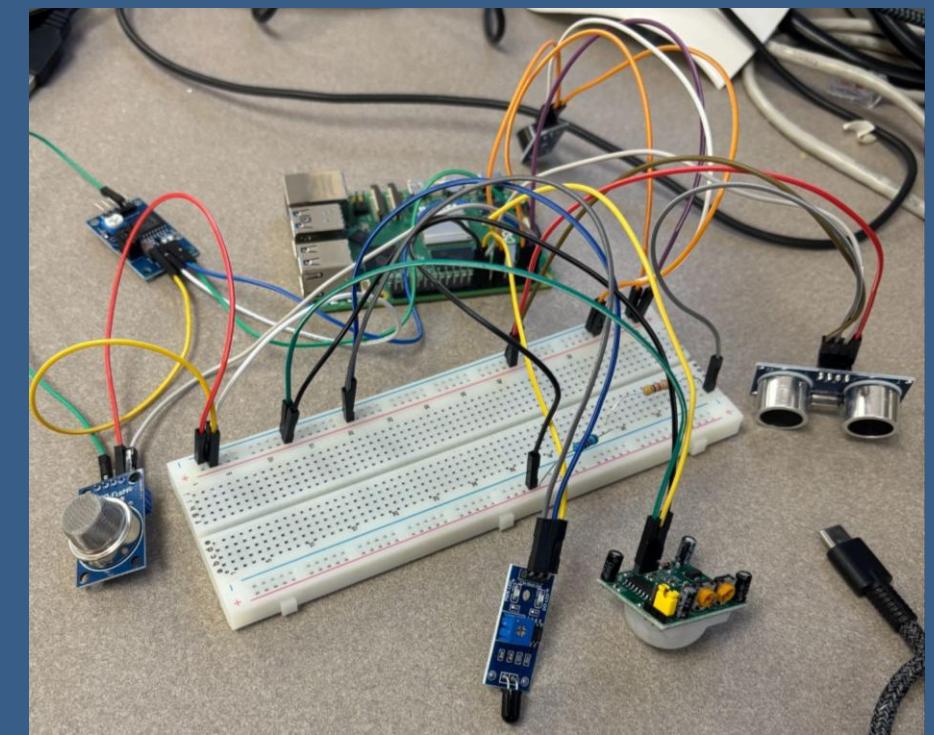
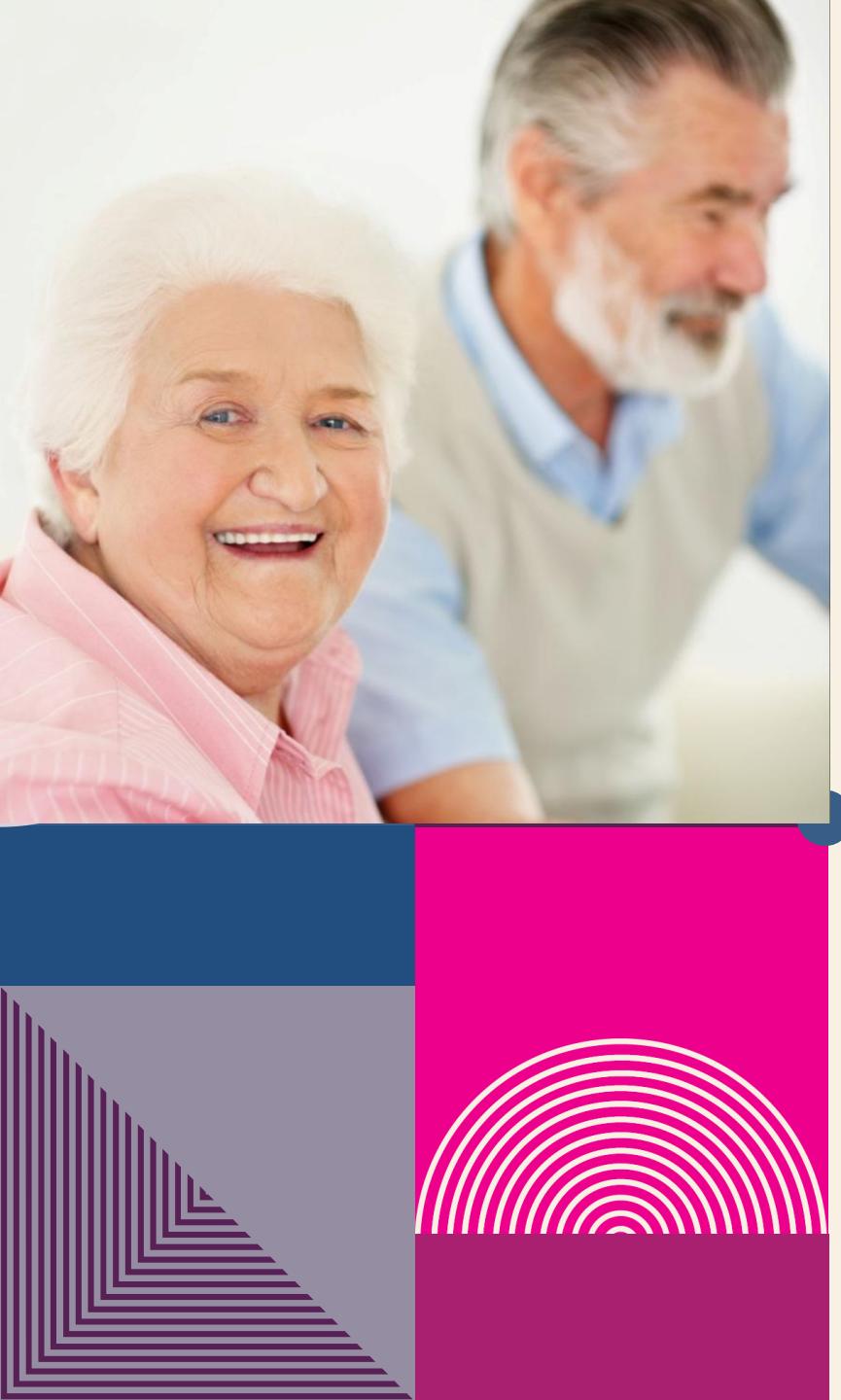


SMART HOME MONITOR



A photograph of a smiling elderly couple. The woman on the left has white hair and is wearing a pink striped shirt. The man on the right has grey hair and a beard, wearing a light blue shirt under a beige vest. They are both looking towards the right of the frame.

TOPIC OF PROJECT

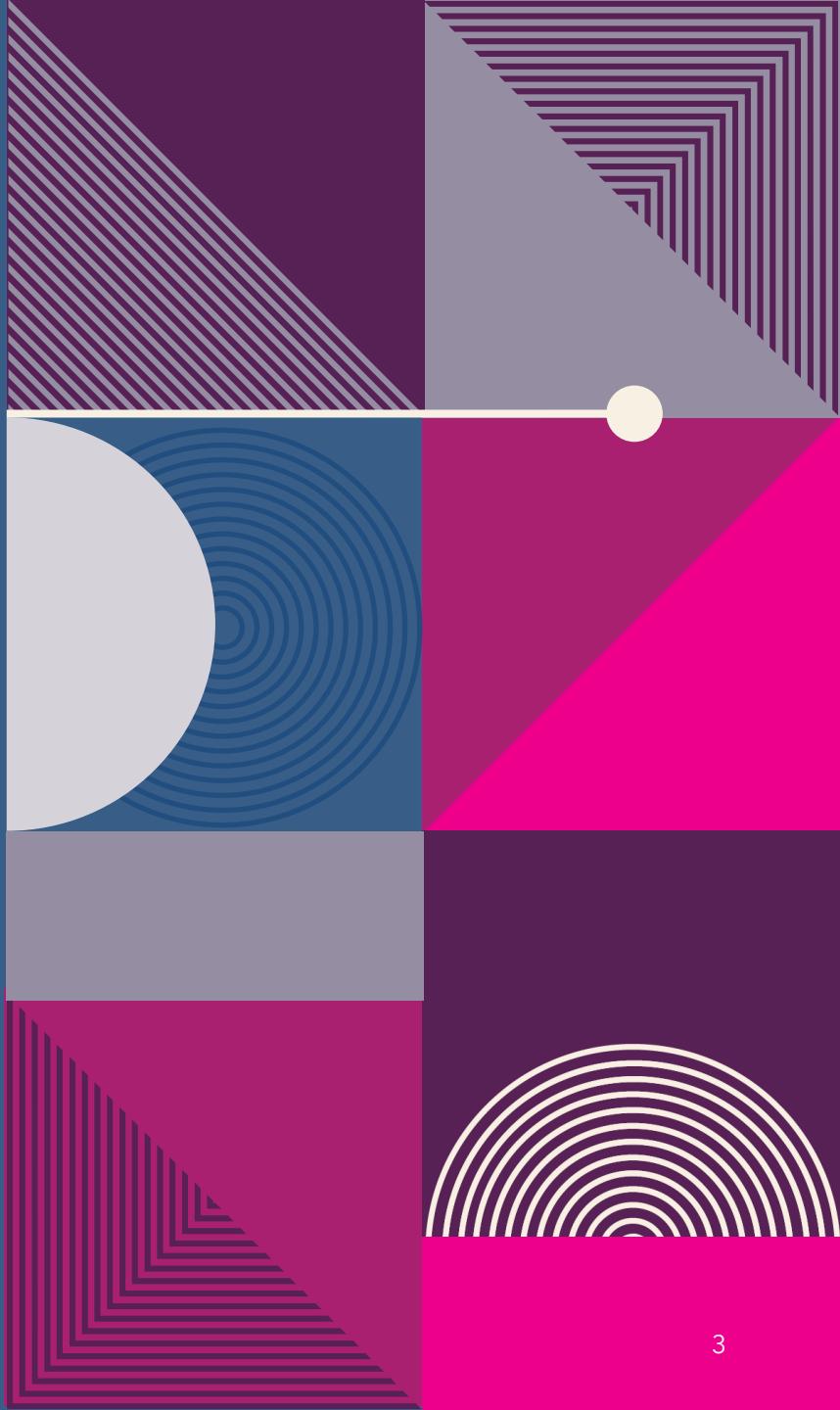
- Smart home monitor using Raspberry Pi 5
Monitor movement inside a room, distance, gas,
and fire levels.
- If any of the sensors reach a set value, the buzzer
will go off, indicating that a threat has been
detected.
- Status for each sensor is displayed in a constantly
updating **CSV** file
- This smart home monitor will be valuable for the
elderly who experience Sensory loss

RELATED WORK

Sharma, Mrinal & Assotally, Ameerah & Bekaroo, Girish. (2022).

RaspiMonitor: A Raspberry Pi-Based Smart Home Monitoring System. 1-6.
10.1109/NextComp55567.2022.9932198.

- This article revolves around a Raspberry Pi-based smart home monitoring system.
- This monitor features sensors that monitor electrical currents, gas, and motion levels.
- Their smart home monitor focuses on security and affordability.
- There are 40 participants in this study, with over half being between the ages of 18-24, and about a quarter being above the age of 40.
- All the participants filled out a questionnaire, which was filled with open-ended questions and also satisfaction ratings on a scale of 1-5.
- This article will be very helpful for us as the research is very similar to ours and we can get a better idea of how we could collect and analyze data.



A vertical decorative bar on the left side of the slide features a collage of elements. At the top is a cluster of modern skyscrapers against a blue sky. Below them is a large, semi-transparent white circle containing several concentric, light-blue circular patterns. The bottom portion of the bar is divided into three horizontal sections: a dark blue section on the left, a maroon section in the middle, and a bright pink section on the right. A thin white diagonal line starts from the bottom right corner of the slide and extends upwards and to the left, ending with a small white circle at the top edge of the bar.

NUMBER OF PARTICIPANTS

- This smart home monitor will be tested on **10 participants**
- The sensor will be tested on a variety of ages with emphasis on people over the age of 55
- Participants will complete a Google Form after using the smart home monitor to rate their experience

SENSORS USED

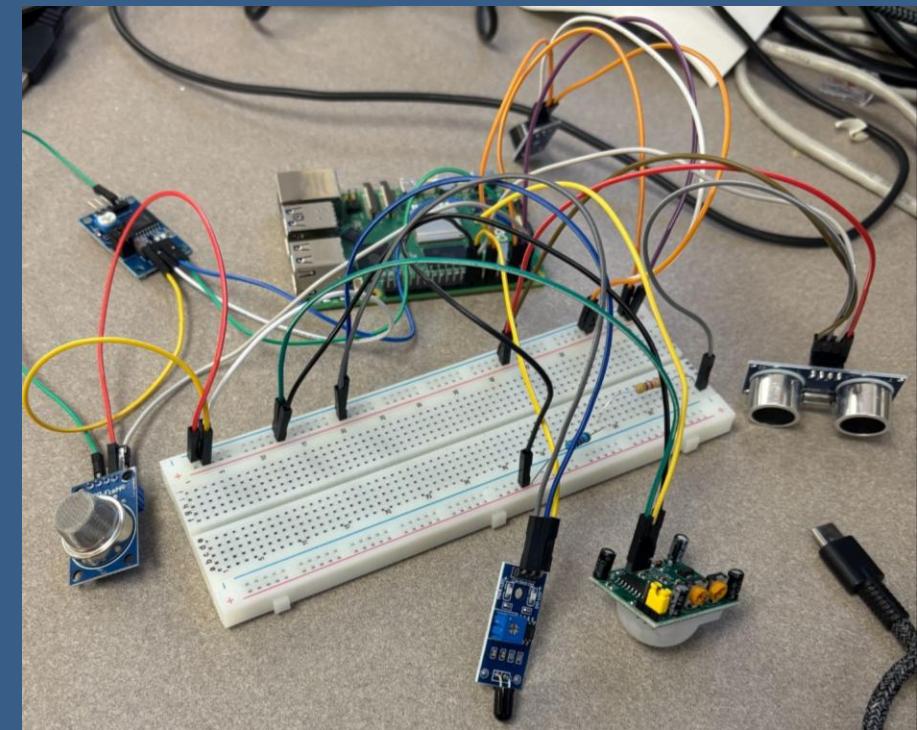
| Sensor | Function | Purpose of System |
|--------------------------------|---|--|
| HC-SR04 Ultrasonic Sensor | Measures distance using ultrasonic waves | Detects open doors, obstacles, or intruders near entrances |
| HC-SR501 PIR Motion Sensor | Detects human movement via infrared radiation | Triggers alerts for motion detection in monitored zones |
| MQ-2 Gas Sensor | Detects smoke, LPG, hydrogen, and methane gases | Provides early warning for gas leaks or smoke presence |
| IR Flame Sensor (LM393 Module) | Detects infrared light emitted by flames | Alerts for possible fire or high heat sources. |
| Buzzer Module | Emits audible alerts. | Provides local sound alarms for detected hazards |

EXPECTED DATA FROM EACH SENSOR

| Sensor | Output Type | Example Data | Purpose |
|-------------------------|----------------------|-------------------------|------------------------------------|
| HC-SR04 Ultrasonic | Digital/Distance(cm) | 0-400cm | Detect open doors or obstacles |
| HC-SR501 PIR Motion | Digital (High/Low) | 1 = motion detected | Trigger alerts when motion sensed |
| MQ-2 Gas | Analog Voltage | 0-1023 (via ADC) | Detect gas/smoke concentration |
| IR Flame Sensor (LM393) | Digital or Analog | 0 = No Flame, 1 = Flame | Detect Fire or Heat sources |
| Buzzer Module | Digital Output | On/Off | Audible alarm when hazard detected |

FINALIZED DEVICE

- Raspberry Pi 5 used as an interface for Python code and Sensors
- HC-SR04 Ultrasonic connected to power via two resistors to avoid damage to Pi (Connected to GPIO 23 for Trig, Connected to GPIO 24 for ECHO)
- Buzzer connected to 3.3v, GND, and GPIO18
- Flame sensor connected to 5v, gnd, and GPIO22
- Gas sensor connected to 5V, GND, and ADC Channel 1
- Motion sensor connected to 5v, gnd, and GPIO17



MAIN CODE SNIPPET

```
# main loop
print("\nSmart home monitor is activated! (Press Ctrl+C to exit)")
initialize_csv()

try:
    while True:
        alert_triggered = False
        distance = read_distance()
        # 0 - 400cm
        if distance > 100:
            status = "DOOR OPEN"
            alert_triggered = True
            print(f"ALERT: DISTANCE DETECTED! Distance: {distance}cm")
        else:
            status = "Door closed"
        insert_to_csv("HC-SR04 Ultrasonic Sensor", distance, status)
        print(f"Distance: {distance}cm - {status}")

        motion = read_motion()
        # 0 - 1
        if motion == 1:
            status = "MOTION DETECTED"
            alert_triggered = True
            print(f"ALERT: MOTION DETECTED!")
        else:
            status = "No motion"
        insert_to_csv("HC-SR501 PIR Motion Sensor", motion, status)
        print(f"Motion: {status} - {motion}")
```

```
gas = read_gas()
# 0 - 1023
if gas > 200:
    status = "DANGEROUS GAS LEVELS DETECTED"
    alert_triggered = True
    print(f"ALERT: GAS DETECTED! {gas}")
else:
    status = "Gas not detected"
insert_to_csv("MQ-2 Gas Sensor", gas, status)
print(f"Gas: {gas} - {status}")

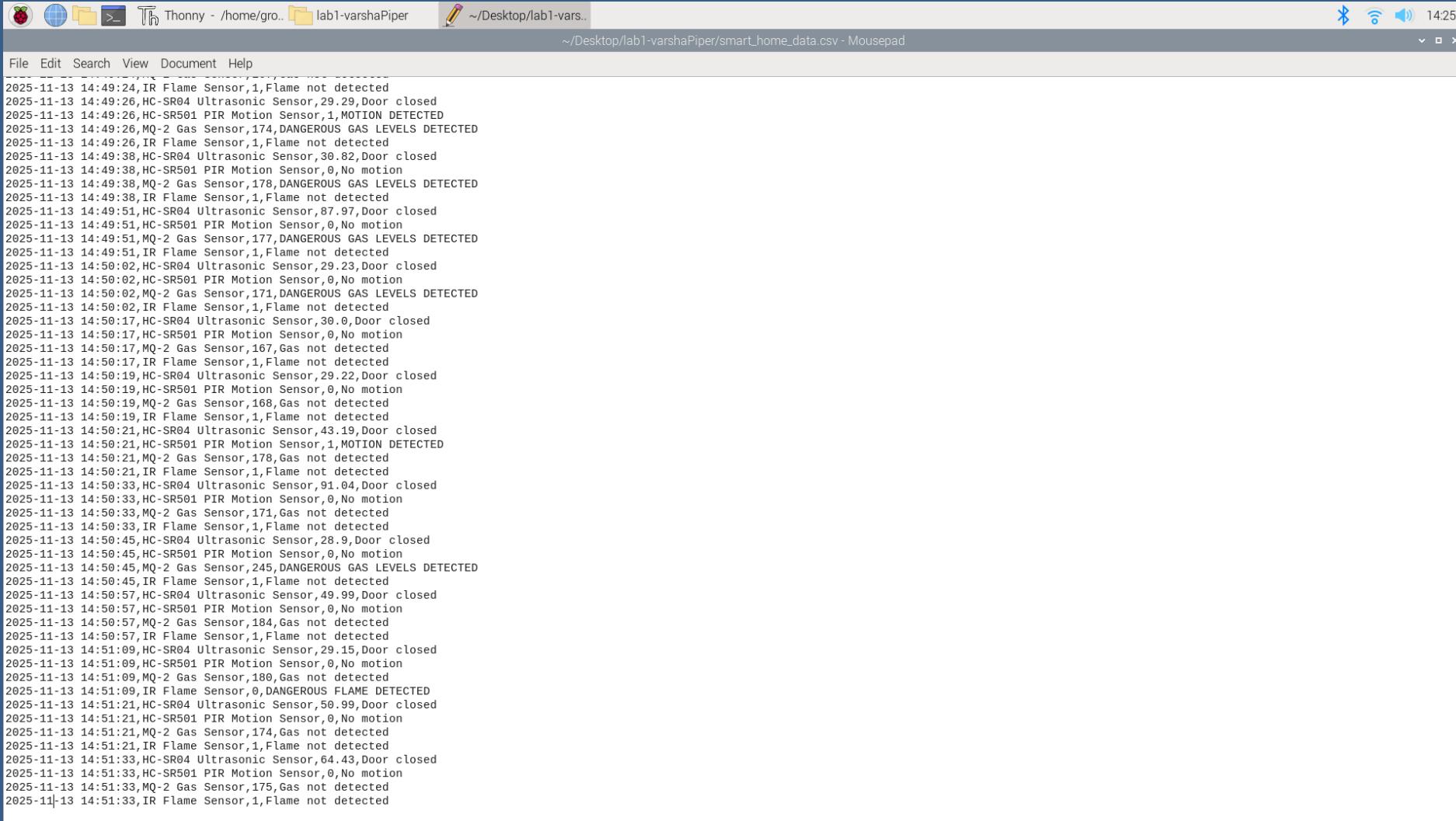
flame = read_flame()
# 0 - 1
if flame == GPIO.HIGH:
    status = "Flame not detected"
    print(f"No fire detected")
else:
    alert_triggered = True
    status = "DANGEROUS FLAME DETECTED"
    print(f"Fire detected")
    insert_to_csv("IR Flame Sensor", flame, status)

    if not alert_triggered:
        GPIO.output(BUZZER, GPIO.HIGH)
    else:
        GPIO.output(BUZZER, GPIO.LOW)

    time.sleep(2)

except KeyboardInterrupt:
    print("\nSmart home monitor shutting down...")
```

CSV FILE ON RASPBERRY PI



The screenshot shows a terminal window on a Raspberry Pi desktop. The window title is "Thonny - /home/gro.. lab1-varshaPiper". The current directory is "~/Desktop/lab1-varshaPiper". The terminal displays a log of sensor data from a CSV file named "smart_home_data.csv". The data includes timestamp, sensor type, sensor ID, and sensor value. Key entries include "HC-SR04 Ultrasonic Sensor" detecting a door closed or open, "MQ-2 Gas Sensor" detecting dangerous gas levels, and "IR Flame Sensor" detecting flame presence or absence.

```
File Edit Search View Document Help
2025-11-13 14:49:24,IR Flame Sensor,1,Flame not detected
2025-11-13 14:49:26,HC-SR04 Ultrasonic Sensor,29.29,Door closed
2025-11-13 14:49:26,HC-SR01 PIR Motion Sensor,1,MOTION DETECTED
2025-11-13 14:49:26,MQ-2 Gas Sensor,174,DANGEROUS GAS LEVELS DETECTED
2025-11-13 14:49:26,IR Flame Sensor,1,Flame not detected
2025-11-13 14:49:38,HC-SR04 Ultrasonic Sensor,30.82,Door closed
2025-11-13 14:49:38,HC-SR01 PIR Motion Sensor,0,No motion
2025-11-13 14:49:38,MQ-2 Gas Sensor,178,DANGEROUS GAS LEVELS DETECTED
2025-11-13 14:49:38,IR Flame Sensor,1,Flame not detected
2025-11-13 14:49:51,HC-SR04 Ultrasonic Sensor,87.97,Door closed
2025-11-13 14:49:51,HC-SR01 PIR Motion Sensor,0,No motion
2025-11-13 14:49:51,MQ-2 Gas Sensor,177,DANGEROUS GAS LEVELS DETECTED
2025-11-13 14:49:51,IR Flame Sensor,1,Flame not detected
2025-11-13 14:50:02,HC-SR04 Ultrasonic Sensor,29.23,Door closed
2025-11-13 14:50:02,HC-SR01 PIR Motion Sensor,0,No motion
2025-11-13 14:50:02,MQ-2 Gas Sensor,171,DANGEROUS GAS LEVELS DETECTED
2025-11-13 14:50:02,IR Flame Sensor,1,Flame not detected
2025-11-13 14:50:17,HC-SR04 Ultrasonic Sensor,30.0,Door closed
2025-11-13 14:50:17,HC-SR01 PIR Motion Sensor,0,No motion
2025-11-13 14:50:17,MQ-2 Gas Sensor,167,Gas not detected
2025-11-13 14:50:17,IR Flame Sensor,1,Flame not detected
2025-11-13 14:50:19,HC-SR04 Ultrasonic Sensor,29.22,Door closed
2025-11-13 14:50:19,HC-SR01 PIR Motion Sensor,0,No motion
2025-11-13 14:50:19,MQ-2 Gas Sensor,168,Gas not detected
2025-11-13 14:50:19,IR Flame Sensor,1,Flame not detected
2025-11-13 14:50:21,HC-SR04 Ultrasonic Sensor,43.19,Door closed
2025-11-13 14:50:21,HC-SR01 PIR Motion Sensor,1,MOTION DETECTED
2025-11-13 14:50:21,MQ-2 Gas Sensor,178,Gas not detected
2025-11-13 14:50:21,IR Flame Sensor,1,Flame not detected
2025-11-13 14:50:33,HC-SR04 Ultrasonic Sensor,91.04,Door closed
2025-11-13 14:50:33,HC-SR01 PIR Motion Sensor,0,No motion
2025-11-13 14:50:33,MQ-2 Gas Sensor,171,Gas not detected
2025-11-13 14:50:33,IR Flame Sensor,1,Flame not detected
2025-11-13 14:50:45,HC-SR04 Ultrasonic Sensor,28.9,Door closed
2025-11-13 14:50:45,HC-SR01 PIR Motion Sensor,0,No motion
2025-11-13 14:50:45,MQ-2 Gas Sensor,245,DANGEROUS GAS LEVELS DETECTED
2025-11-13 14:50:45,IR Flame Sensor,1,Flame not detected
2025-11-13 14:50:57,HC-SR04 Ultrasonic Sensor,49.99,Door closed
2025-11-13 14:50:57,HC-SR01 PIR Motion Sensor,0,No motion
2025-11-13 14:50:57,MQ-2 Gas Sensor,184,Gas not detected
2025-11-13 14:50:57,IR Flame Sensor,1,Flame not detected
2025-11-13 14:51:09,HC-SR04 Ultrasonic Sensor,29.15,Door closed
2025-11-13 14:51:09,HC-SR01 PIR Motion Sensor,0,No motion
2025-11-13 14:51:09,MQ-2 Gas Sensor,180,Gas not detected
2025-11-13 14:51:09,IR Flame Sensor,0,DANGEROUS FLAME DETECTED
2025-11-13 14:51:21,HC-SR04 Ultrasonic Sensor,50.99,Door closed
2025-11-13 14:51:21,HC-SR01 PIR Motion Sensor,0,No motion
2025-11-13 14:51:21,MQ-2 Gas Sensor,174,Gas not detected
2025-11-13 14:51:21,IR Flame Sensor,1,Flame not detected
2025-11-13 14:51:33,HC-SR04 Ultrasonic Sensor,64.43,Door closed
2025-11-13 14:51:33,HC-SR01 PIR Motion Sensor,0,No motion
2025-11-13 14:51:33,MQ-2 Gas Sensor,175,Gas not detected
2025-11-13 14:51:33,IR Flame Sensor,1,Flame not detected
```

WHY THIS PROJECT

- Enhances safety for elderly individuals who may have reduced hearing, vision, or reaction time
- Provides early detection of hazards like gas leaks, smoke, motion, and open doors
- Offers peace of mind for families, caregivers, and individuals living alone
- Increases home security with real-time monitoring and alerts
- Creates a smarter, more responsive living environment for all users
- Combines multiple sensors to deliver a comprehensive, reliable home-monitoring system
- Cheaper alternative to other smart home monitors

SENSOR SETUP

- Turn on the device using the power switch on the Raspberry PI. The system will activate when the display is powered on and the script is started.
- Once powered, the monitor begins scanning using all connected sensors, including motion, distance, gas, and flame detection modules.
- Place the device in a central or frequently used area of the home for best coverage. Keep sensors unobstructed for accurate readings.
- The system will automatically detect motion, nearby obstacles, gas leaks, smoke, or flame activity and trigger the buzzer if a hazard is present.
- Alerts are provided through sound, ensuring users, especially elderly individuals, are notified.
- To power down the device, switch the on/off button back to off.

ETHICAL CONCERNS

DATA COLLECTION AND ANALYSIS: PRIVACY

Why?

- Home activity data is sensitive
- Location information can be identifying
- Environmental alerts may reveal household conditions
- Stored logs could expose personal habits

Steps taken:

- No personal identifiers taken besides age
- Data anonymized using participant ID
- Minimal data collection
- Local storage only
- Residents informed of what is being recorded

ETHICAL CONCERNS

DATA COLLECTION AND ANALYSIS: DIRECT HARM

Why?

- Privacy Intrusion
- Stress or Discomfort From Monitoring
- False Alarms
- Ultrasonic sensor can get hot with improper wiring
- Flame or gas sensor incorrectly going off could cause unnecessary panic
- Data Misinterpretation

Steps taken:

- Informed all residents
- Tested alarm thresholds carefully
- Implemented safe hardware wiring
- Limited buzzer activation
- Stored data locally

PROCEDURE

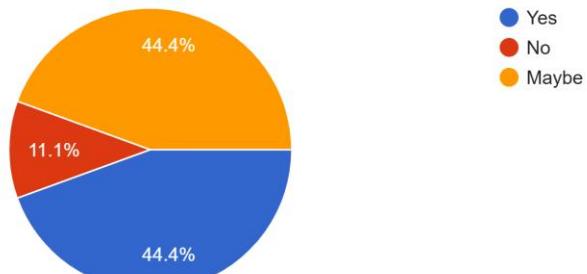
- Used **5 sensors** connected to Raspberry Pi 5 as an interface
- Require **human participants** to use the smart home sensor
- **Collected and stored home data** into a CSV file
- Then, Participants are required to fill out a **Google Form** related to sensors, how useful they found them, and overall how they liked the sensor



SURVEY RESULTS

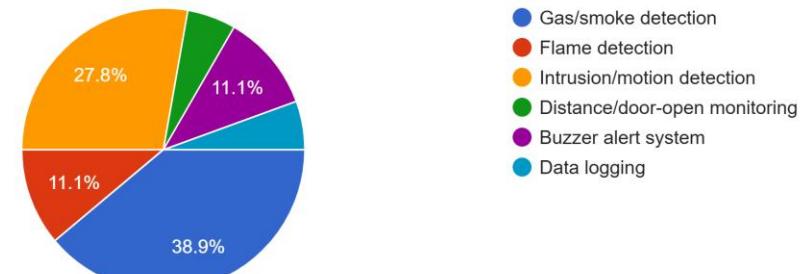
Would you consider using this multi-sensor safety device in your own home?

18 responses



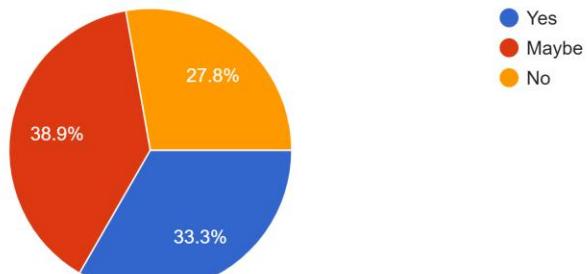
Which part of the system do you find most valuable?

18 responses



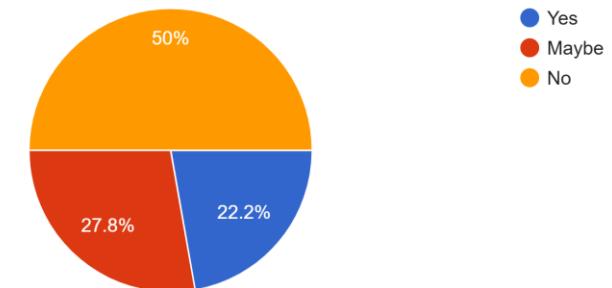
Do you have concerns about false alarms?

18 responses



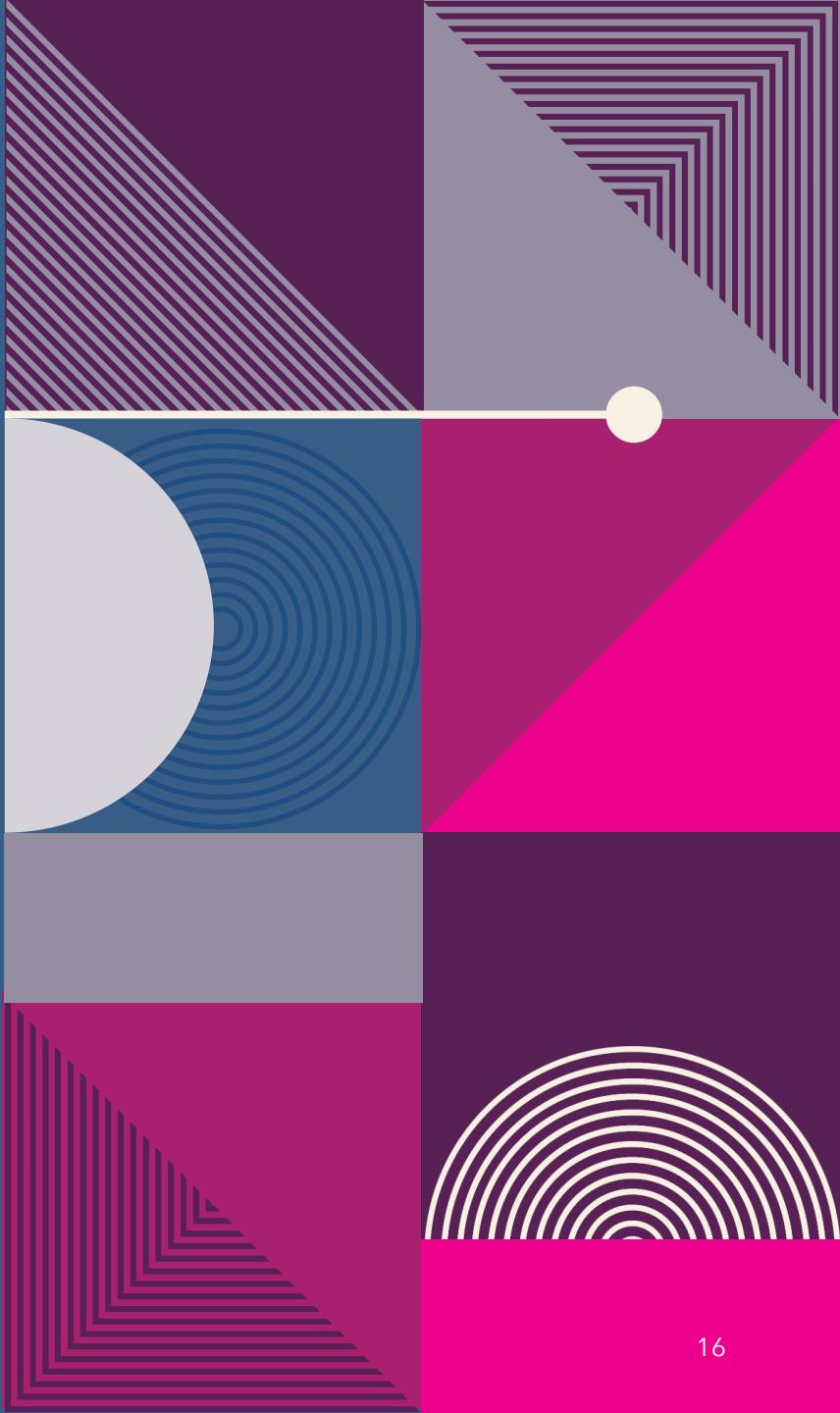
Do you have concerns about device safety (electricity, wiring, overheating, etc.)?

18 responses



RESULTS

- The average participant age was 54.7 years, which aligns well with the intended target audience of adults who may be responsible for or concerned about elderly family members.
- Most participants indicated that they would use the smart home monitor in their own homes.
- Users generally found the device easy to operate and intuitive.
- Participants reported that the sensor functions were straightforward and easy to understand.
- The buzzer volume was sufficient for the majority of participants.
- Several participants recommended adding an indicator light and a enclosure to improve the overall product appearance.
- Feedback on the ultrasonic sensor was mixed, particularly regarding its usefulness and reliability.
- Adjustable buzzer volume was also suggested as a valuable enhancement for future versions



FUTURE OF PROJECT

- Develop a **fully enclosed housing** to improve durability, safety, and overall product appearance.
- Add **adjustable buzzer volume** to make alerts customizable and more user-friendly.
- Integrate an **LED indicator** for clearer status notifications and improved accessibility.
- Upgrade to **higher-quality, more accurate sensors** for improved reliability across all monitored conditions.
- Create **clear, user-friendly instructions** to support easy setup and operation for all age groups.
- Implement **wireless connectivity or mobile notifications** for remote monitoring and alerts.

PROBLEMS ENCOUNTERED

- **The buzzer would constantly go off**
 - After reading documentation and forums, people had similar complaints, and the solution was to connect the buzzer to 3.3V rather than 5V, even though the sensor is rated for 5V
- **Gas sensor constantly showing an alert**
 - Changed the threshold at which the gas connector would go off and connected the gas sensor to an analog connection (to the ADC) rather than directly to the GPIO port
- **Wrong resistors for the ultrasonic sensor**
 - Purchased resistors to avoid damage to the Raspberry Pi, but initially, we got the wrong resistors