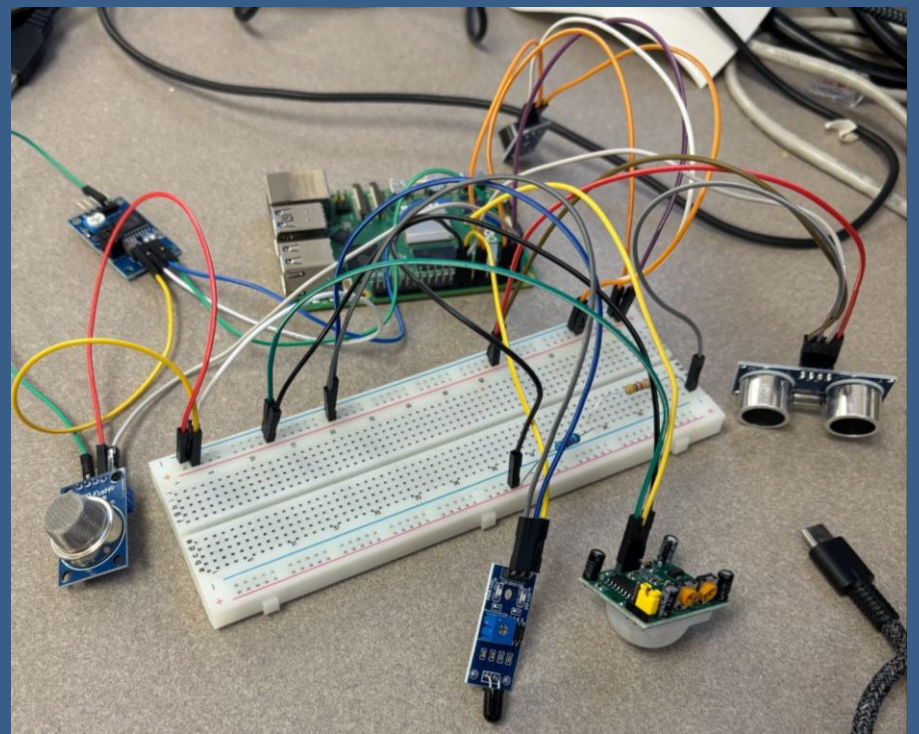
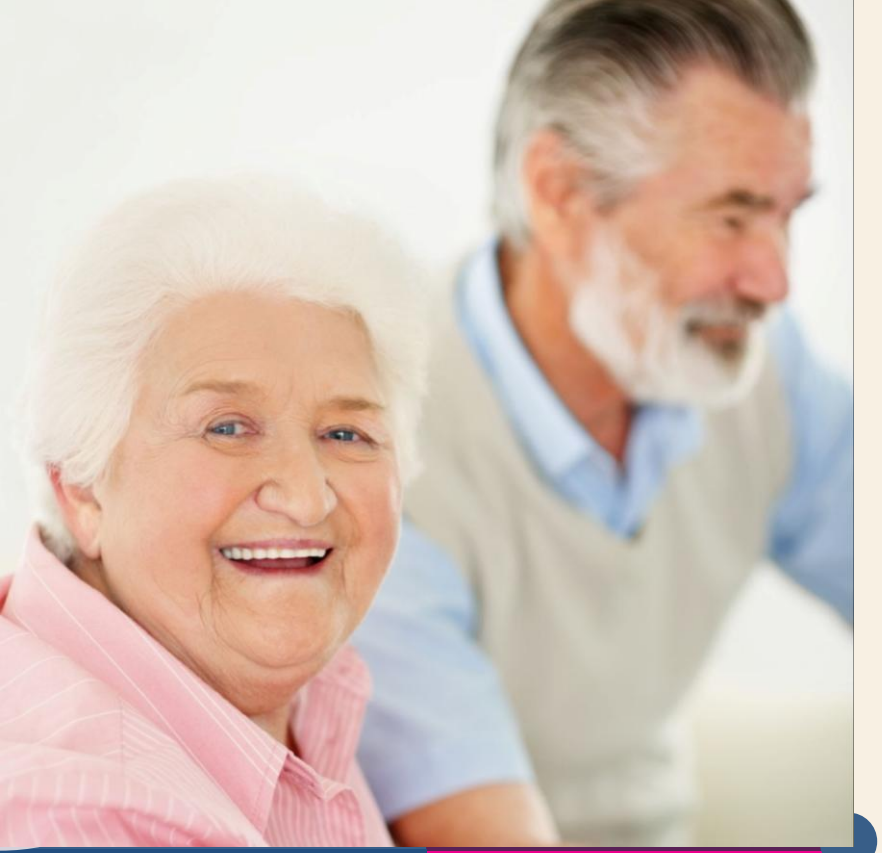
SMART HOME MONITOR





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.

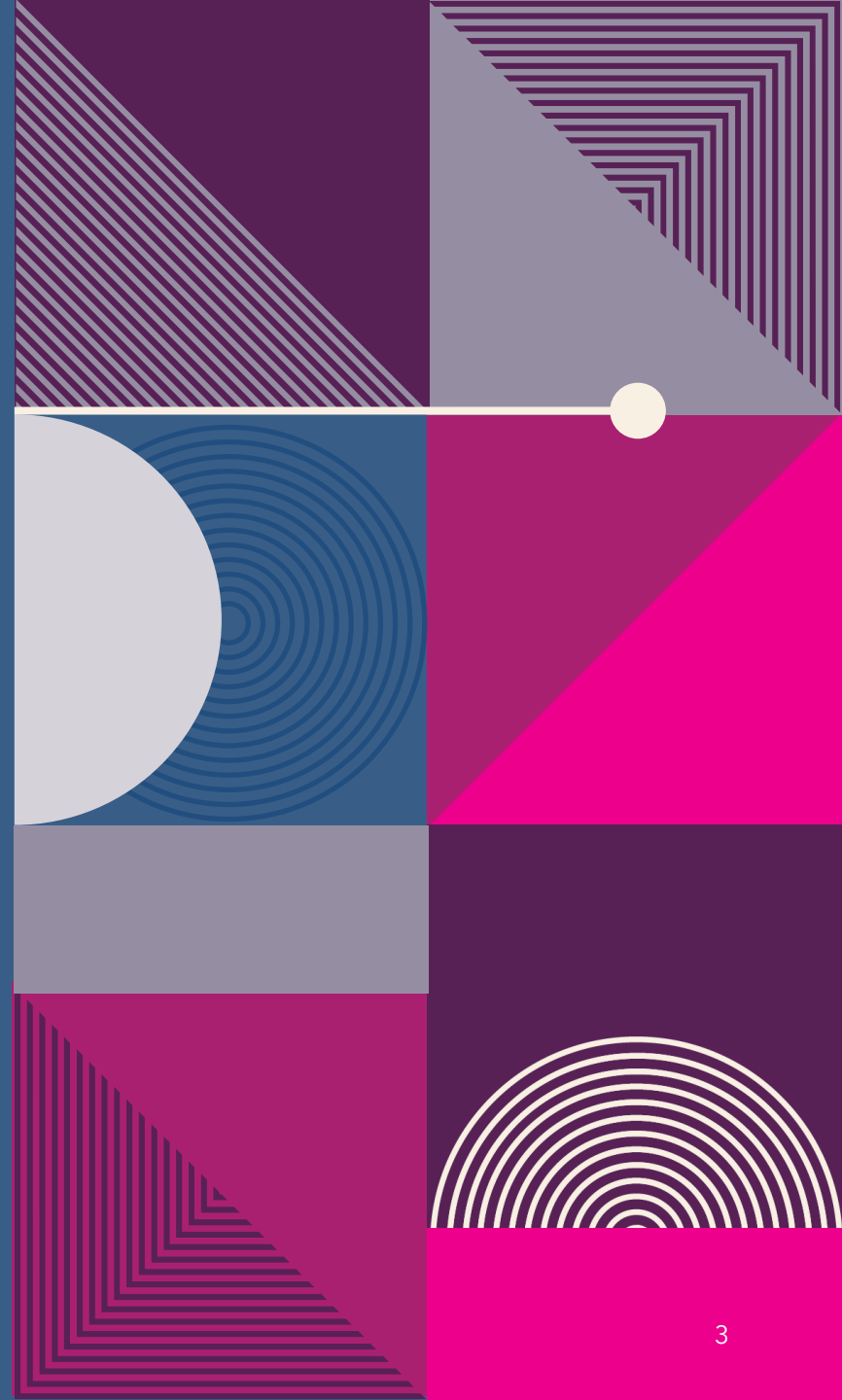
- Status for each sensor is displayed in a constantly updating **CSV** file

- 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.



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

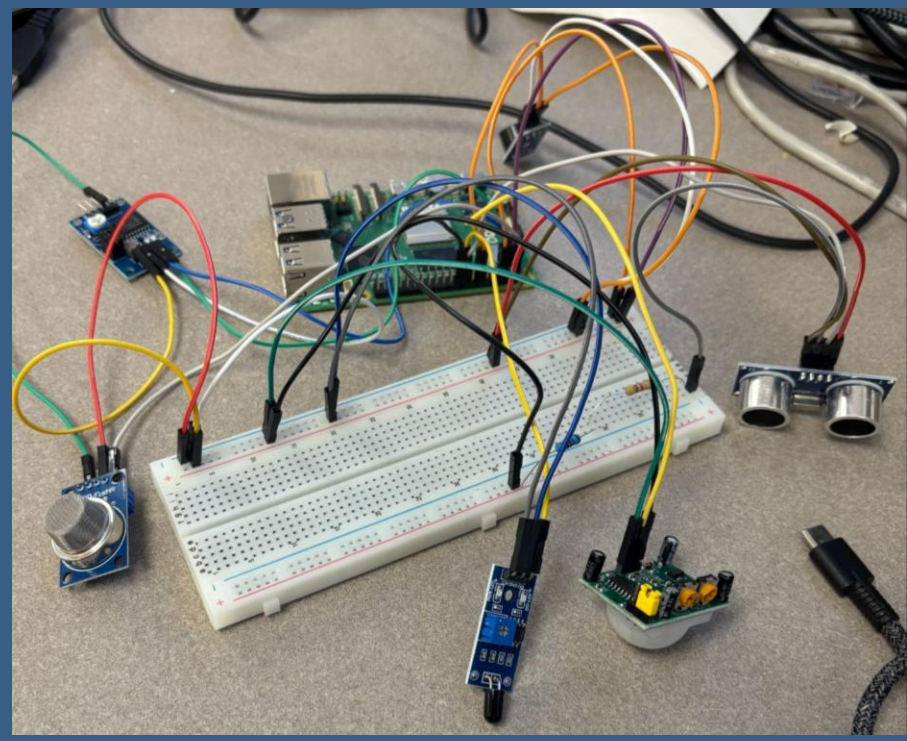
Sensor	Function	Purpose of System
HC-SR04 Ultrasonic Sensor	Measures distance using ultrasonic waves	Detects open doors, obstacles, or intruders near entrances
HC-SR501 PIR Motion Sensor	Detects human movement via infrared radiation	Triggers alerts for motion detection in monitored zones
MQ-2 Gas Sensor	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

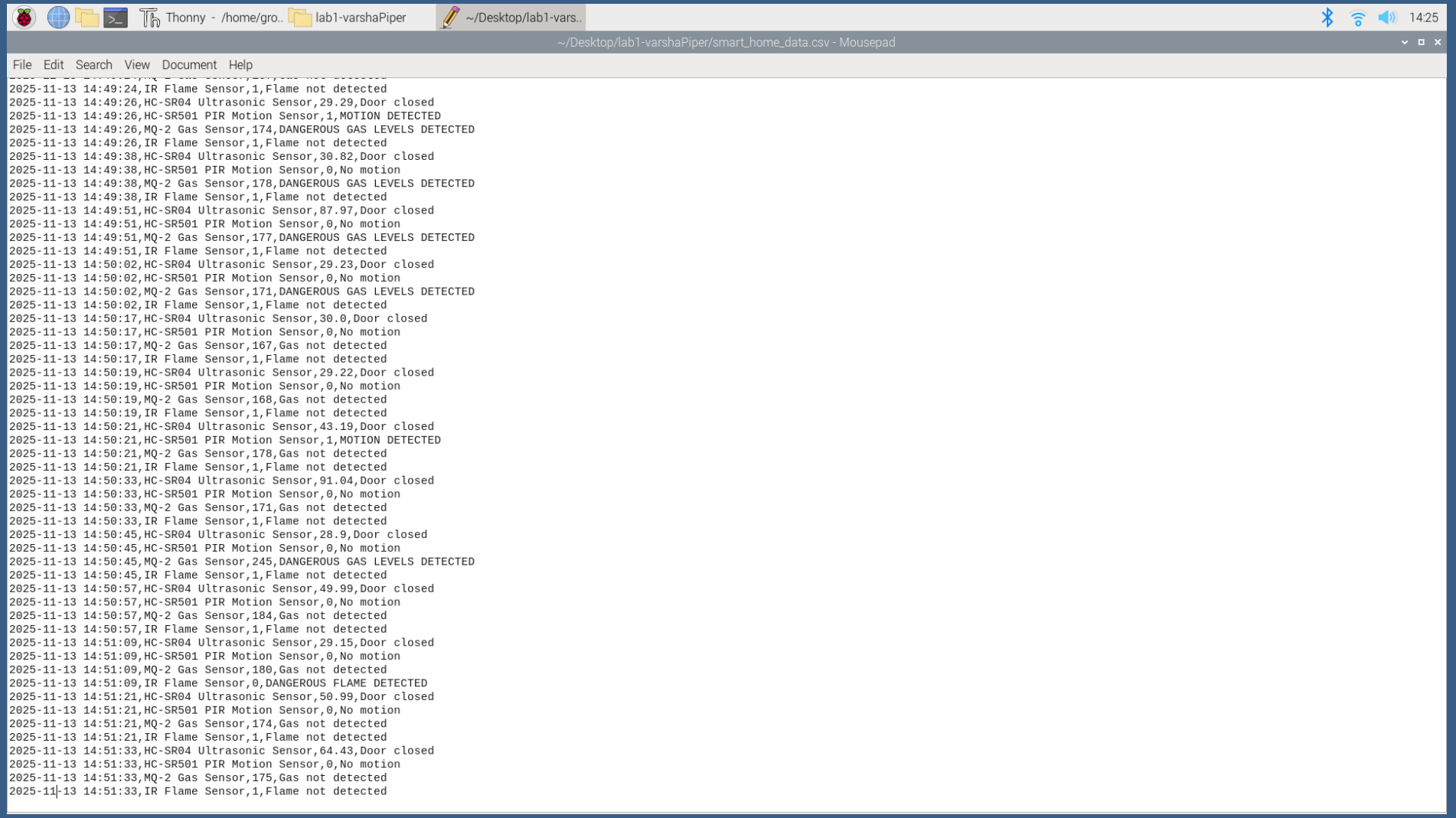
- Raspberry Pi 5 used as an interface for Python code and Sensors
- HC-SR04 Ultrasonic connected to power via two resistors to avoid damage to Pi (Connected to GPIO 23 for Trig, Connected to GPIO 24 for ECHO)
- Buzzer connected to 3.3v, GND, and GPIO18
- Flame sensor connected to 5v, gnd, and GPIO22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



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

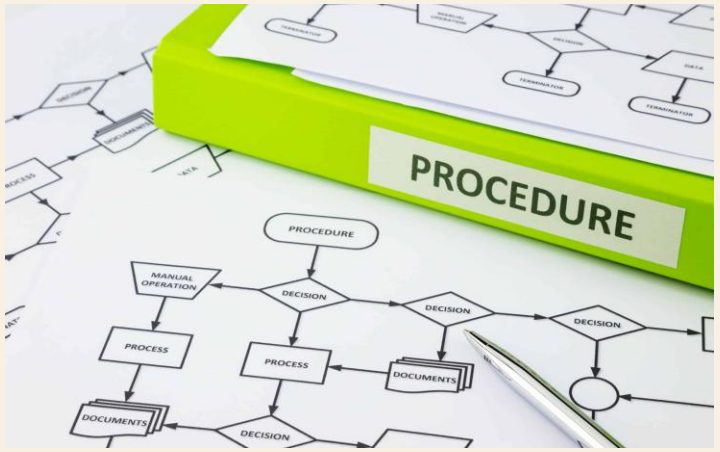
Why?

- 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

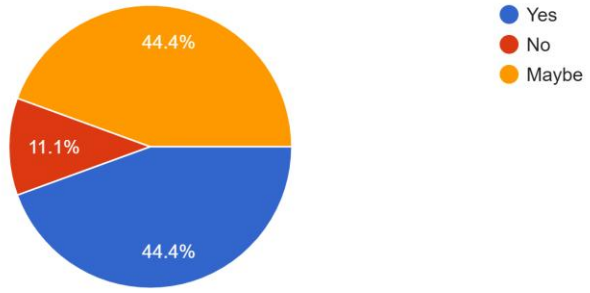


- Used **5 sensors** connected to Raspberry Pi 5 as an interface
- Require **human participants** to use the smart home sensor
- **Collected and stored home data** into a CSV file
- Then, Participants are required to fill out a **Google Form** related to sensors, how useful they found them, and overall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

SURVEY RESULTS

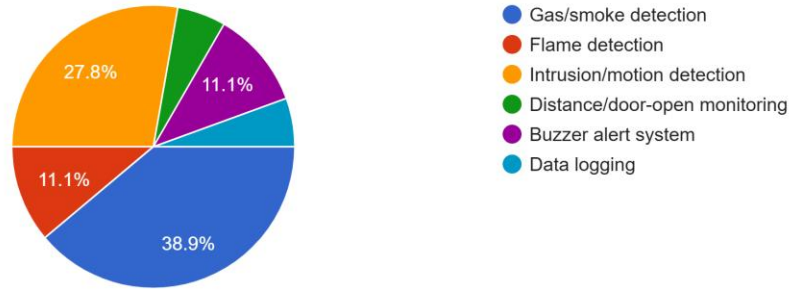
Would you consider using this multi-sensor safety device in your own home?

18 responses



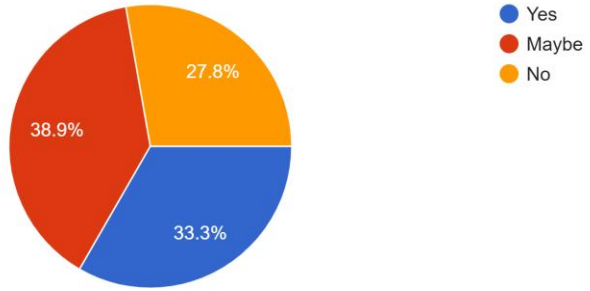
Which part of the system do you find most valuable?

18 responses



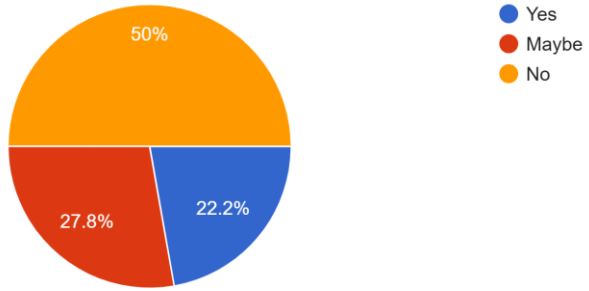
Do you have concerns about false alarms?

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