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Forest Fire Alerting System Using IOT

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***Abstract*—**Protecting our environment is essential in today's developing world. Around the world, a lot of instances involving natural and man-made calamities were occurring. One such environmental tragedy is wildfire. Once it gets going, the fire in the deep forest spreads throughout the entire area, burning and destroying everything in its path. Due to dry conditions, fire spreads more readily on hot days and decimates grasses and trees in forested areas. Such forest fire catastrophes need to be reduced in order to safeguard the habitats of the forest's flora and animals. The objective of this project is to develop and execute a system using Internet of Things technology. This system aims to anticipate and identify forest fires, transmitting the exact location to relevant authorities. By doing so, it empowers firefighters to promptly extinguish the fire at its initial point of ignition. This proactive approach prevents the fire from spreading across a wide area and enables preemptive measures to prevent any potential fires that might occur soon.

I. INTRODUCTION

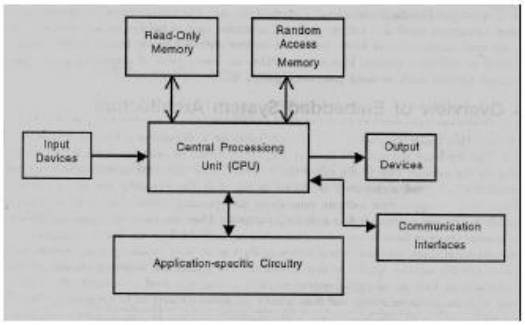
A significant resource for human life is the forest. Its protection is crucial for the preservation of natural resources, climatic conditions, and the health of the environment. Emergency situations brought on by natural disasters cause significant loss of material and personal assets nowadays. Environmental pollution and natural disasters cause additional harm to the ecosystem and the spread of illness. A lack of effective resource planning can cause the effects of such threats to be amplified. Security flaws or bad management, disaster preparedness strategies, and warning systems could all be contributing factors. We can have more alternatives for identifying and containing big threats and their spread with the use of such measures. The density of polluting gases in the air, such as CO2 and CO, can rise as a result of problematic circumstances. and can also lead to forest fires, which happen often . Such occurrences create emergency situations that call for effective management services and agencies.

The topography of the ground, vegetation types in the vicinity, and prevailing weather conditions all play significant roles in exacerbating emergency situations. To identify the source of fires and monitor their progression, it is crucial to regulate and observe atmospheric elements such as temperature, relative humidity, atmospheric pressure, and the concentration of specific pollutant gases. In this scenario, certain factors like rising temperatures, decreasing humidity, or increased pollution levels serve as indicators of a potential fire emergency. To address these concerns, an information system has been developed that combines Internet of Things (IoT) devices with sensors capable of detecting smoke and light for fire detection. Smoke and fire not only worsen atmospheric pollution but also pose risks to human health, forest ecosystems, and signify the onset of a fire emergency [6]. Figure 1 illustrates the block diagram. With advancements in robotics, human involvement has been minimized, and robots are increasingly utilized to enhance safety measures. Fire incidents have become commonplace in our daily lives and can often lead to perilous situations where firefighters struggle to protect human lives. To mitigate such cases, this robot is employed to safeguard human lives, surroundings, and assets from fire accidents.

This project consists the usage of the following concept:

Embedded system- In order to carry out a certain task, an embedded system combines computer hardware, software, and sometimes extra mechanical or other components. A component of a bigger system is an embedded system. The architecture of embedded system is represented in the above flow chart diagram

The blocks of the Embedded system architecture are



Central Processing Unit - A Central Processing Unit, also known as a processor, can be a microcontroller, microprocessor, or Digital Signal Processor (DSP). A microcontroller is a cost-effective processor that stands out for its integration of various components directly onto the chip, including memory, a serial communication interface, an analog-to-digital converter, and more.

Memory - Memory can be classified into two types: read-only memory (ROM) and random access memory (RAM). When the chip loses power, the contents of RAM are erased, while the contents of ROM remain intact. Consequently, the ROM stores the firmware. When power is supplied, the processor reads the ROM, and the program is executed accordingly.

Input devices - In embedded systems, the available input devices are more limited compared to desktop computers. Without a keyboard or mouse, interacting with an embedded system is less straightforward. A common input device for embedded systems is a small keypad, allowing commands to be issued by pressing a single key. Typically, keypads are limited to entering numeric values only. Many embedded systems used in process control lack user interaction input devices and instead rely on sensors or transducers to collect inputs, convert them into electrical signals, and transmit those signals to other systems.

Output devices - Output devices in embedded systems also have limited functionalities. In some cases, a few Light Emitting Diodes (LEDs) are employed to indicate the system's module status or to visually signal alarms. Additionally, a small Liquid Crystal Display (LCD) may be utilized to display important parameters.

Communication Interfaces - Embedded systems often require communication with other embedded systems or the provision of data to desktop computers. To facilitate this, embedded systems are equipped with one or more communication interfaces such as RS232, RS422, RS485, Universal Serial Bus (USB), IEEE 1394, Ethernet, among others.

Application-specific circuitry - Depending on the specific application, an embedded system may require sensors, transducers, specialized processing, and control circuits. This circuitry communicates with the processor to fulfill the necessary tasks. Power for the entire hardware system can be supplied by either a battery or the standard 230-volt mains. It is important to design the hardware with minimal power consumption in mind.

II. LITERATURE SURVEY

Kwon, O.H., Cho, S.M., and Hwang, S.M [1] conducted a study on fire detection systems and developed a cost-effective, portable, and reliable microcontroller-based automated fire alarm system. The system was designed to remotely alert property owners about fire incidents in residential or industrial premises. It utilizes a linear integrated temperature sensor to detect temperatures beyond a preset threshold, and a semiconductor type sensor to detect the presence of smoke or gas from fire hazards. These sensors are connected to an ATMega8L AVR microcontroller through a common data line. To send alert messages, a SIM300CZ GSM kit-based network module, operating in standard GSM bands, is employed. The system was implemented on a printed circuit board (PCB) and tested under various experimental conditions to assess its performance.

Similarly, Omar Asif, Md. Belayat Hossain, Mamun Hasan, Mir Toufikur Rahman, and Muhammad E. H. Chowdhury [3] conducted a review of existing fire detector types and developed a low-cost, portable, and reliable microcontroller-based automated fire alarm system. The objective of their system was to efficiently and swiftly alert property owners about fire incidents in residential or industrial premises by sending short message (SMS) notifications via the GSM network. The system incorporates a linear integrated temperature sensor to detect excessive temperatures and a semiconductor type sensor to detect smoke or gas associated with fire hazards. These sensor units are connected to an ATMega8L AVR microcontroller through a shared data line. A SIM300CZ GSM kit-based network module, compatible with standard GSM bands, is used for sending alert messages. The system was implemented on a printed circuit board (PCB) and subjected to diverse experimental conditions to evaluate its performance.

III. BLOCK DIAGRAM OF PROJECT AND FUNCTIONING

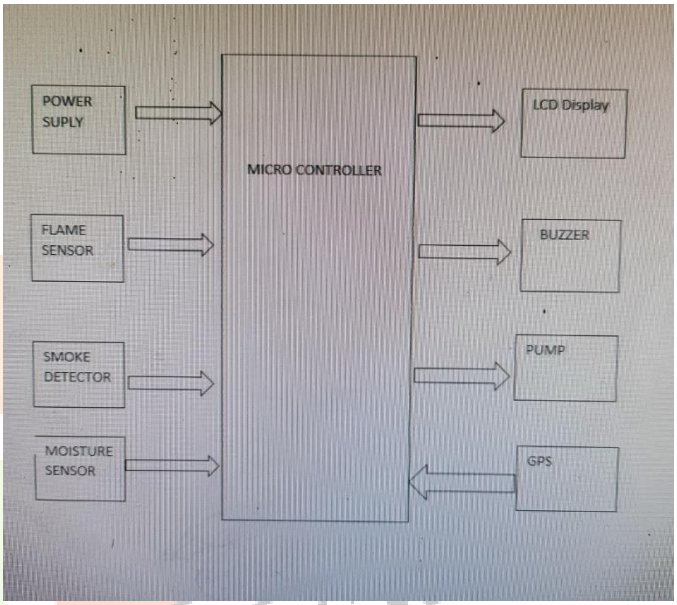


Fig: Block diagram of project and functioning

POWER SUPPLY BLOCK DIAGRAM:

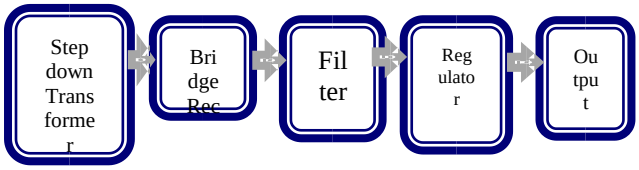


Fig: Block diagram of power supply

IV. COMPONENTS

Arduino- The Arduino Uno, a microcontroller board, utilizes the ATmega328 (datasheet) as its foundation. It incorporates a 16 MHz ceramic resonator, 6 analog inputs, 14 digital input/output pins (with 6 of them capable of functioning as PWM outputs), a USB port, a power jack, an ICSP header, and a reset button. It is equipped with all the necessary components to support the microcontroller. To activate it, simply connect a USB cable, an AC-to-DC adapter, or a battery to supply power.

The power pins are as follows:

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VIN: The input voltage of the Arduino board when it is powered by an external source, such as the power jack, rather than the 5 volts provided by the USB connection or another regulated power source. This pin can be used to access the supplied voltage or to provide voltage to it.

5V: This pin supplies a regulated 5V output from the board's regulator. The board can be powered through the USB connector (5V), the DC power port (7-12V), or the VIN pin (7-12V). Applying power directly to the 5V or 3.3V pins without going through the regulator can cause damage to the board.

Memory: Out of the ATmega328's 32KB memory, 0.5KB is occupied by the bootloader. It also has 1KB of EEPROM, which can be read and written using the EEPROM library, and 2KB of SRAM.

Input and Output: Each of the 14 digital pins on the Arduino Uno can be configured as an input or output using the pinMode(), digitalWrite(), and digitalRead() functions. These pins operate at 5 volts. Each pin has an internal pull-up resistor with a value of 20-50 kOhm, which is not connected by default. The maximum current capacity of each pin is 40mA. Additionally, certain pins have specific functions:

Serial: Pins 0 (RX) and 1 (TX) are used for TTL serial data transmission and reception. These pins are connected to the corresponding pins of the ATmega8U2 USB-to-TTL chip.
External interrupts: Pins 2 and 3 can be programmed to trigger an interrupt based on a low value, a rising or falling edge, or a change in value. The attachInterrupt() function provides more details.
PWM: Pins 3, 5, 6, 9, 10, and 11 support Pulse Width Modulation (PWM) and can output an 8-bit PWM signal using the analogWrite() function.
SPI: Pins 10 (SS), 11 (MOSI), 12 (MISO), and 13 (SCK) are used for SPI communication and are supported by the SPI library.
LED: Pin 13 is connected to a built-in LED. The LED is on when the pin is set to HIGH and off when it is set to LOW.
The Arduino Uno also has six analog inputs labeled A0 to A5, which offer 10 bits of resolution (1024 distinct values). The upper limit of their measurement range can be adjusted from the default ground to 5 volts by using the AREF pin and the analogReference() function. Additionally, there are other pins on the board with specific functions:

TWI: Pins A4 (SDA) and A5 (SCL) are used for Two-Wire Interface (TWI) communication and are supported by the Wire library.
AREF: This pin provides a reference voltage for the analog inputs used with the analogReference() function.
Reset: Pulling this line LOW resets the microcontroller. It is commonly used with shields that obstruct the board's reset button. You can also refer to the mapping of Arduino pins to ATmega328 ports, which remains the same for Atmega8, 168, and 328.

Power Supply- The controlled power source provides the circuit with its input. The transformer steps down the a.c. input, or 230V from the mains supply, to 12V before feeding it to a rectifier. A pulsing d.c voltage is produced by the rectifier as its output. Hence, the voltage produced by the rectifier undergoes filtration to eliminate any remaining alternating current components, ensuring a clean direct current value. To achieve a stable and constant direct current voltage, this filtered voltage is directed to a voltage regulator. The diagram below illustrates the configuration of the Power Supply system.

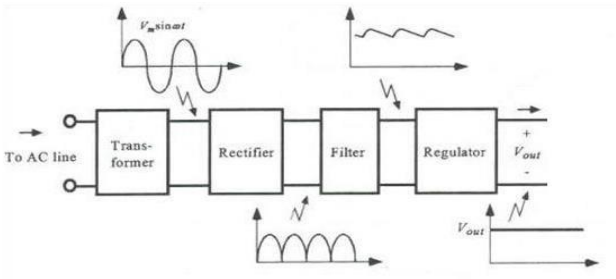


Fig: Block Diagram of Power Supply

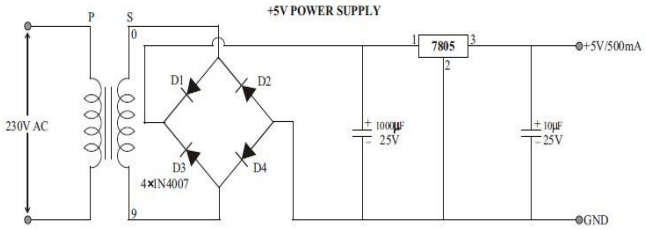


Fig: Circuit Diagram of Power Supply

Step Down Transformer- To power various electrical devices with specific DC voltages like 5V, 9V, or 12V, it is necessary to transform the input voltage. Since direct access to these voltages is not available, the 230V AC input from the main power supply needs to be reduced to the required voltage level. This task is accomplished by using a step-down transformer, which lowers the voltage to the desired level.

Rectifier- The output from the transformer is then fed into a rectifier, which converts the AC voltage into pulsating DC voltage. Depending on the design, either a half-wave or full-wave rectifier can be employed. In this project, a bridge rectifier is chosen for its advantages, such as improved stability and full-wave rectification.

Filter- To smoothen the pulsating DC voltage and remove any ripples or fluctuations in the rectifier's output, a capacitive filter is utilized. This filter ensures a constant output as long as the mains voltage and load remain stable. However, any changes in either of these factors can affect the DC voltage received at this stage.

LCD (LIQUID CRYSTAL DISPLAY)
The liquid crystal display, commonly referred to as LCD, is highly beneficial for both debugging purposes and providing a user interface. The foundation of most character-based LCDs is the Hitachi HD44780 controller or a compatible device such as HD44580. The prevailing LCD models available today include 1 Line, 2 Line, or 4 Line LCDs, which utilize a single HD44780 controller and can display a maximum of 80 characters. LCDs that require support for a greater number of characters employ two HD44780 controllers.

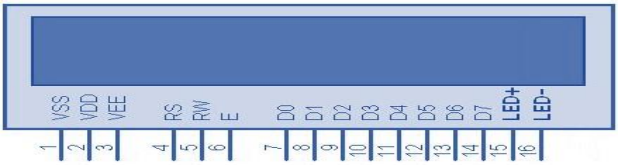


Fig: Pin diagram of LCD

Pin No.	Name	Description
1	**VSS**	Power supply (GND)
2	**VCC**	Power supply (+5V)
3	**VEE**	Contrast adjust
4	**RS**	0 = Instruction input 1 = Data input
5	**R/W**	0 = Write to LCD module 1 = Read from LCD module
6	**EN**	Enable signal
7	**D0**	Data bus line 0 (LSB)
8	**D1**	Data bus line 1
9	**D2**	Data bus line 2
10	**D3**	Data bus line 3
11	**D4**	Data bus line 4
12	**D5**	Data bus line 5
13	**D6**	Data bus line 6
14	**D7**	Data bus line 7 (MSB)
15	**LED+**	Back Light VCC
16	**LED-**	Back Light GND

Table: Description of LCD

FIRE SENSOR(FLAME):

A flame sensor is a specialized type of detector designed to detect and respond to the presence of a fire or flame. Its fitment may affect the flame detection reaction. It has a propane tank, a fire suppression system, a natural gas line, and an alarm system. Industrial boilers use this sensor. This mostly serves to verify whether or not the boiler is operating properly. Because of its technique for sensing the flame, these sensors' response is quicker and more precise when compared to a heat/smoke detector.

Below is a diagram showing how this sensor's pins are set up. The following four pins are included.

•Pin1 (VCC pin): Voltage supply rages from 3.3V to 5.3V
•Pin2 (GND): This is a ground pin
•Pin3 (AOUT): This is an analog output pin (MCU.IO)
•Pin4 (DOUT): This is a digital output pin (MCU.IO)

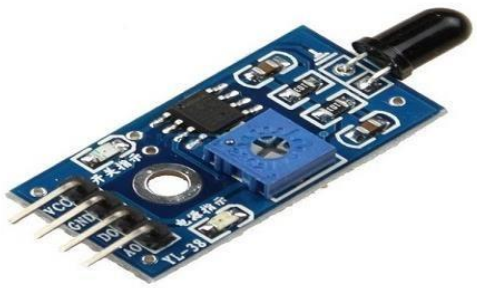


Fig: Flame Sensor

INSTALLATION AND IMPLEMENTATION:

ARDUINO – INSTALLATION

After familiarizing ourselves with the main components of the Arduino UNO board, we are now ready to understand the process of setting up the Arduino IDE. Once we have completed this setup, we will be able to upload our program to the Arduino board. This section provides a step-by-step guide on how to configure the Arduino IDE on your computer and prepare your board for program uploading via a USB cable.

Step 1: To begin, make sure you have an Arduino board of your choice and a USB cord on hand. For most Arduino models such as Arduino UNO, Arduino Duemilanove, Nano, Arduino Mega 2560, or Diecimila, you will need a standard USB cable (with an A plug on one end and a B plug on the other), similar to the one used for connecting to a USB printer.

Step 2: Multiple versions of the Arduino IDE are available for download on the official Arduino website's Download page. It is essential to select the appropriate software compatible with your operating system, whether it is Windows, iOS, or Linux. Once the download is complete, you need to extract the files from the downloaded zip file..

Step 3: The Arduino Uno, Mega, Duemilanove, and Nano automatically utilize the USB port on the computer or an external power source. However, if you are using the Arduino Diecimila, you need to ensure that it is configured to receive power from the USB connection. This can be done by using a jumper, a small plastic piece that connects two out of the three pins located between the USB and power connections. Make sure the jumper is connected to the two pins closest to the USB port. To establish a connection between the Arduino board and your computer, use the USB cable provided. When the connection is established, the green power LED, labeled as PWR, should illuminate..

Step 4: After downloading the Arduino IDE program, it is necessary to extract the contents of the folder. Inside the folder, you will find an application icon named "application.exe" accompanied by an infinity sign. To open the IDE, simply double-click on this icon..

ARDUINO – PROGRAM STRUCTURE

We thoroughly explored the structure of Arduino programs and familiarize ourselves with additional terminology commonly used in the Arduino community. The Arduino software is freely available for download. The C/C++ microcontroller libraries are governed by the LGPL license, while the source code for the Java environment follows the GPL license.

One of the new terms introduced is "sketch," which refers to an Arduino program. We delved into the details of the Arduino software program in this tutorial, learning how to develop programs without encountering syntax or compilation errors. We will start by discussing the program structure, which consists of three fundamental components: Structure, Values (variables and constants), and Functions.

It will provide a comprehensive explanation of the software structure, focusing on two main functions:

The Setup() function
The Loop() function

WIFI –
Radio waves are used by wireless networks, just like they are by radios, televisions, and cell phones. In actuality, two-way radio communication and communication over a wireless network are very similar.
Here is what transpires:

The wireless adapter in a computer converts data into a radio signal and transmits it through an antenna. This signal is then received and decoded by a wireless router. The router, using a wired Ethernet connection, sends the data to the Internet.

Conversely, the process can also be reversed. The router retrieves data from the Internet, converts it into a radio signal, and transmits it to the computer's wireless adapter. The radios used for Wi-Fi connections are similar to those found in cell phones, walkie-talkies, and other devices. They have the capability to convert binary data (1s and 0s) into radio waves and vice versa. They can also transmit and receive radio waves. However, Wi-Fi radios differ from traditional radios in several ways. For example, they operate at higher frequencies of 2.4 GHz or 5 GHz, allowing for the transmission of more data compared to frequencies used by televisions, walkie-talkies, and cell phones.

Moving on to the topic of buzzers, they are audio signaling devices that can be mechanical, electromechanical, or piezoelectric. Buzzers or beepers are commonly used as alarm clocks, timers, and to provide feedback for human inputs such as mouse clicks or keystrokes. In various electronic devices such as computers, printers, copiers, alarms, electronic toys, automotive electronics, telephones, timers, and other sound-emitting products, buzzers are often integrated components that include electronic transducers and DC power supplies

FEATURES

Input supply: 5 VDC

- Current consumption: 9.0 mA max.
- Oscillating frequency: 3.0 ±0.5 KHz
- Sound Pressure Level: 85dB min

MOISTURE SENSOR - The soil moisture sensor is a type of sensor used to determine the amount of water present in the soil. Instead of directly measuring the gravimetric dimension of soil moisture, which involves drying and weighing soil samples, these sensors indirectly measure the volumetric water content using various soil properties such as electrical resistance, neutron interaction, dielectric constant, and other soil laws.

The relationship between the calculated property and soil moisture needs to be adjusted and may vary depending on environmental factors such as temperature, soil type, and electrical conductivity. The moisture content of the soil can affect the microwave emission and reflection, making soil moisture sensors particularly useful in agricultural and hydrological applications using remote sensing technology.

FEATURES

- The required voltage for working is 5V
- The required current for working is <20mA
- Type of interface is analog
- The required working temperature of this sensor is 10°C~30°C

MQ3 SENSOR - The MQ3 alcohol gas sensor is a module designed to detect various substances including alcohol, CO, CH4,LPG,Benzene,hexane and gasoline. It utilizes a sensitive material called SnO2 to detect alcohol gas, which exhibits lower electrical conductivity in clean air. This semiconductor sensor specifically detects or monitors the presence or absence of alcohol. It is commonly referred to as a chemiresistor because its sensitive material's response relies on changes in resistance when exposed to alcohol gas.

FEATURES

It necessitates a 5VDC power source with a current consumption of 165mA when the heater is turned on, and 60mA when the heater is turned off.

• Draws a current of 150mA.

• Operates in humidity conditions exceeding 95% relative humidity.

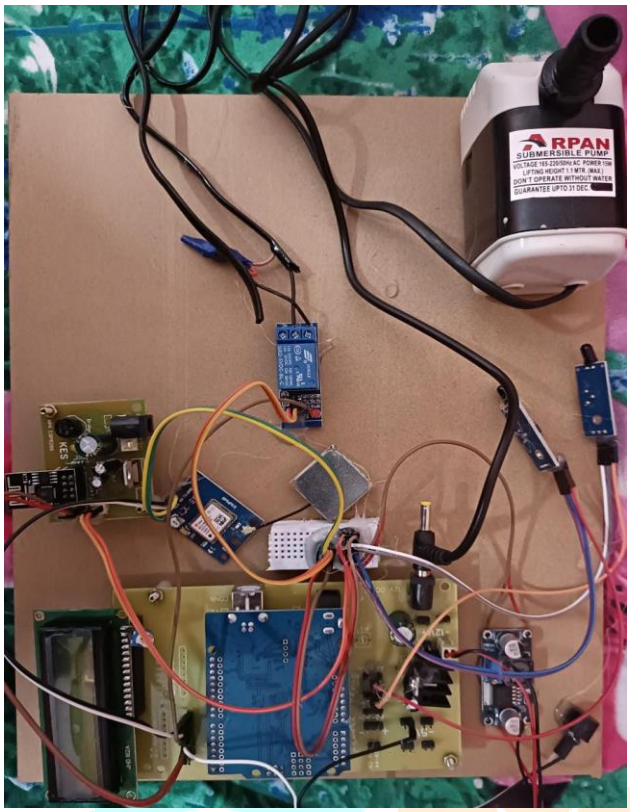
• Can function within a temperature range of -10°C to 50°C (14°F to 122°F).

• Can be stored in temperatures ranging from 20°C to 70°C.

• Works with a load resistance of 200 kilo ohms.

• Demonstrates sensitivity with a value of Rs greater than or equal to 5, calculated as Rs(in the air) divided by Rs(0.4mg/L Alcohol).

RESULT



CONCLUSION

Through this we can infer that employing robots instead of humans can minimize the dangers faced by firefighters, thereby reducing the risk to their lives. These robots can be utilized in various settings such as homes, laboratories, and offices. They offer enhanced effectiveness in detecting flames, enabling early intervention and extinguishing before the situation escalates into an uncontrollable threat to human life. Therefore, these robots can assume a vital role in fire safety measures.

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