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Automatic Water Sprinkling System based on Intensified Fire Detection System using Proteus and Keil C

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Abstract: ***The main responsibility for safeguarding and preserving the structures, collections, activities and inhabitants of an institution or any property is declared as property management. To mitigate adverse impacts due to climatic change, various type of hazardous emissions, mold and fire, relentless attention should be devoted. Fire, which is very destructive due to its intensity of spreading at a higher tempo, serves as a severe threat to us. Objects that are engulfed by fire, is really very hard to recover. In a few minutes, an unrestricted fire will wipe out the resources of an entire room and eventually destroy a large building in a few hours. The major and initial step in preventing a fire is to correctly identify the case, trigger the alarm at the earliest, and then inform professionals from rescue operation team. These requirements can be fulfilled by the fire detection and alarm system. Depending on the particular requirements of the special zone, various device types and options are available. Fire detection with alarm system can be improvised by adding automatic water sprinklers with the fire detection module. Specialists in fire safety always believe that if automatic water sprinklers can be developed, installed and maintained properly then we can minimize the shortcomings arises due to fire. In this paper, we have used Proteus software for hardware design and validation of proof of concept. Keil C is used to program the Microcontroller unit.***

Index Terms: ATMEL89C51 Microcontroller, Water Pump, Photo diode, LDR, LM35, Relay

I. INTRODUCTION

In spite of continuing attempts to decrease the incidence and seriousness of industrial fire accidents, there are still frequent disastrous events, which occurs worldwide. There are multiple companies trying to collect and analyze data from such fire incidents and create underlying correlation between the causes and contexts of different fires [1-3]. Mostly flame sensors, heat sensors, flame sensors can identify the existence of fire. The main moto of this project is to minimize the risk of fire by properly selecting the sensors which are prone and accurate in detecting the fire. After the detection alarm system needs to be triggered [4-7]. If fire detection will be added with automatic water sprinklers with the help of Microcontroller programming, it will be definitely a remarkable advantage. With the help of alarm system people can be alerted instantly and fire professionals can be called without any delay [8-11]. The time gap between the arrivals of Fire brigades to the location can create heavy loss but in our project with the help of sprinklers it can be minimized. The mainly used smoke sensor based fire detection module has some disadvantages as it detects smoke coming from cooking as a fire due its sensitivity, it is not that much sensitive to smoldering fire. To overcome all these issues we have improvised the fire detection module with the help of three sensors such as LM35, LDR and Photo diode to increase the efficiency, sensitivity and accuracy as the main properties of fire are illuminance of light and heat/temperature. In the output section we have used water pump to sprinkle the water with the help of relay circuit along with buzzer and LCD display unit. Each sensor output is recognized by a status LED. Indeed we have received better performance with the proposed design.

II. PROPOSED ARCHITECTURE

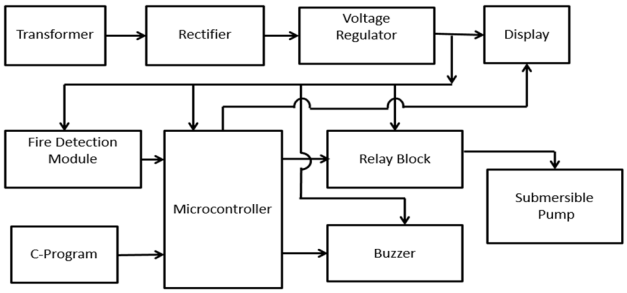

Fig 1: Block Diagram of Fire Detection System

Generally a power supply module in DC world uses a Step-Down transformer to minimize the high supply voltage (230V) to a safer low voltage range. The output of the stepdown transfer is fed to rectifier circuit to get DC output voltage with the help of a smoothing capacitor. We have used voltage regulators to get desired value of DC outputs. We have used ATMEL89C51 microcontroller which is a 40-pin dual-in-line (DIL) package. The PORT 0 of this microcontroller is used as LCD display, the fire detection module is given to the PORT 1. The output is measured from PORT 3. Pin number 20 is given to the ground and pin number 40 is supplied as Vcc. In Input block we are using sensors LM35, LDR, PHOTODIODE. All the outputs are connected to microcontroller. The output of fire detection module is fed to microcontroller. When all the outputs of LM35, PHOTODIODE & LDR are 1 then the buzzer rings, the message "FIRE DETECTED" is displayed on the LCD and water sprinkles with the help of motor simultaneously. The output block contains the relay circuit. Here relay circuit is used to drive the AC pump through the help of external AC supply. The display unit uses 16x2 LCD which indicates that 16 characters per line can be displayed and total two lines can be visualized. Each character is shown in a matrix of 5x7 pixels. The 16x2 LCD has basically 2 registers named as Data and Command registers. The command register keeps instructions provided to the LCD with the command. A command is an instruction given to the LCD to perform a predefined operation, such as initializing it, clearing the screen, setting the location of the cursor, display control, etc. The data register saves the information on the LCD to be displayed. The data is the character's ASCII value to be displayed on the LCD.

III.CIRCUIT DESCRIPTION AND OPERATION

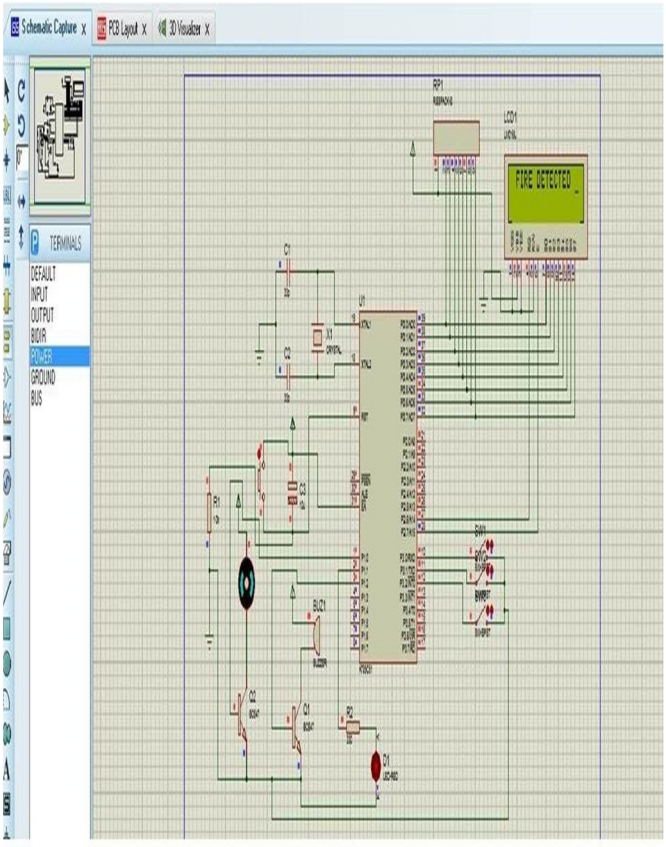

Fig.2: Circuit Diagram of Microcontroller Block

220V supplied AC voltage is converted to 22v ac by the help of step down transformer. The ac voltage is converted to dc by the help of rectifier circuit. This voltage is fed to microcontroller, fire detection module, and relay circuit. Fire detection module includes LM35, PHOTODIODE & LDR. The output of fire detection module is fed to microcontroller. When all the outputs of LM35, PHOTODIODE & LDR are high, it indicates the detection of fire. At that time the buzzer rings, the message "FIRE DETECTED" is displayed on the LCD with the help of Microcontroller and water sprinkles instantly with the help of motor. Generally motors are run with help of AC supply, so we have used Relay circuit for this purpose.

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A relay is a basic electromechanical switch consisting of an electromagnet, a set of contact and operating on the electromagnetic induction principle. A Light-Controlled Variable Resistor is a light-dependent resistor (**LDR**) or photocell. With rising incident light intensity, the resistance of a photo resistor decreases; in other words, it exhibits photoconductivity. In light-sensitive detector circuits, light and dark-activated switching circuits, a photo resistor can be applied.

Fig.3: Light Dependent Resistor

A semiconductor chip that transforms light into current is called **Photodiode**. The current is produced in the photodiode when photons are absorbed. When no light is present, a small amount of current is also produced.

Fig.4: Photo Diode

LM35 is temperature sensor IC which is best known for its exactness which can operate in the temperature range of -55°C to 150°C. The sensor output is voltage which is proportional to temperature (in ^{o}C). The circuitry of the sensor is sealed and is therefore not susceptible to oxidation or other processes. With LM35, it is possible to calculate the temperature more precisely than with a thermistor. It has low levels of self-heating and does not induce temperature increase in still air of more than 0.1^{o}C. It's a 3 pin IC having input voltage range is 4 to 20 volt and scale factor of 0.01V/ ^{o}C i.e. the o/p voltage varies by 10mv when there is raise or fall of temperature by 1^{o}C.

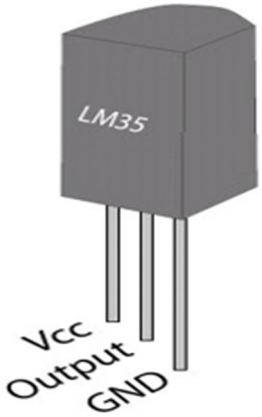

Fig.5: LM35 Temperature Sensor

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The Atmel 89C51 Microcontroller is basically a 40-pin IC with the following design: 128 x 8 RAM, Four 8-bit I/O ports, 4KB ROM, Full-duplex enhanced UART, three 16-bit counter/timers, on-chip oscillator. This Microcontroller is programed by using Keil C software using C programming language. This Microcontroller can be re programmed if needed.

Fig.6: ATMEL 89C51 Microcontroller

IV. PROTEUS SCHEMATIC DESIGN AND PCB LAYOUT

Proteus software is used to design the schematic and obtain the PCB layout. The layout is printed on a glossy paper. The print is placed on the PCB bare board according to the dimensions of layout. Then we have to use to flat iron with temperature 275 to 375^{o}F for around half an hour.

After the print comes to bare board, we used ferric chloride to start the etching process. In this process the unwanted cupper parts are eliminated and only the layout parts will sustain. Then we place the components at the desired places.

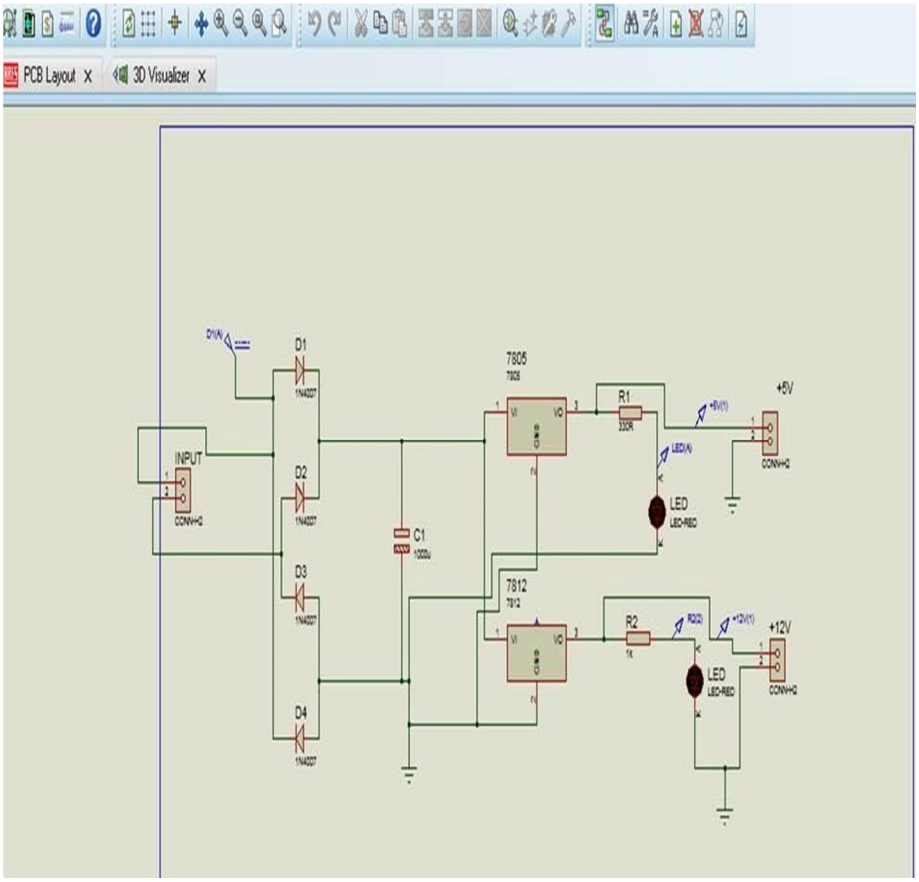

Fig.7: Schematic Circuit diagram of power supply

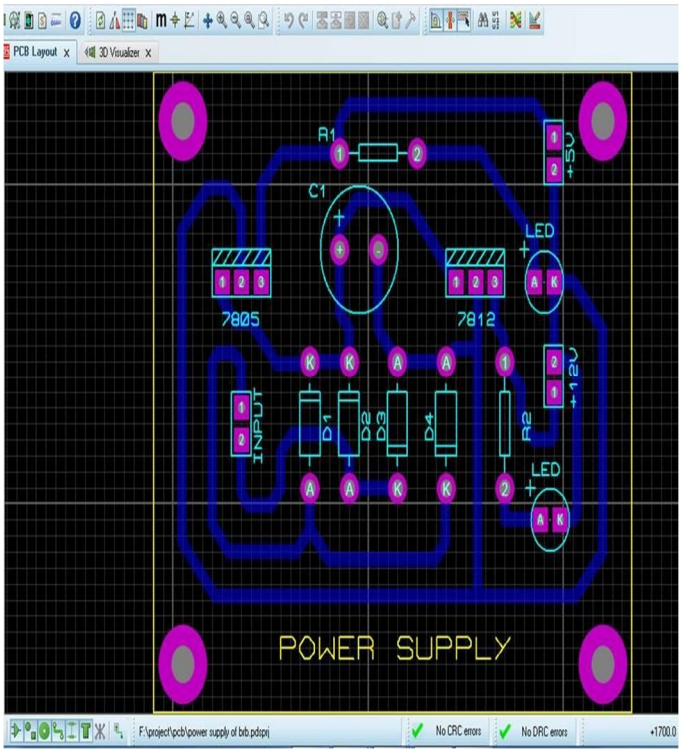

Fig.8: PCB Layout of power supply

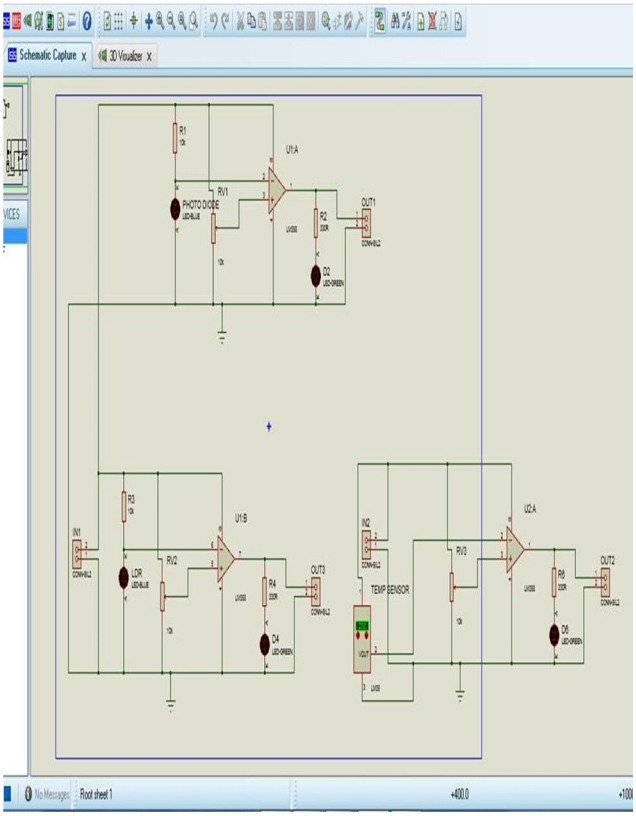

Fig.9: Schematic Circuit design for Fire Detection Module

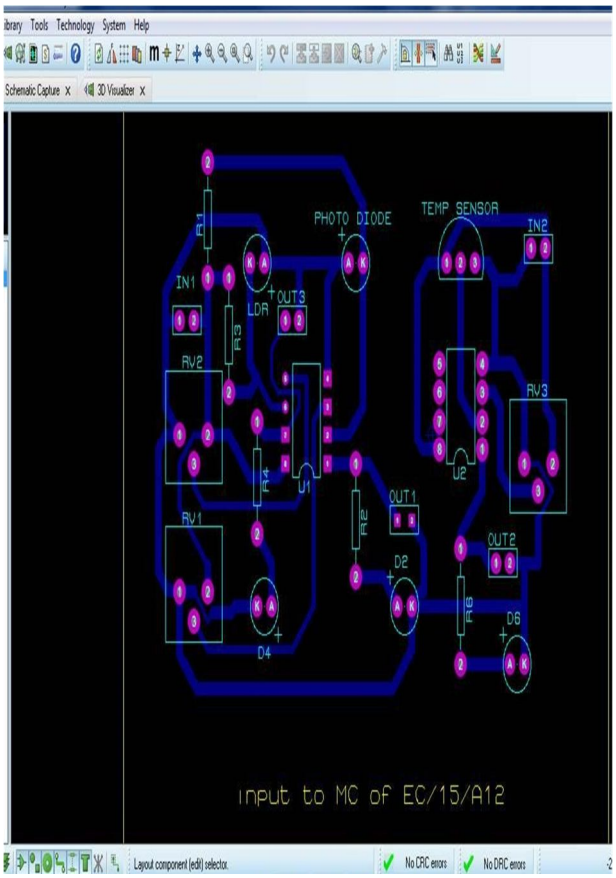

Fig. 10: PCB Layout of Fire Detection Module

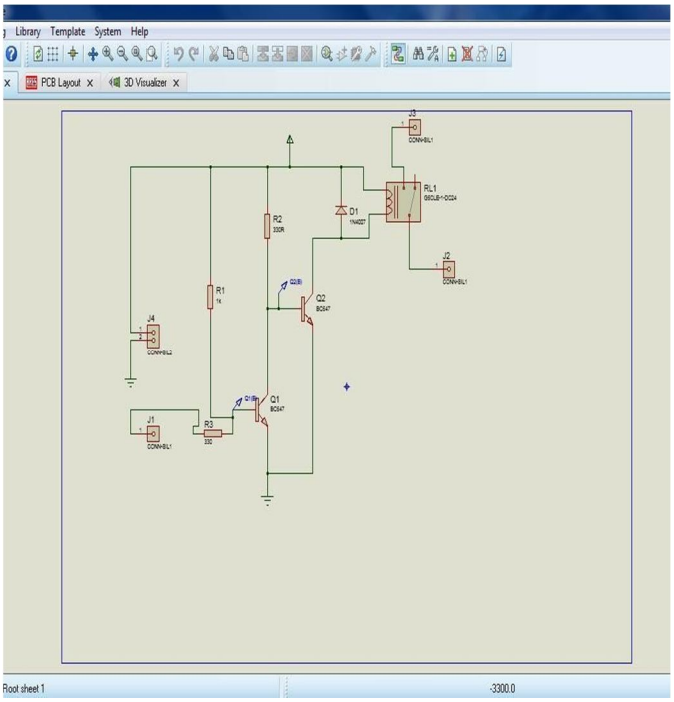

Fig 11: Schematic Circuit design for Relay Circuit

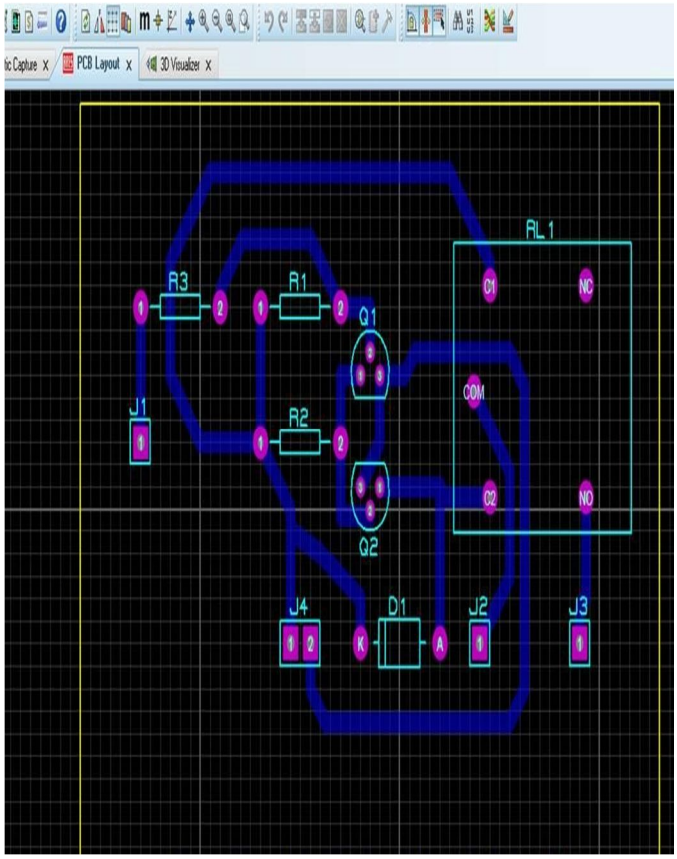

Fig 12: PCB Layout of Relay Circuit

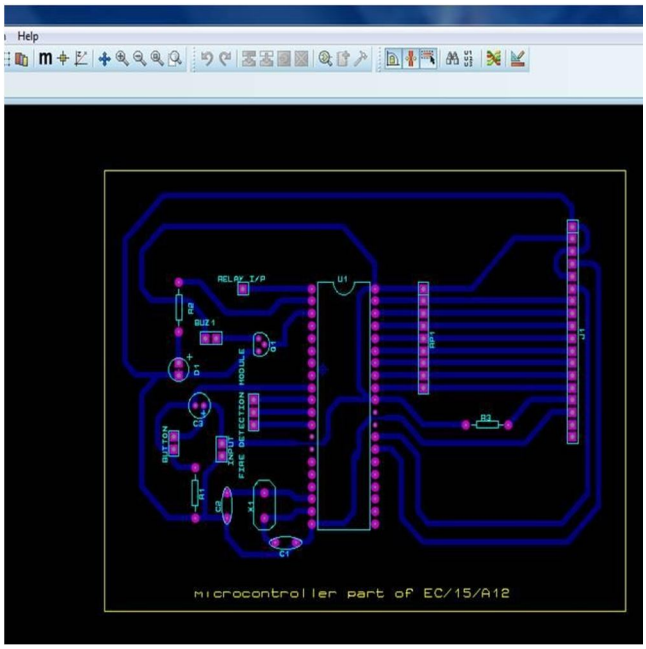

Fig 13: PCB Layout of Microcontroller Unit

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V. RESULTS AND TESTING

Fig.14: External View of Fire Detection System

After the completion of design and preparation of boards we have performed Continuity test and Power On test to check the stability of our device. A continuity test is the checking of an electric circuit to see if current flows (that it is in fact a complete circuit). A continuity test is executed to check whether any discontinuity has occurred or not in the layout or circuitry path after the etching process. We place the multi-meter in continuity or buzzer mode. Two terminals of the multi-meter is placed across the paths of layout. If the path is closed/complete we can hear the beep sound from multi-meter. It indicates the loop is closed. This test needs to be conducted carefully as it detects the fault in our PCB making process. If we will not perform this test thoroughly, later stage it will be very difficult to identify the problems. The next test that to be performed is Power On test. This test is performed after placing all the components except the Microcontroller unit. If we will not remove the Microcontroller, the entire system can be damaged if there is an unwanted excessive voltage flow for any reason. This process is done with the help of a multi-meter putting in voltage mode. First we checked the output voltage from transformer which is very crucial i.e. to check whether it is 12v AC or not. Then we apply this voltage to the power supply circuit which includes the rectifier circuit. We check for the input to the voltage regulator i.e. whether we are getting an input of 12v and an output of 5v. We checked every sensor's input Vcc as per requirement. 5v supply is given to the microcontroller's 40^{th} pin. After the hardware design we have written the code in Keil C software to create the hex file. After this step we have to burn the Microcontroller using the microcontroller kit with hex files.

VI. ADVANTAGES AND APPLICATION

Automatic water sprinkling system based on fire detection module saves lives i.e. act as a lifeguard, reduce the property loss. By installing both fire detective alarm and sprinkler, we can reduce the risk of death in home by 82% relative to having nothing. Just a portion of the water applied by fire department hoses, is utilized by home fire sprinklers. 90% of fires are managed by only one sprinkler operation. It will trigger only the sprinkler nearest to the fire, spraying water directly on the fire. The proposed system is very inexpensive i.e. in new building, on average, home fire sprinkler systems add 1 percent to 1.5 percent to the overall construction cost. Usually, similar to what you'd be paying for a carpeting upgrade. This automatic water sprinkling system based on fire detection module can be widely implemented in various factories, industries, ware houses, hospitals etc. These systems are very helpful in environments that are not subject to freezing. It can remove the disadvantage of smoke sensor implemented in various areas.

VII. CONCLUSION

The possible impact of a fire detection system, as with all situations, is directly related to the length of the beginning stages prior to accelerate fire development. Notwithstanding the activation of the suppression system or the location of the fire, if the detection is capable of providing an alert 10-15 mins before the end of the initial stage, the fire department should be able to minimize the damage. Fire detection would have a greater effect on a wider range of fire situations, assuming a response within three mins, if there are on-site, trained staff for fire response. In our proposed project we have used both siren to alert the onsite personals and sprinklers to spray the water instantly in the respective area which is under fire. We can increase the number of sprinklers based on our space or area, which needs to be covered. It can save our precious time, health and wealth of a person. It can also control the fire in the initial stage so that in that time span fire brigade can come and initiate the further rescue operation.

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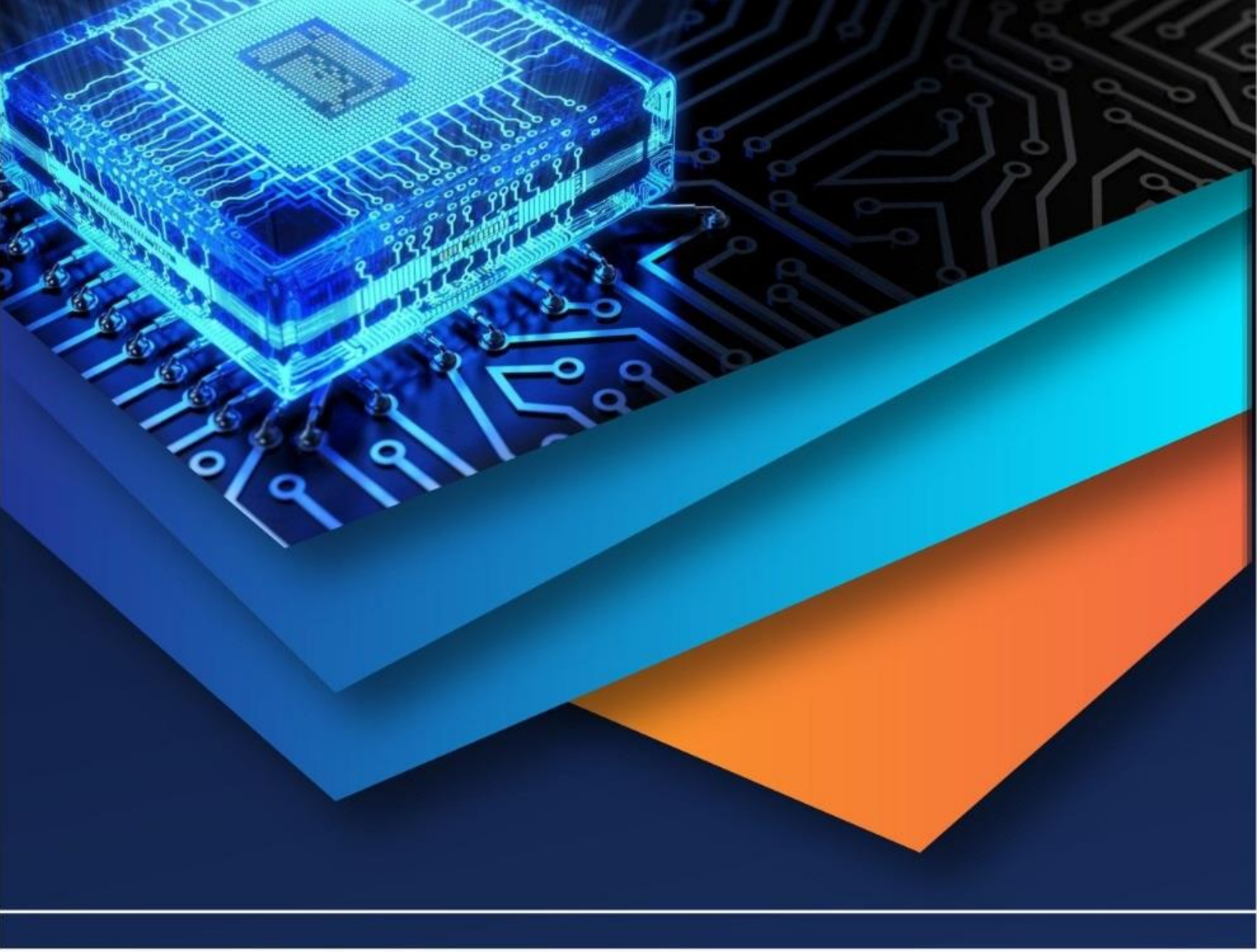

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