IJCRT.ORG ISSN : 2320-2882
INTERNATIONAL JOURNAL OF CREATIVE RESEARCH THOUGHTS (IJCRT)
An International Open Access, Peer-reviewed, Refereed Journal

Smoke Detection System Using The Internet Of Things

Sandhya Yamala,
Computer Science and Engineering,
Hyderabad, India

Abstract: This research project presents the design and implementation of a smoke detection system utilizing Internet of Things (IoT) technology to mitigate the risks of fire accidents, which often lead to significant property loss and fatalities. The primary objective is to develop an interconnected safety system that can identify smoke and hazardous gases without human intervention. The system's methodology centers on a prototype developed within the Tinkercad simulation environment. The core hardware consists of an Arduino UNO R3 microcontroller and an MQ-2 metal oxide semiconductor (MOS) sensor. The MQ-2 sensor is chosen for its ability to detect flammable gas concentrations between 300 and 10,000 ppm, including smoke, LPG, propylene, and hydrogen. Additional components include a piezo buzzer for audible alerts, red and green LEDs for visual status indicators, and an LCD screen for real-time messaging. The system functions by monitoring voltage fluctuations from the MQ-2 sensor, which are proportional to smoke concentrations in the environment. Through an if-else control loop, the system compares live sensor data against a predefined threshold of 400. Results from testing demonstrate that when smoke levels exceed this threshold, the system successfully triggers a red LED and a continuous buzzing alarm, while maintaining a green LED status during safe conditions. The proposed system offers a portable and efficient solution for early fire detection, with future work recommended to improve sensitivity for low-energy flames and further minimize false alarms.

***Index Terms* -** IoT, Smoke Detection, Arduino UNO, MQ-2 Sensor, Fire Safety, Embedded Systems.

I. Introduction

A fire accident is a sad incident that may result in the loss of possessions, serious injuries, permanent deformity, disability, the need for ongoing medical care, and even death. Because of their injuries, survivors may be unable to work and support their families even while their medical and living expenses continue to increase (Houston Fire Accident Lawyer: Fire & Explosion Accident Lawyer, 2023). When the fire might have been prevented if but for another person's carelessness, the loss is much greater. We need a system that detects fire incidents to prevent fire accidents. We build a smoke detection system with the help of the Internet of Things.

The Internet of Things (IoT) is an interconnected system that connects different kinds of gadgets, which include computers, mechanical and digital devices, objects, creatures, and even people. Each of these devices is given a unique identifier (UID), and they can all communicate with other nodes in the network without the need for human intervention. The phrase "Internet of things" refers to a wide range of devices, including individuals who have heart implants, livestock with biochip transponders, automobiles with integrated sensors that warn the driver when the pressure in the tires is low, and almost everything else (Gillis, 2022).

A smoke detector is an apparatus that detects smoke, usually in the presence of a fire. Smoke detectors include plastic housings that are normally a disc form, measuring around 150 millimeters (6 in) in diameter and 25 millimeters (1 in) in thickness, however, these dimensions and other design details might vary. Both photoelectric and ionization optical methods exist for detecting smoke. Detectors may use either one sensing technique or both. To discourage and detect smoking in restricted locations, sensitive alarms might be installed. Detectors in big offices and factory buildings are often hardwired into an emergency alert system. All smoke alarms in an interconnected building will go off if one building senses smoke. Even if the power goes off, this will still occur (Smoke detector, 2023).

Commercial smoke detectors are a component of a fire alarm system that communicates with a fire alarm controlling panel. Despite the absence of alarms in the majority of freestanding commercial smoke detectors, certain models do include sirens.

In homes equipped with functional smoke detectors, the chance of dying in a fire is reduced by half. From 2009-2013, the National Fire Protection Association in the United States found that households with functional smoke detectors had 0.53 fewer fatalities per 100 fires compared to those without smoke detectors. However, not all houses have smoke alarms, and even in those that do, some may not have functional batteries.

II. PRINCIPLE

When anything begins to burn, smoke rises, hence the detector must be fastened to the ceiling. Hot gases produced by a fire ascend because they are less dense (or weigh less per unit of volume) than regular air, carrying fine smoke particles with them. That the detector has openings all around its housing that go to the primary detecting chamber. A light-emitting diode (LED) fires an invisible, infrared light beam into the chamber, much like the ones Tom Cruise evaded. An electronic light detector called a photocell is housed in the same space and produces electricity when exposed to light. The LED's light beam normally does not reach the detector when there is no smoke present. Nothing occurs because a photocell monitoring electronic circuit determines that everything is OK. The alarm does not sound. However, smoke from the fire enters the chamber, dispersing a portion of the light beam, which reaches the photocell. This shorts the circuit, saving your life by waking you with a blaring and unpleasant alarm (Tarun, 2020).

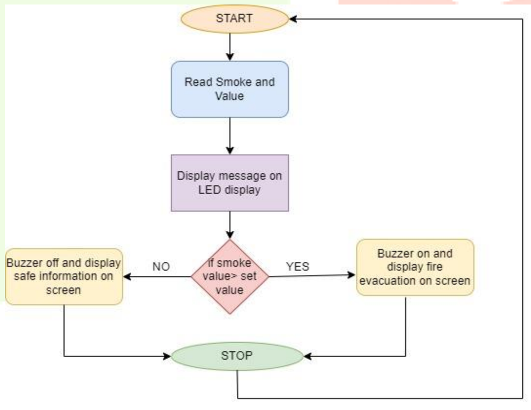

Figure 1: Block diagram of smoke detection system.

This MQ02-based smoke alarm circuit uses just a handful of cheap, commonly available parts. This circuit's primary component is a gas sensor designated MQ-02, which can identify the presence of smoke, LPG, propylene, and hydrogen. Smoke and the gas leak detection is a need in a wide variety of contexts, and this device may help. The following prototype is a test circuit that may be built using a breakout board and PCB once the individual components have been calibrated. When this smoke detector circuit detects smoke, an audio and visual alarm will sound.

III. COMPONENTS REQUIRED

Arduino UNO R3: ATmega328P serves as the foundation for the Arduino UNO R3 microcontroller board, which is based on the Arduino UNO. The circuit board is equipped with a reset button, an ICSP header, a USB port, and a power connection. Additionally, it features 14 digital I/O pins, six of which can be utilized as PWM outputs. Additionally, it has a ceramic resonator operating at 16 MHz, as well as six analog inputs and a button to reset it. It is equipped with everything necessary to begin working with the microcontroller; all that is required of you is to connect it to a computer through USB or give power utilizing an AC-to-DC converter or battery (Macharla, 2022). If you screw up your UNO game and the chip can be changed for a few dollars, you are able to begin again and learn how to play starting from scratch again. If you don't screw up your UNO game, you can't mess it up.

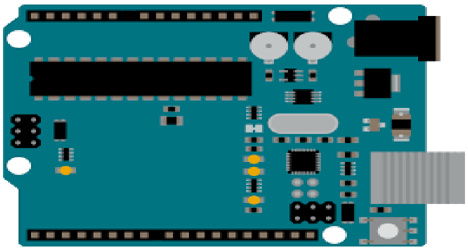

Figure 2: Picture of Arduino UNO R3.

Bread Board: A breadboard is a device used to quickly create electrical prototypes and test circuitry without the need for solder. Most electrical components in electronic circuits have leads or terminals that may be inserted into the holes and subsequently linked through wires. Metal strips attached to the breadboard's underside serve to link the board's top-side holes. The metal strips are arranged as seen below. The two outermost rows of holes are joined horizontally and divided vertically in the center, whereas the innermost rows are joined only vertically.

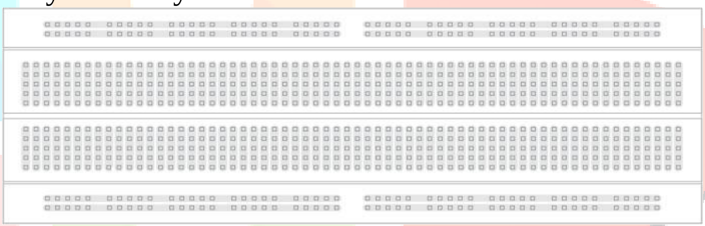

Figure 3: Image of Bread Board.

MQ-2 Smoke Sensor: Within the MQ sensor family, the MQ2 sensor is one of the models that sees the most action overall. It is a MOS sensor, which stands for metal oxide semiconductor. Because gases create a change in the resistance of the sensing material, metal oxide sensors are sometimes referred to as Chemiresistors. This is because the detection is based on this change. The MQ-2 is Winsen's smoke and flammable gas detector. Flammable gas concentrations between 300 and 10000 ppm may be detected. Most often, it is used in detectors and alarms for propane and smoke gas leaks in the home. SNO2 is used as a sensor because its conductivity is greater when exposed to smoke or combustible gas and lower when not. Calibrating a simple circuit makes it easy to measure this shift in conductivity and convert it into data.

Figure 4: MQ-2 Smoke Detector.

MQ2 Gas Sensor's Internal Structure and Components: In reality, the sensor is protected from potential explosions by being wrapped in not one, but two layers of a very tiny mesh made of stainless steel. The fact that we are detecting combustible gases, prevents the explosion that may be caused by the heating element found within the sensor.

Figure 5: MQ-2 structure.

In addition to this, it serves as a shield for the sensor and filters out any particles that may be floating in the air, allowing only gaseous components to enter the chamber. The clamping ring, which has a copper plating, is what holds the mesh to the remainder of the body.

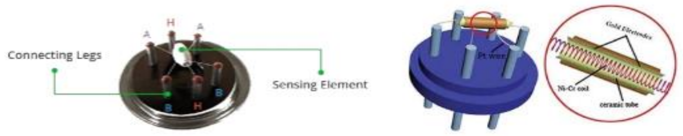

Figure 6: MQ-2 internal structure and components.

When the sensor outside mesh is taken off, it reveals its true form. The star form is produced by the sensor component together with its six interconnecting legs that extend beyond the Bakelite base. Another recognized conductive alloy which is used to heat the sensor element and nickel-chromium is used to wind a coil that connects 2 of the 6 leads (H) in an inductor. Platinum Wires are used to link the remaining four leads (A and B), which carry the signal to the output. These wires are attached to the sensing element's main body and transmit minute fluctuations in the current flowing through it.

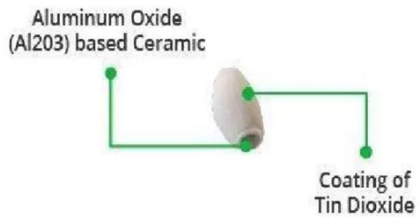

Figure 7: Sensing element of smoke detection sensor.

The ceramic tubular sensing element is based on aluminium oxide (AL_2O_3), and it is coated with tin dioxide (SnO_2) for improved performance. The most crucial component, because of its sensitivity to gases that are combustible, is tin dioxide. Nonetheless, the ceramic substrate does nothing except increase the heating efficiency and ensure that the temperature of the sensor region is maintained at a constant working level.

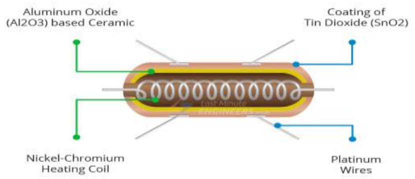

Figure 8: Coil-based heating system.

That's why we have a Coil-based Heating System Composed of Nickel and Chrome wrapped in a ceramic made of Aluminium Oxide, and a Sensing System made of Platinum wires coated in Tin Dioxide.

How does a gas sensor work: Adsorbed oxygen occurs during high-temperature heating of tin dioxide (semiconductor particles) in the air. Tin dioxide's donor electrons, when exposed to clean air, are lured to the oxygen molecules that have been adsorbing to its surface of it. Electricity cannot flow freely due to the obstruction. Therefore, Adsorbed oxygen interacts with reducing gases, causing a reduction in the surface density of the oxygen. Once the tin dioxide has had its electrons liberated, the current may flow unimpeded through the sensor.

Jumper wire: The term "jumper wire" refers to a kind of electrical cable that is soldered onto printed circuit boards to link various electrical components. By attaching a jumper wire to the electrical wiring and then short-circuiting it, a jump may be created. By connecting a wire known as a jumper to the system makes it possible to to exert control over the flow of electricity, halt the functioning of the circuit, and use a circuit in a way that is not possible with the wiring that is typically used. Reinforcement of the faulty part, partial stop of the superfluous function, and changing of the wiring configuration of the unused output portion may be done by connecting or detaching the jumper wire when it is essential to modify the specifications or design of the printed circuit board.

Figure 9: Jumper wires.

Red LED: LEDs that are generally red perform the job of light emitters, but they also have the capability of performing the function of photo sensors. Even within the same circuit, a single LED can perform the duties of both a light emitter and a light detector. The fundamental concept is to pulse the LED, where the on-time is used to illuminate it and the off-time is used to measure the photovoltaic current produced by the LED in response to the surrounding light.

Figure 10: Red LED Light.

Green LED: When everything is set up correctly and ready to start, a solid green LED will illuminate. This should take no more than a few minutes after connecting the Hub's power wire and Ethernet connection and telling the SmartThings smartphone application to begin the setup process.

Figure 11: Green LED Light.

Resistor: Resistors, which are designated by the symbol R, are passive components. This implies that resistors do not produce any energy at all; rather, they lower voltage and current by releasing power in the form of heat, making them non-active components. Ohms () are the standard measure of resistance, and carbon or metal wire is often used for fabricating resistors.

Figure 12: Resistors.

Piezo Buzzers: When subjected to mechanical stress, piezoelectric materials produce an electric charge, which powers an auditory signaling device known as a piezo buzzer. Japanese producers are responsible for the development of the piezo buzzer.

Figure 13: Piezo Buzzer.

LCD: LCD stands for "liquid crystal display" and refers to a kind of electronic display used to show text and images. It can display 32 characters since it contains 16 columns and 2 rows, as the name suggests. Pins 8 through 14 are the data pins among the available 16.

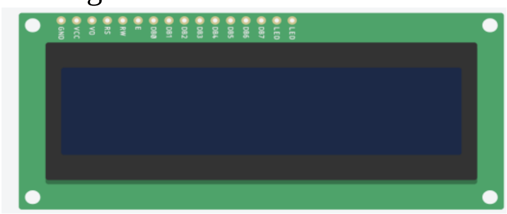

Figure 14: LCD display (16*2).

IV. SETTING UP THE SMOKE DETECTOR

First things first, you need to drag all the components that were discussed before into the Tinkercad workspace (*Tinkercard*).

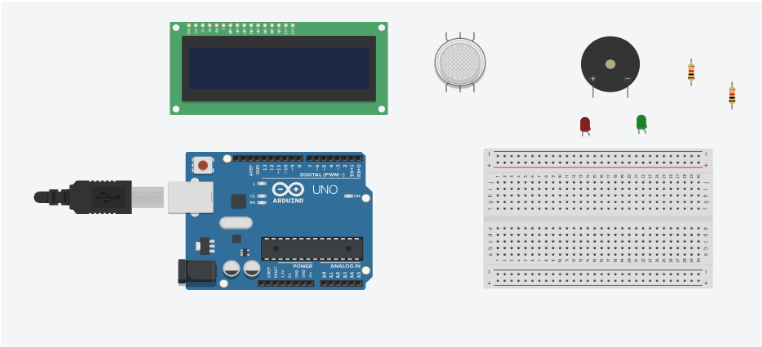

Figure 15: All the components of smoke detection system.

Following that, let's begin connecting the individual components one at a time. Therefore, let's begin by investigating the connections for the gas sensors. Tinkercad includes a gas sensor that has a total of 6 terminals, which are labeled as follows: A1, H1, A2, B1, H2, and B2. Establish a connection to the power supply using the connections labeled A1, H1, and A2. After that, connect terminal B1 to the power supply, while simultaneously connecting terminals H2 and B2 to the ground. We connect a load resistor with resistance between terminal B2 and the ground so that we can get better results and sensitivity of the gas sensor.

After that, let's go on to connecting the Red and Green LED, which will serve as an indication for the smoke detector after it's been set up. The RED, and GREEN LEDs each have their own dedicated terminal on the device. Establish a connection between the ground terminal and the cathode terminal. Next, connect the red, and green terminals to the digital pins 9 and 18 accordingly (while we have decided to use these particular digital connectors for this task; any of the pins that are digital may be utilized). The connection between the terminals and the digital pins is made using the resistors that we have provided. This is done in order to control the amount of current that flows through the LED. As a direct consequence of this, the configuration would look like this.

After this, we will proceed to attach the piezo sensor to our apparatus. This is done so that a buzzing sound would be produced once smoke is detected. The piezo sensor has two terminals, which are labeled respectively as POSITIVE (+) and NEGATIVE (-). You should Plug in the positive terminal to pin number 28, and you should Plug in the negative terminal to the ground. We need to regulate the amount of current that is flowing to the sensor. As a result, you should attach the 1k resistor to the link that runs from the positive terminal to the digital pin.

Following this, we will proceed to attach the LED screen to our system to the application to show the message on the detecting system. Connect the ground of the LED to the ground and voltage input to the breadboard input. Connect all other terminals as shown in the below figure. The final circuit will look like the below diagram.

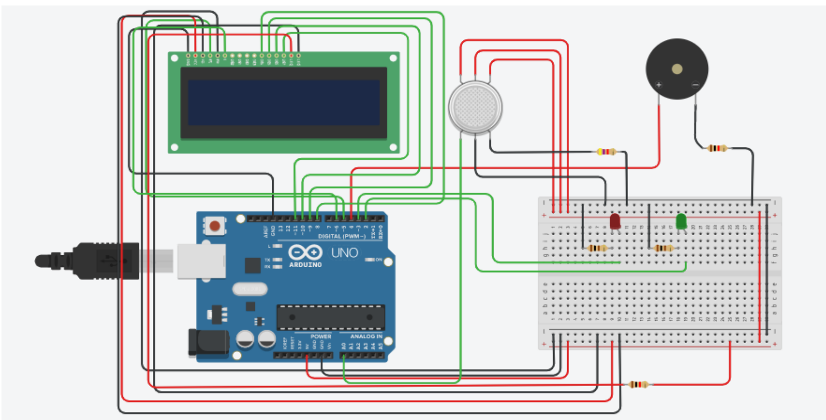

Figure 16: Final circuit of smoke detection system.

V. CODE AND WORKING FUNCTION OF THE SMOKE DETECTOR

```
#include <LiquidCrystal.h>
LiquidCrystal lcd(5,6,8,9,10,11);

int redled=3;
int greenled=2;
int buzzer=4;
int sensor= A0;
int sensorThresh=400;
void setup()
{
pinMode(redled,OUTPUT);
pinMode(greenled,OUTPUT);
pinMode(buzzer,OUTPUT);
pinMode(sensor,INPUT);
Serial.begin(9600);
lcd.begin(16,2);
}
void loop()
{
int analogValue= analogRead(sensor);
Serial.print(analogValue);
Serial.print("\n");
if(analogValue>sensorThresh)
{

digitalWrite(redled,HIGH);
digitalWrite(greenled,LOW);
tone(buzzer,1000,10000);
lcd.clear();
lcd.setCursor(0,1);
lcd.print("ALERT");
delay(1000);
lcd.clear();
lcd.setCursor(0,1);
lcd.print("EVACUATE");
delay(1000);
}
else
{
digitalWrite(greenled,HIGH);
digitalWrite(redled,LOW);
noTone(buzzer);
lcd.clear();
lcd.setCursor(0,0);
lcd.print("SAFE");
delay(1000);
lcd.clear();
lcd.setCursor(0,1);
lcd.print("ALL CLEAR");
delay(1000);
}
}
```

Figure 17: Code Snippet of the smoke detection system.

First, to start a serial connection, we utilize the method known as Serial.begin(), which is located inside the setup() function. Using the pinMode() method, we assigned pin A0 to be the input, while pins 5,6,8,9, 10, and 11 were assigned to be the output, red led to 3, green led to 2, and buzzer to 4.
Following that, we begin writing the code for the loop() method. Using the analogRead() method, we get the values from the smoke sensor which is connected to pin A0. After that, we give the values the name "sensorValue" and assign them to an integer type variable. In the next step, we use the Serial.print() method to send the values from the gas sensor to the serial monitor. For the sake of this project, we have decided that a value of 400 will serve as the threshold for the readings of the gas sensors. Therefore, if the readings are more than the threshold value, the LED will turn RED, and the piezo sensor will begin to buzz. If the readings are lower than the threshold value, the LED will continue to stay in the green state, and the piezo sensor will not emit any buzzing noise. We are able to do this by using the if-else loop and changing the pins to either a HIGH or LOW state by utilizing the digitalWrite() routines.
The coding phase may now be considered finished. In addition, why don't we run a simulation of the circuit and check out the results?

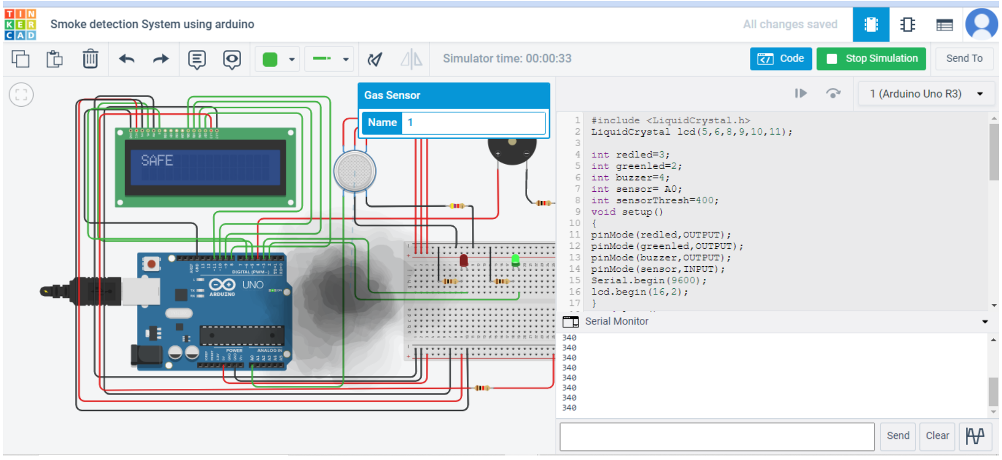

Figure 18: When the results of the gas sensor are lower than the threshold value.

When the readings from the gas sensor are below the threshold value, we can observe that the LED continues to stay in the green state, and the piezo sensor does not generate any buzzing noises. The values from the gas sensor are shown in a continuous fashion and in real-time on the serial monitor.

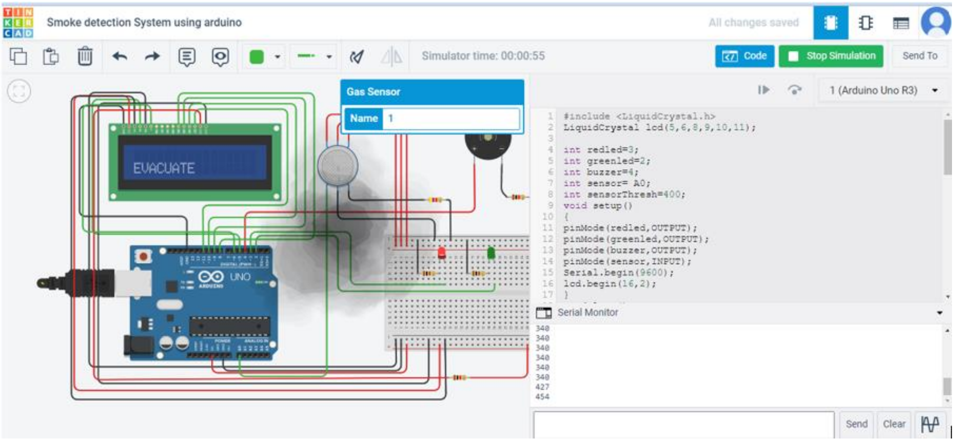

Figure 19: When the measurements of the gas sensor are higher than the threshold value.

When the readings are more than the threshold value, as we can see above, the LED changes color to RED and the piezo sensor begins buzzing. When the smoke is moved closer to the gas sensor, the value on the serial monitor automatically changes.

VI. CONCLUSION

The experiment of the SMOKE DETECTOR has been successfully completed by employing the MQ-2 smoke-detecting sensor, and the results are presented. This model may be used very simply as an alternative to extremely huge pianos, and by adding a few more components, we can make it much lighter and much easier to play. Additionally, it will be much simpler for a novice to learn how to play the piano with this model.

- A smoke detector is one of the more affordable and straightforward options.
- The vast majority of sectors make use of it since it offers the highest level of protection possible while also being the most effective.
- With this, we are able to detect the smoke in an easy manner.
- LDS can pinpoint the location of leaks in a system without requiring the participation of any other individuals.

REFERENCES

[1] Gillis, A.S. (2022) *What is IOT (internet of things) and how does it work? - definition from techtarget.com*, *IoT Agenda*. Available at: https://www.techtarget.com/iotagenda/definition/Internet-of-Things-IoT#:~:text=The%20internet%20of%20things%2C%20or,human%2Dto%2Dcomputer%20interaction.

[2] *Houston Fire Accident Lawyer: Fire & Explosion Accident Lawyer* (2023) *Terry Bryant Accident & Injury Law*. Available at: https://www.terrybryant.com/personal-injury-lawyer/burn-injury-lawyer/what-are-common-causes-fire-accident.
[3] *Login* (no date) *Tinkercad*. Available at: https://www.tinkercad.com/things/77oPbDwjLk5-smoke-detection-system-using-arduino/editel.
[4] Macharla, M. (2022) *How to create a smoke detector using Arduino in Tinkercad*, *IoTEDU*. Available at: https://iot4beginners.com/how-to-create-a-smoke-detector-using-arduino-in-tinkercad.
[5] *Smoke detector* (2023) *Wikipedia*. Available at: https://en.wikipedia.org/wiki/Smoke_detector.
[6] Tarun, D.T. (2020) *A project reports on Smoke Detector*, *TCRLS*. Available at: https://www.academia.edu/42839868/A_project_reports_On_SMOKE_DETECTOR.