PLC Based Fire Alarm Control System in Building Automation

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Abstract-
Fire alarm system is a combination of number of devices working together to detect and warn the people through a visual and audible appliances when smoke and/or fire are present. The alarm used in such system may be activated from flame or smoke detectors and heat detectors. Alarms can be either motorized bells or wall mountable sounders or horns. Fire alarm system plays the main role in maintaining and monitoring the safety in all kinds of environments and situations. However, the usability of many existing fire alarm and detection system is well known but the primary constraint is the high cost. The main objective of this Fire Alarm Control System in Building Automation Using PLC is to make a fire control and suppression system with high reliability and low cost. The Fire Alarm Control System based on PLC has three main systems: 1) the detection of fire, 2) the monitoring system and 3) the appliance system in which the main door will get opened and lift will come to ground floor for safety purpose. The detection system operates as the fire detector. This detection system has components like bimetallic strips as a flame detector, smoke detector, and heat detector.

Key Words- **Fire Alarm System, Control System, PLC, Building Automation, Solenoid Valve, Flame/Smoke Detector, Power Supply**

1. OBJECTIVE

Fire alarm system is one in which the smoke or fire is detected through the sensors and this signal is sent to the microcontroller which operates solenoids located in the rooms.
Objectives for using Programmable Logic Controller (PLC) are as follows:

1) Solenoid of only particular room is operated.
2) Recovery is made easy.

2. INTRODUCTION

In this present world of advanced technology electronic systems are widely used which is one of the primary reasons for short circuits in homes and commercial applications. Due to this fire hazard, fighting system for commercial as well as residential purposes are being implementation with fire fighting system. But recently fire fighting panels are designed and developed using microprocessor which can breakdown at any time and whose trouble shooting is very difficult and time consuming, So, we have designed and developed this PLC based fire alarm control system project in which PLC is the heart of automation that is being used in our fire fighting panel.

We present a prototype model of 3 rooms and one water tank. Each room consists of individual fire or smoke sensor and sub water pump/electric valve, and also the water level sensor for tank and main pump.

This project is designed and implemented for a fire alarm system using the PLC which operates the entire system. The detectors are placed in such a way that they are present in different rooms. Any signal from each detector at any room is detected and monitored using monitoring system installed individually for each room. The appliance system has components like buzzer for alarming and motor pump to stop the fire and installed individually for each room. Relay driver is used to make switch on/off relay according to PLC output. The entire system is controlled by PLC in each room. The PLC is programmed in such way by using ladder diagrams. In this project, the system can detect smoke, heat etc. and are sensed by the detector, followed by the monitoring system which indicates smoke, heat etc. at that particular level. Finally when the sensors form each level are triggered individually, the main buzzer operates and disconnects the AC power supply. Then it runs the emergency exit door motor to escape, the lift comes to ground level and the water pump motor to the affected zone starts to stop the fire.

Fig. 1: Actual fire panel.

3. SCIENCE OF EXTINGUISHMENT

3.1 Fire Elements:

There are four elements needed to start and sustain a fire and/or flame. These elements are classified in the “fire tetrahedron” and are:

1. Fuel (Reducing agent)
2. Heat
3. Oxygen (Oxidizing agent)
4. Chemical reaction

The fuel or reducing agent is the substance or material that is being oxidized or burned in the combustion process. The most common fuels contain carbon along with combinations of hydrogen and oxygen. Heat is the energy component of the fire tetrahedron. When heat comes into contact with a fuel, it provides the energy necessary for ignition and causes the continuous production and ignition of fuel vapours or gases so that the combustion reaction can continue, and causes the vaporization of solid and liquid fuels. The self-sustained chemical chain reaction is a complex reaction that requires a fuel, an oxidizer, and heat energy to come together in a very specific way. An oxidizing agent is a material or substance that when the proper conditions exist will release gases, including oxygen. This is crucial to the sustainment of a flame or fire. A fire can be extinguished by taking away any of the four components of the tetrahedron.

One method to extinguish a fire is to use water. The first way that water extinguishes a fire is by cooling, which removes heat from the fire. This is possible through the ability of water to absorb massive amounts of heat by converting water to water vapor. Without heat, the fuel cannot keep the oxidizer from reducing the fuel to sustain the fire. The second way water extinguishes a fire is by smothering the fire. When water is heated to its boiling point, it converts to water vapour. When this conversion takes place, it dilutes the oxygen in the air with water vapour, thus removing one of the elements that the fire requires to burn. This can also be done with foam.

Another way to extinguish a fire is fuel removal. This can be accomplished by stopping the flow of liquid or gaseous fuel or by removing solid fuel in the path of a fire. Another way to accomplish this is to allow the fire to burn until all the fuel is consumed, at which point the fire will self-extinguish.

One final extinguishing method is chemical flame inhibition. This can be accomplished through dry chemical and halogenated agents. These agents interrupt the chemical chain reaction and stop flaming. This method is effective on gas and liquid fuels because they must flame to burn.

3.2 Use of Water:

Airmen from the 20th Civil Engineer Squadron Fire Protection Flight neutralize a live fire during a field training exercise at Shaw Air Force Base. Often, the main way to extinguish a fire is to spray with water. The water has two roles: in contact with the fire, it vaporizes, and this vapour displaces the oxygen (the volume of water vapour is 1,700 times greater than liquid water, at 1,000°F (540°C) this expansion is over 4,000 times); leaving the fire with insufficient combustive agent to continue, and it dies out. The vaporization of water absorbs the heat; it cools the smoke, air, walls, objects in the room, etc., that could act as further fuel, and thus prevents one of the means that fires grow, which is by "jumping" to nearby heat/fuel sources to start new fires, which then combine.

The extinguishment is thus a combination of "asphyxia" and cooling. The flame itself is suppressed by asphyxia, but the cooling is the most important element to master a fire in a closed area. Water may be accessed from a pressurized fire hydrant, pumped from water sources such as lakes or rivers, delivered by tanker truck, or dropped from aircraft tankers in fighting forest fires. In China, a fire fighting tank equipped with water and foam retardant guns is deployed in cases where access to the area is difficult.

3.3 Open Air Fire:

For fires in the open, the seat of the fire is sprayed with a straight spray so that the cooling effect immediately follows the "asphyxia" by vapor and reduces the amount of water required. A straight spray is used so the water arrives massively to the seat without being vaporized before. A strong spray may also have a mechanical effect viz. it can disperse the combustible product and thus prevent the fire from starting again. The fire is always fed with air, but the risk to people is limited as they can move away, except in the case of wildfires or bushfires where they risk being easily surrounded by the flames.

Spray is aimed at a surface, or object so that for this reason, the strategy is sometimes called two-dimensional attack or 2D attack. It might be necessary to protect specific items (house, gas tank, etc.) against infrared radiation, and thus to use a diffused spray between the fire and the object. Breathing apparatus is often required as there is still the risk of inhaling smoke or poisonous gases.

3.4 Closed Volume Fire:

Until the 1970s, fires were usually attacked while they declined, so the same strategy that was used for open air fires was effective. In recent times, fires are now attacked in their development phase itself as fire-fighters arrive sooner.

Thermal insulation of houses confines the heat; modern materials, especially the polymers, produce a lot more heat than traditional materials (wood, plaster, stone, bricks, etc.). Additionally, in these conditions, there is a greater risk of back draft and of flashover. Spraying of the seat of the fire directly can have unfortunate and dramatic consequences such as the water pushes air in front of it, so the fire is supplied with extra oxygen before the water reaches it.

At the Fire Department Instructors Conference (FDIC) held in Memphis in 1950, using Grimwood's modified 3D attack

strategy, the ceiling was first sprayed with short pulses of a diffused spray so that it cools the smoke, thus the smoke is less likely to start a fire when it moves away; cooler gas become more denser (Charles's law), thus it also reduces the mobility of the smoke and avoids a "backfire" of water vapour. It creates an inert "water vapour sky", which prevents *roll-over* (rolls of flames on the ceiling created by the burning of hot gases). Only short pulses of water must be sprayed, otherwise the spraying modifies the equilibrium, and the gases mix instead of remaining stratified. The hot gases (initially at the ceiling) move around the room and the temperature rises at the ground, which is dangerous for fire-fighters. An alternative is to cool the atmosphere by spraying the whole atmosphere as if drawing letters in the air ("pencilling"). The modern methods for an urban fire dictate the use of a massive initial water flow, e.g. 500 L/min for each fire hose. The aim is to absorb as much heat as possible at the beginning to stop the expansion of the fire, and to reduce the smoke.

4. BLOCK DIAGRAM

The various components used are shown in the Fig. 2 representing the block diagram of the fire alarm control system.

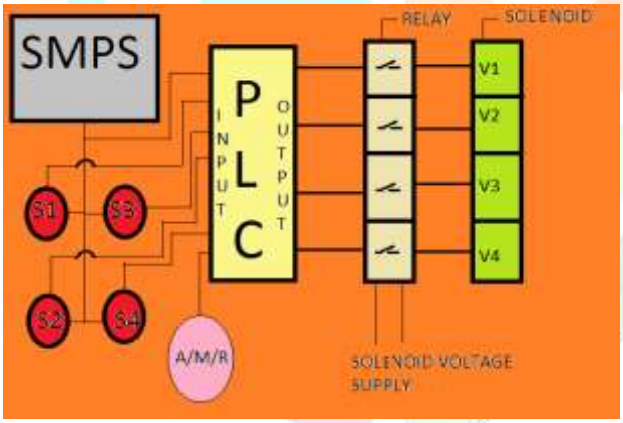

Fig. 2: Block diagram of the fire alarm control system.

4.1 Solenoid Valve:

Located in the field which is operated by the relay and run by the motor connected to it.

4.2 Relay:

A relay is usually an electromechanical device that is actuated by an electrical current. The current flowing in one circuit causes the opening or closing of another circuit. Relays are like remote-control switches and are used in many applications because of their relative simplicity, long life, and proven high reliability. Relays are used in a wide variety of applications throughout industry, such as in telephone exchanges, digital computers and actuation system.

Fig. 3: Relay.

4.3 Programmable Logic Controller (PLC):

A Programmable Logic Controller (PLC) is a device that was invented to replace the necessary sequential relay circuits from Machine control. The PLC works by looking at its inputs and depending upon their state, turning on/off its outputs. The user enters program, usually via software, that gives the desired results. PLC is a microcontroller system that are specially designed to survive in harsh situations and shielded from heat, cold, dust and moisture etc. PLC can be used for storing instructions for the execution of logic, sequencing and timing to control various digital and analog inputs and outputs.

Fig. 4: Programmable Logic Controller (PLC)..

4.4 Switched-Mode Power Supply (SMPS):

Power supply is a broad term but for this project it is restricted to discussion of circuits that generate a fixed or controllable magnitude dc voltage from the available form of input voltage. Integrated-circuit (IC) chips used in the electronic circuits need standard dc voltage of fixed magnitude. Many of these circuits need well-regulated dc supply for their proper operation. In majority of the cases the required voltages are of magnitudes varying between -18 to +18 volts. Some equipment may need multiple output power supplies.

Fig. 5: Switched-Mode Power Supply (SMPS).

4.5 Sector Switch:

Sector switch is also called as a 3-pole switch. It is used in the panel to put the panel in the manual or automatic mode.

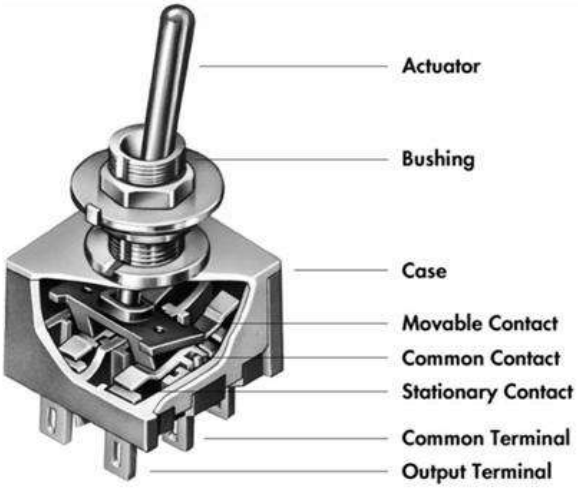

Fig. 6: Sector switch.

5. CONCLUSIONS

In this project,we have implemented the Programmable Logic Controller (PLC) to control and not only detect the fire, but also suppression of the fire. The PLC programming is done to perform the operations using pro-logix. In performance, of the designed model is superior than other controllers. The fire is detected with bi-metallic strip and suppressed with sprinkler system. The model is designed with power supply and relay devices, when the detectors sense the heat simultaneously and PLC perform the output operations.

6. REFERENCES

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