logic Controllers (PLC) has significantly enhanced fire safety systems. PLCs provide reliable and real-time control in harsh industrial environments. According to various studies, PLC-based systems are preferred over microcontroller-based systems in large-scale applications due to their robustness, flexibility, and ease of maintenance. Researchers have demonstrated that PLCs can efficiently process sensor data, execute programmed logic, and initiate alarms or suppression systems without delay.

In industrial safety automation, studies have shown the effectiveness of integrating fire detection systems with automated suppression mechanisms. When a fire condition is detected, PLCs can automatically activate sprinklers, fire extinguishing systems, ventilation shutdown, and emergency exits. This level of automation reduces human dependency and ensures faster response, minimizing damage and loss.

III. OBJECTIVE

The objective of this project is to design and implement a reliable and efficient fire detection and alarm system using a Programmable Logic Controller (PLC) that can detect fires in a building or industrial setting and trigger alarms to alert occupants and authorities.

Specific Objectives:

1. Detect Fires: Use fire sensors to detect smoke, heat, or flames in the monitored area.

2. Trigger Alarms: Trigger alarm devices, such as sirens, bells, or strobe lights, to alert occupants and authorities in case of a fire.

3. Monitor System Status: Continuously monitor the system status and display it on a Human-Machine Interface (HMI).

4. Remote Monitoring: Enable remote monitoring and control of the system through a communication module.

5. Improve Safety: Improve safety by providing early detection and warning of fires, reducing the risk of injury or damage.

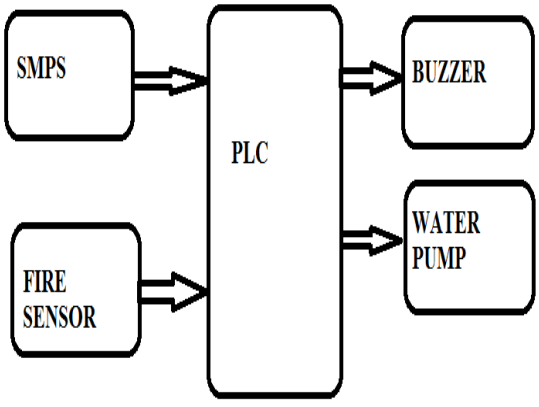
IV. METHODOLOGY

1. Requirements Gathering:
- Identify the building or industrial setting and its specific fire safety requirements
- Determine the types of fires that can occur (e.g., Class A, B, C, etc.)
- Identify the relevant fire safety regulations and standards

2. System Design:
- Design the overall system architecture, including the PLC, fire sensors, alarm devices, HMI, and communication module
- Select the PLC and other system components based on the requirements

3. PLC Programming:
- Program the PLC to detect fires, trigger alarms, and monitor system status
- Use a programming language such as Ladder Logic or Function Block
- Implement the following functions:
- Alarm triggering logic

Block Diagram



Project Working

The PLC based fire detection and alarm system works as follows:

1. Fire Detection:

- Fire sensors, such as smoke detectors, heat detectors, or flame detectors, are installed in the monitored area.
- The sensors detect fires and send signals to the PLC.
- The PLC receives the signals and determines if a fire is present.

2. Alarm Triggering:

- If a fire is detected, the PLC triggers the alarm devices, such as sirens, bells, or strobe lights.
- The alarm devices alert occupants and authorities of the fire.

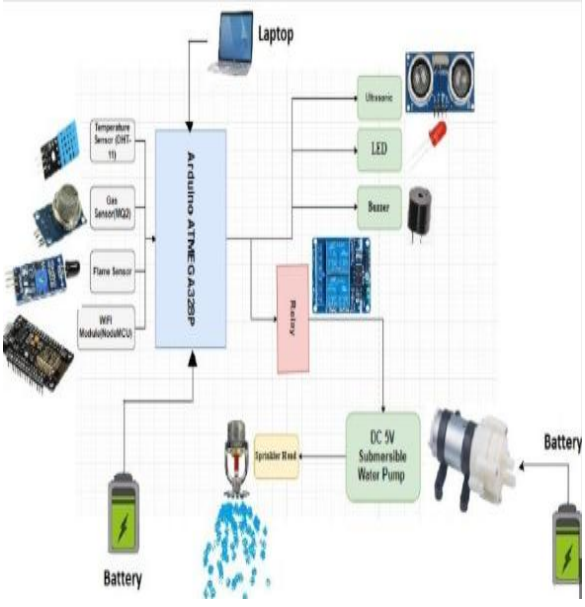
3. System Monitoring:

- The PLC continuously monitors the system status and reports it to the HMI.
- The HMI displays the system status and alerts the user of any issues or alarms.

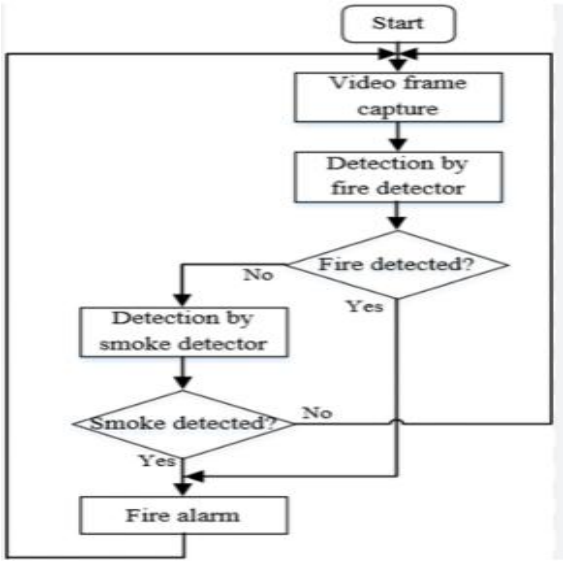
4. Communication:

- The PLC communicates with the HMI and remote monitoring systems to report system status and receive commands.
- The HMI and remote monitoring systems can be used to configure the system, acknowledge alarms, and view historic aldata

V. CIRCUIT DIAGRAM



VI. FLOW CHART



VII. SOFTWARE SPECIFICATION

User Interface: TIA Portal features a user-friendly and intuitive interface, making it easy forengineers and programmers to navigate and work within the software environment. The interface is organized into different perspectives, such as Project View, Device & Network View, and Online & Diagnostics View, allowing users to access various project-related tasks and functionalities.

Integrated Engineering: One of the key advantages of TIA Portal is its integrated engineering framework, which enables seamless collaboration between different engineering disciplines, such as PLC programming, HMI design, and motion control configuration. Engineers can workon different aspects of the automation project within a single software environment, facilitatingefficient project development and management.

PLC Programming: TIA Portal supports programming of Siemens PLCs using multiple programming languages, including ladder logic (LAD), function block diagram (FBD), structured text (ST), and graphical programming (Grafcet). Engineers can create, edit, and debug PLC programs directly within the TIA Portal environment, with features such as syntax highlighting, code completion, and online monitoring to aid in programming tasks.

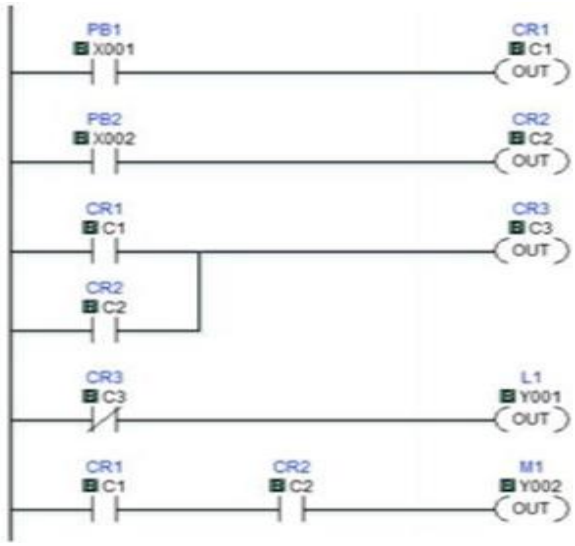
Hardware Configuration: TIA Portal provides tools for configuring hardware components such as PLCs, IO

modules, HMI panels, drives, and communication networks. Engineers can define hardware configurations, assign hardware addresses, and establish communication links between devices, ensuring proper integration and functionality of the automation system.

Simulation and Testing: TIA Portal offers simulation and testing capabilities that allow engineers to validate PLC programs, HMI screens, and motion control sequences before deploying them to the actual hardware. Simulation tools enable virtual testing of automation projects, helping to identify and rectify errors or optimize performance prior to commissioning.

Diagnostics and Troubleshooting: TIA Portal provides diagnostic tools for monitoring and troubleshooting PLCs and other automation devices during runtime. Engineers can access real-time diagnostic information, view system status, and analyze error messages to diagnose issues and ensure smooth operation of the automation system.

Ladder Logic



VIII. RESULT

The result of a Programmable Logic Controller (PLC) fire detection and alarm program is a highly reliable, automated response. When sensors detect hazards, the PLC instantly triggers audible/visual alarms, initiates ventilation to clear smoke, activates automated suppression (like water or release), and triggers safe evacuations.

IX. CONCLUSION

The PLC-Based Fire Alarm System performed efficiently based on the result of all the observations and also resulted in high performance in functionality. The acceptability level of the device described as very good because the experts relate the usefulness of the device especially in saving the life of the people in a certain building in case of a fire emergency. Thus, using PLC-Based Fire Alarm System to provide notification in case of fire emergency was highly acceptable. The PLC based fire detection and alarm system is a reliable and efficient solution for detecting fires and alerting occupants and authorities. The system has numerous advantages, including improved safety, reliability, and accuracy. It can be used in various applications, including industrial settings, commercial & residential building.

REFERANCE

[1] Electrical Machines II, U. A. Bakshi and A. V. Bakshi, *Electrical Machines II*. Pune, India: Technical Publications, 2009.

[2] Electrical Transformer and Rotating Machines, S. Herman, *Electrical Transformer and Rotating Machines*, 2nd ed. U.S.A.: International Thomson Publishing Inc., 2006.

[3] Mouser Electronics Industrial Application Logic Controller Guide.

[4] Muhy, “Principles of PLC Operation: CPU Inputs,” 2012. Blog Reference

[5] Industrial Control Electronics: Devices, Systems, and Applications, T. Bartelt, *Industrial Control Electronics: Devices, Systems, and Applications*, 3rd ed. Thomson Delmar Learning, 2006.

[6] NEDCC Fire Detection and Automatic Fire Sprinklers Resource.

[7] Teach Yourself Electricity and Electronics, S. Gibilisco, *Teach Yourself Electricity and Electronics*. U.S.A.: McGraw-Hill Companies, Inc., 2007.

[8] M. Kranzberg, “Technology and History: Kranzberg’s Law,” Aug. 16, 2016. Wikipedia Article on Kranzberg's Law

[9] Automation Essay Reference.