PHASE 1

Fire is a major contributing factor to fatalities, property damage, and economic disruption. A large number of fire incidents across the world cause devastation beyond measure and description every year. To minimize their impacts, innovative and effective fire detection technologies are required. Fire detection technology still confronts hurdles in decreasing false alerts, improving sensitivity and dynamic responsibility, and protecting costly and complicated installations.

emphasis on the methods of detecting fire through the continuous monitoring of variables, such as temperature, flame, gaseous content, and smoke, along with their respective benefits and drawbacks, measuring standards, and parameter measurement spans.

Techniques for measuring practically every stable gaseous species generated before or during combustion are now available.

Various fire elements, such as smoke, heat, and carbon monoxide, are detected by multiple sensors, and a complicated algorithm is used to intelligently discern the difference between fire and non-threatening conditions.

In recent years, the development in fire sensors has been reviewed and summarized from several perspectives: chemical sensors associated with fire detection [7], fire detection algorithms [8], video fire detection [9], video smoke detection [10], sensors modules [11], fire monitoring systems [12], forest fire detection [13], distributed heat sensors [14], and fire sensors for specific location [15] and extreme conditions [16].

Ignition, fire growth, and eventually flashover, followed by a cooling phase, are the stages of fire development in enclosures. The primary concern throughout the ignition and growth phases is lifesaving, which is where fire sensors play a big role by warning and alarming.

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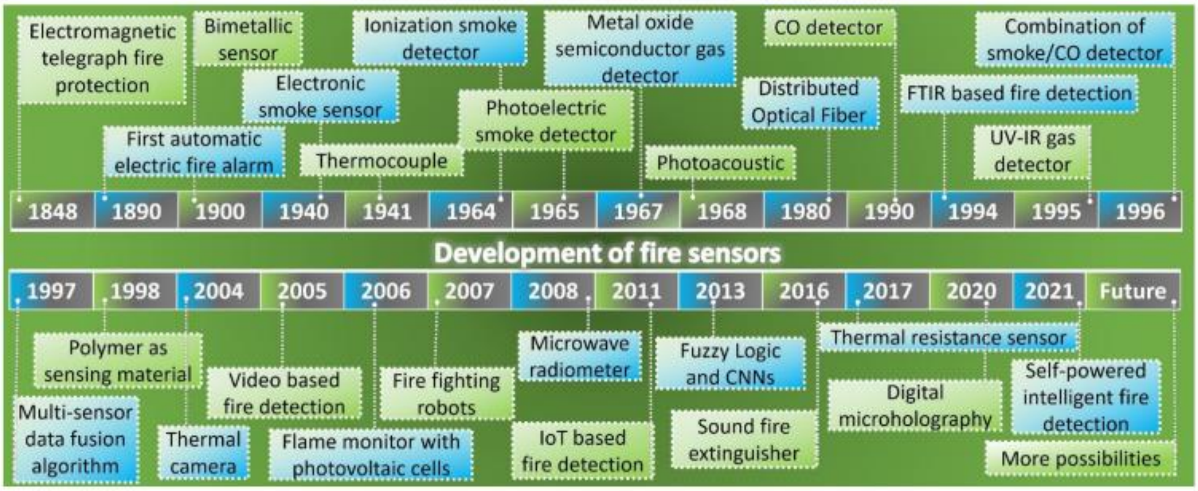
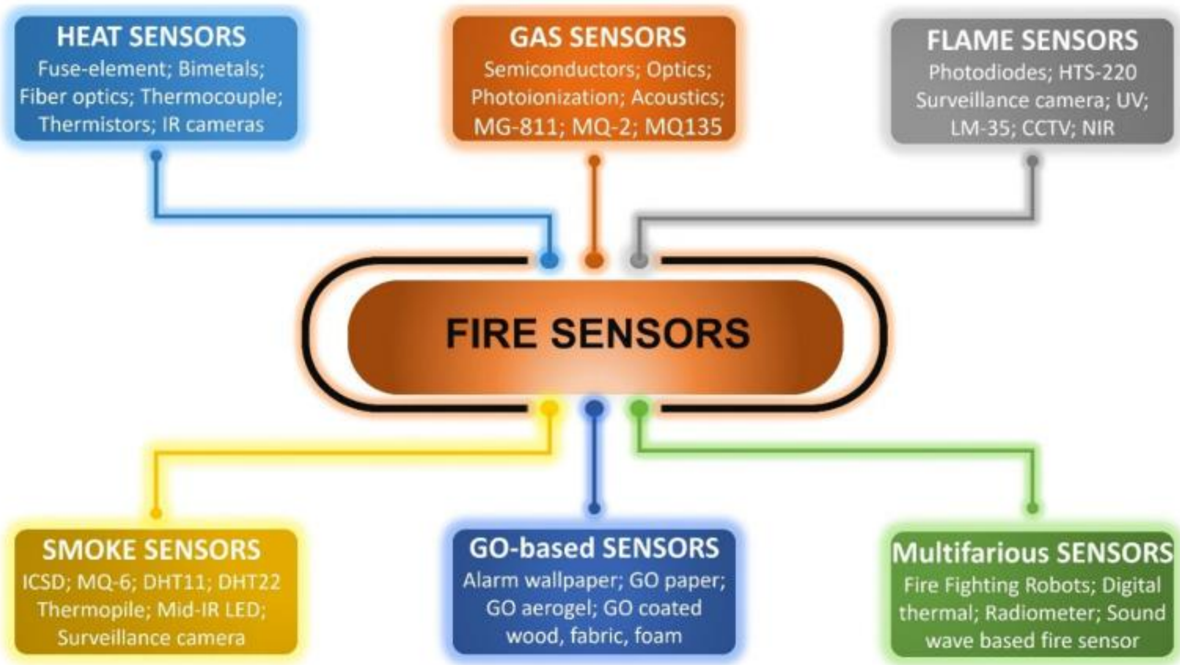
“Fire Sensors”





There are key five detecting methods, comprising heat, gas, flame, smoke, and graphene oxide (GO) based sensing.

In fire detection based on heat sensing, most current fire detection systems use electronic and distributed optical thermal detectors based on thermistors.

Thermal sensing based on infrared is a helpful technique, especially appropriate for thermal detection of the targeted location. Compared with non-visual methods, visual approaches for smoke and flame detecting are attracting research focus because of their rapid response time and low imprecision output rate.

Among different gas sensing technologies, gas sensors based on semiconductor metal oxides have been useful in practice due to their great sensibility, small size and reduced cost. However, they have problems with stability, which require more study to resolve.

Microwave radiometer-based fire sensing is one of the most important contemporary approaches due to its key benefit of fire detection across barriers such as walls. For fire detection, the multi-sensor fusion method based on wireless sensor networks (WSNs) and the Internet of Things (IoT) is suitable. The new emerging technique of graphene oxide (GO) based sensing has shown an outstanding short response time.

Heat Sensors

Heat sensors are used to measure the ambient heat in a residence because of the occurrence of fires. The sensors are sensitive to the temperature that is related to the resistance variation, displacement, and refractive index, etc.

Generally, there are three types of heat sensors:

- fixed temperature,
- increase rate,
- compensation rate.

The fixed temperature heat sensor is triggered when the temperature rises above the threshold value, which is at or above 60 °C.

Gas Sensors

Gases are emitted at every stage of combustion, and unique gas characteristics can be used to reliably detect fires.

the density of CO, CO_2, H_2, O_2, and smoke produced by wood fire, cotton fire, plastic fire, liquid *n*-heptane and spirit fires. The chemical composition of smoke from various types of fires varies radically, according to their source. CO is the best of the four warning gases, appearing in all six types of fires. CO fire sensors that work at room temperature, require a low-power source in comparison to traditional detectors and can protect against smoldering fire, including the combustion of organic materials in which substantial amounts of carbon dioxide are emitted early in the combustion process.

By measuring the change in gas sensor output, the existence of gases in a certain position is sensed by the gas sensor.

Low oxygen concentration changes are a sign of smoldering, while a high oxygen concentration change is a warning of the combustion of liquid fuel.

One of its issues is that their output signals fluctuate with changes in ambient temperature. In the event of explosive situations, it can result in either false alarms or a lack of response

Metal Oxide Semiconductor Gas Sensor

Metal oxide semiconductor (MOS) gas sensors have high sensitivity and a low price. The gas sensing mechanism of MOS-based sensors is primarily based on changes in resistance caused by chemical interactions between target gas molecules and adsorbed oxygen ions on the MOS surface when they are exposed to the target gases.

They do, however, have stability concerns that lead to a false alarm.

Because of having a large band gap along with a high surface to volume ratio, SnO_2 has the highest relative sensitivity ratio of multiple metal oxides, such as SnO_2, TiO_2, and ZnO. To detect fire-related gases, such as benzene, CO, and isopropanol, a gas sensor was developed by Abid et al. [86] using SnO_2 nanowires. When heated to 200 °C, it detects cotton, beech, and printed circuit board smells. It operates on the principle of calculating the variation in the resistance of the components of the sub-sensor caused by the above gases.

Optical Gas Sensors

The optical gas detection method based on the principles of spectroscopy is more reliable and sensitive and has a short response time. However, with these detection approaches, the main issues are their high cost and large size.

FLAME SENSORS

The fire itself is a radiation source, which can be sensed by identifying the radiation generated in the combustion zone.

Flame is the visible part of fire, which is caused by the exothermic reaction between fuel and oxidant .

The flame temperature depends on the material being burned. It has both features of flame that are color (chromatic properties) and radiation.

Centered on non-visual and visual techniques, there are two methods of flame detection. The non-visual technology is based on flame radiation, while the visual technology is based on the color of the flame.

The radiation emitted by the flame depends on the temperature of the flame and the type of fuel burned. The ultraviolet, visible, and infrared sensors are available for flame sensing and categorized on the basis of their spectrum.

Smoke Sensors

Smoke is emitted far earlier than other fire characteristics throughout the growth and development phases. In the initial phases of fire, quick smoke detection will increase the likelihood of effective fire suppression, successful firefighting, escape, and survival. Through making a light beam or electromagnetic radiation pass the interface of the particles, smoke can be detected. Smoke mass concentration, volume fraction, and size dissemination are known as primary smoke detection parameters.

A smoke sensor has a high false alarm, but the combination of visual sensing systems can increase its performance.

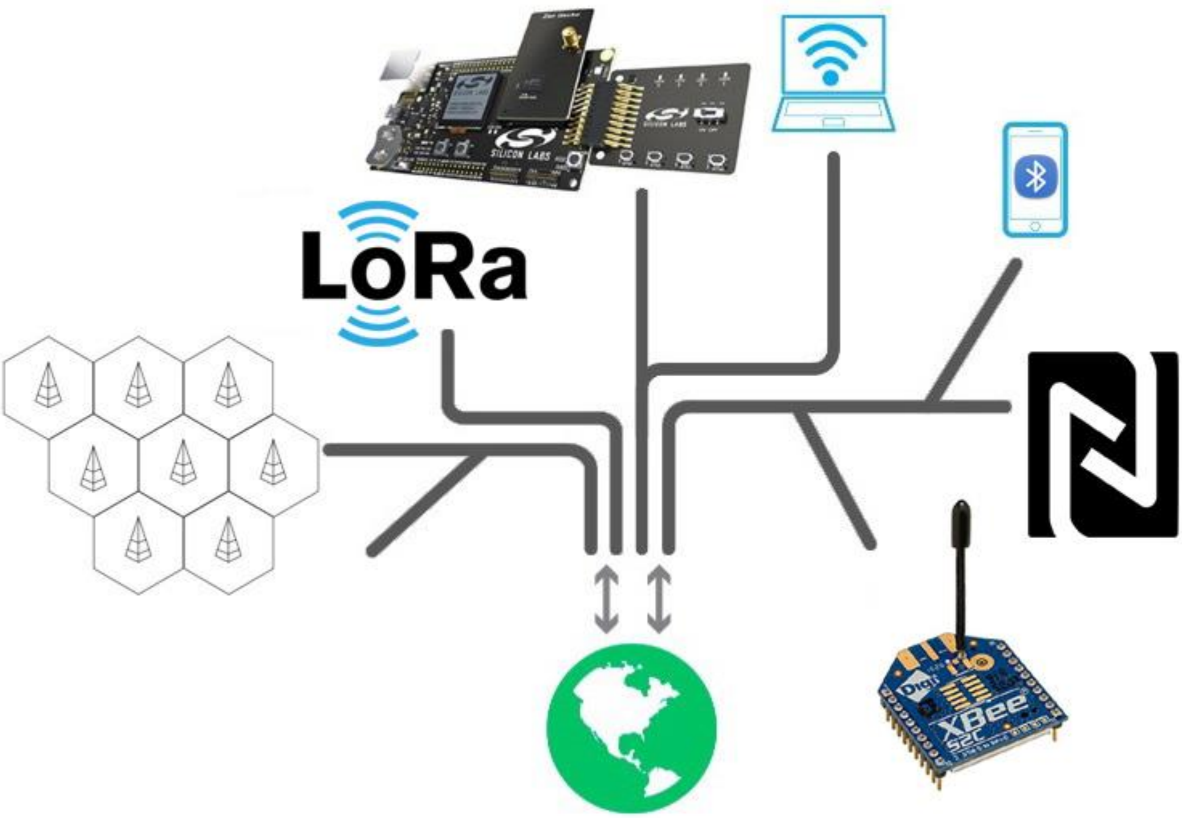
CONCLUSION

The main issues with most gas sensors are irreversibility, volatility, and low selectivity, and as a result, their usage in buildings is restricted. Metal oxide semiconductor gas sensors have high sensitivity and are inexpensive. However, their inability to maintain equilibrium necessitates temperature compensation. Since temperature usually varies during a fire hazard, this aspect becomes even more significant, because it has the potential to reduce the productivity of gas sensors. Hence, it is necessary to carry out experimental research on the temperature recompense of CO, CO_2, HCN, and other fire dangerous gases produced during fire. Nonlinearity is another issue with metal oxide semiconductor gas sensors.

The gas sensor based on carbon nanotubes has a high sensitivity, is less corrosive, and has a low cost, short response time, strong adsorptive capability, and a wide bandwidth. Optical gas sensors are highly sensitive, selective, and reliable but they have heavy weight and are more expensive.

The use of robots in the detection of fires has opened up a new research field. The firefighting robots will supplement the work of human firefighters, while they cannot take their place since human intellect surpasses that of robots. However, if there is a major fire hazard, human life cannot be put in jeopardy, and using robots is a safer choice.

Wireless Communication Protocols

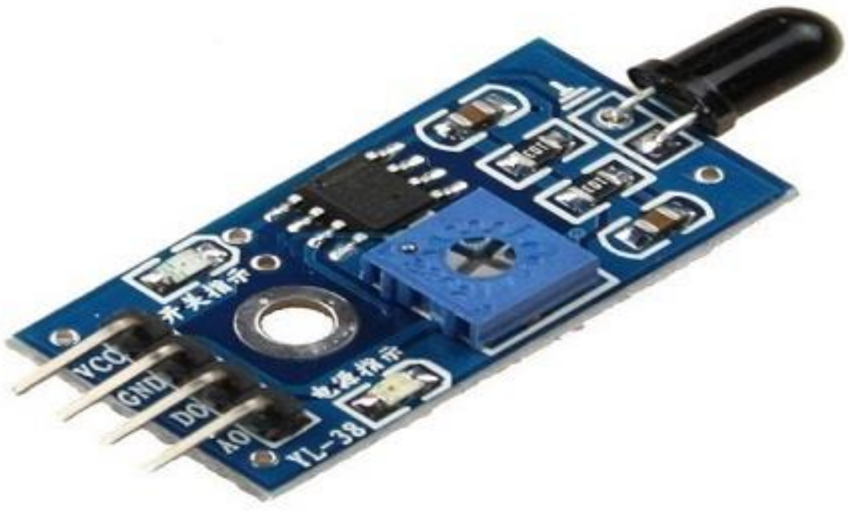


1. WiFi
2. Zigbee
3. Bluetooth
4. MQTT
5. OPC-UA
6. Cellular
7. Z-Wave
8. NFC
9. Lora-WAN
10. Sigfox

Wi-Fi (Wireless Fidelity) is the most popular **IOT communication protocols** for wireless local area network (WLAN) that utilizes the IEEE 802.11 standard through 2.4 GHz UHF and 5 GHz ISM frequencies. Wi-Fi provides Internet access to devices that are within the range of about 20 - 40 meters from the source. It has a data rate upto 600 Mbps maximum, depending on channel frequency used and the number of antennas. In embedded systems, ESP series controllers from Espressif are popular for building IoT based Applications. **ESP32** and **ESP8266** are the most commonly use wifi modules for embedded applications.
There are many development boards available that allow people to build IOT applications using Wi-Fi. The most popular ones are the Raspberry Pi and Node MCU.

Flame Sensor Module

The pin configuration of this sensor is shown below. It includes four pins which include the following. When this module works with a microcontroller unit then the pins are



flame-sensor

- 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)

Different Types

Flame-sensors are classified into four types

- IR single frequency
- IR multi-spectrum
- UV flame detectors
- UV/ IR flame detectors

Features & Specifications

The features of this sensor include the following.

- Photosensitivity is high
- Response time is fast
- Simple to use
- Sensitivity is adjustable
- Detection angle is 600,
- It is responsive to the flame range.
- Accuracy can be adjustable
- Operating voltage of this sensor is 3.3V to 5V
- Analog voltage o/ps and digital switch o/ps
- The PCB size is 3cm X 1.6cm
- Power indicator & digital switch o/p indicator
- If the flame intensity is lighter within 0.8m then the flame test can be activated, if the flame intensity is high, then the detection of distance will be improved.

Applications

These sensors are used in several dangerous situations which include the following.

- Hydrogen stations
- Industrial heating
- Fire detection
- Fire alarm
- Fire fighting robot
- Drying systems
- Industrial gas turbines
- Domestic heating systems
- Gas-powered cooking devices

Fire Fighting Robot

The firefighting robot has a water tanker to pump water and spray it on fire; it is controlled through wireless communication.

Advantages of GSM

- With GSM technology, we can have a low-cost mobile set and base stations.
- It improves spectrum efficiency.
- The data or voice signals are of high quality in GSM.
- The GSM is compatible with ISDN (Integrated Services Digital Network)

The key features and components of GSM network system are as follows.
• GSM operates in several bands including 900 MHz and 1800 MHz in Europe, Asia and Africa as well as 850 MHz and 1900 MHz in North America.
• GSM uses digital technology to transmit voice and data which provides better call quality, improved security and more efficient use of spectrum.
• GSM follows global standard which makes devices and networks operate seamlessly in most of the countries of the world.

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• GSM supports data services such as GPRS and EDGE to allow for mobile internet access and fast data communication.
• GSM supports total bandwidth of 25 MHz in 900 MHz and 1800 MHz bands . In this 25 MHz BW, channels are spaced 200 KHz apart. Each carrier channel has a bandwidth of approx. 200 KHz.
• In GSM, Voice calls support 13 kbps per channel, GPRS supports data rates ranging from 20 Kbps to 40 kbps and EDGE supports data rates up to 384 kpbs.

The main theme of the project is to detect fire and extinguishing it. This whole project is divided into three categories as detection, processing of signal and extinguishing of fire. In the process of signal detection, a fire sensor will be there which detects combustible gas. After switching on the project , it takes some subtle time to establish. This time is called pre hitting time which is of 40 seconds. This fire detected signal will be sent to the user in the form of a message which is performes by the use of GSM. In addition to it, we have a buzzer, for the detection of the fire. The second category of the project is to process the signal. There are total three motors in this robot. Two motors will be for the motion of the robot. Remaining one is used for splashing of the water over the fire. For this purpose we are using the motor of car wind screen. Relays are to be used along with the motors. Totally we use 5 relays in this project. One relay is for the pump motor, remaining four relays are used for the motors which are used for motion purpose.