The Headcount: Autonomous Systems, Sensing and Data Processing, Search & Rescue

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Motivation

Main Goal: **Safety + Statistics**

➔ **Safety**: helpful for emergency responders to have real-time knowledge of how many people are in a space

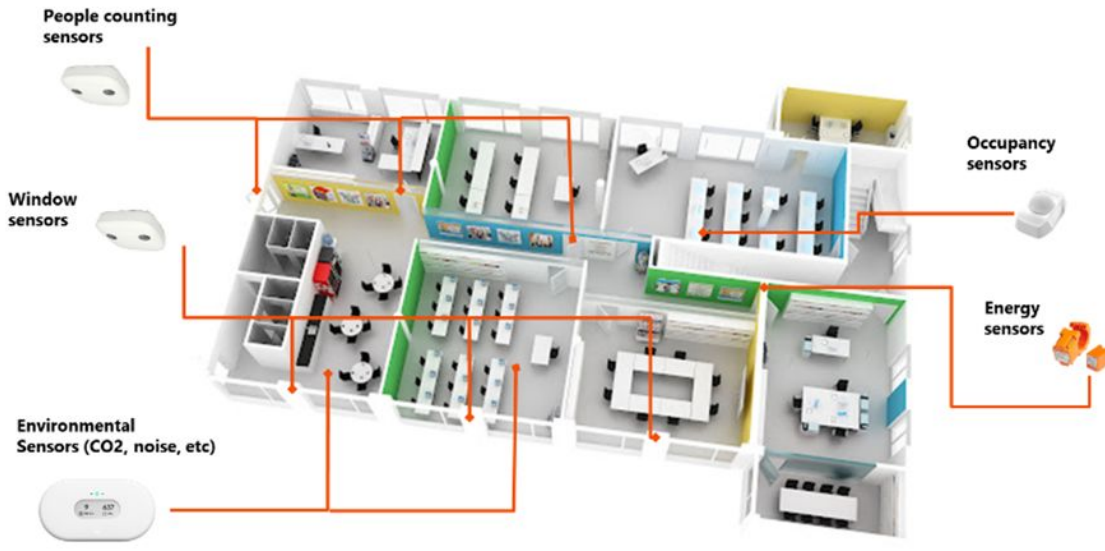➔ **Statistics**: compare tickets sold vs. number of people in attendance

Concert Venues Crowd Monitoring

Fire Marshall Safety Standards

Prior Work

- First motion sensor invented in 1940 during WW2 for room monitoring
- Modern systems involve a wide array of sensors

People counting sensors

Window sensors

Occupancy sensors

Energy sensors
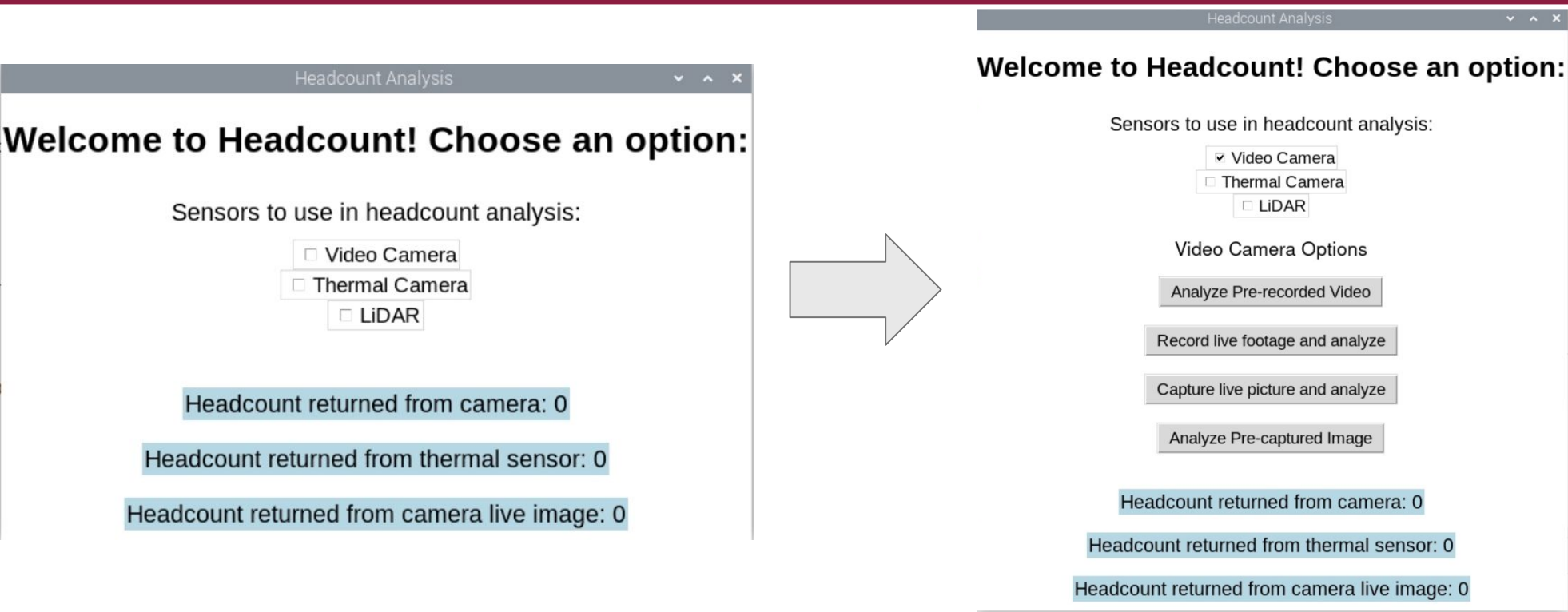
Environmental Sensors (CO2, noise, etc)

Requirements

Design Requirements:

1. Count people in real time
2. Provide live data through a GUI
3. Be affordable (cost < $200)
4. Be modular and scalable
5. Interface with the user well

System Design and Results

GUI:

Welcome to Headcount! Choose an option:

Sensors to use in headcount analysis:
- Video Camera
- Thermal Camera
- LiDAR

Headcount returned from camera: 0
Headcount returned from thermal sensor: 0
Headcount returned from camera live image: 0

Welcome to Headcount! Choose an option:

Sensors to use in headcount analysis:
- Video Camera
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- LiDAR

Video Camera Options
- Analyze Pre-recorded Video
- Record live footage and analyze
- Capture live picture and analyze
- Analyze Pre-captured Image

Headcount returned from camera: 0
Headcount returned from thermal sensor: 0
Headcount returned from camera live image: 0

Storage Mode Options
Select Mode: Store Video
Video Duration: 10 seconds
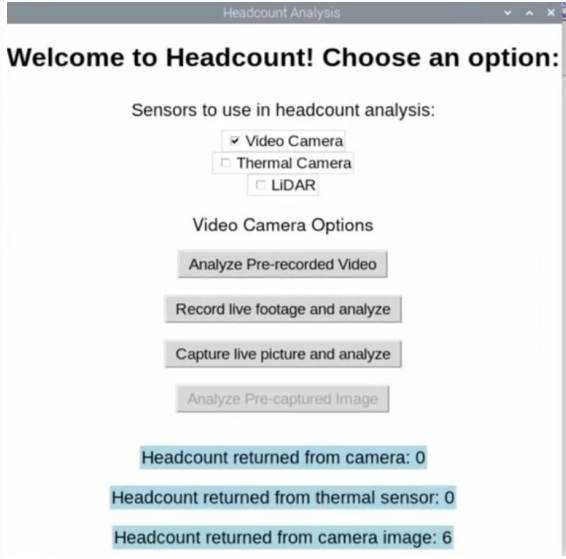Start Storage Mode   Exit Storage Mode

Exit GUI

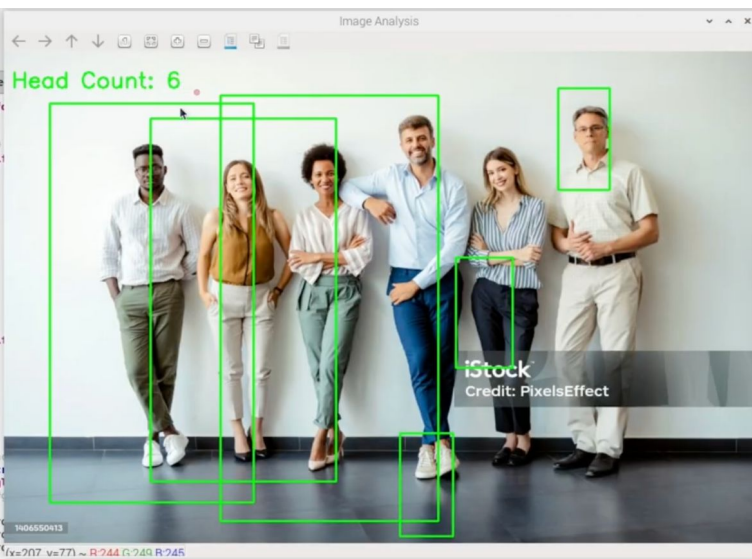GUI Foundation allowing users to connect to sensors or upload footage and obtain a HeadCount

Storage Mode part of GUI, allows user to collect data at certain time increments to then analyze for HeadCount
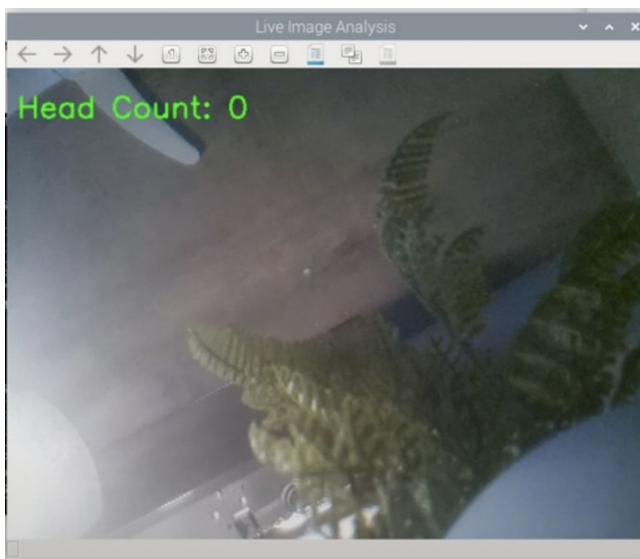
Camera Sensing:

Blue label update example based on camera option

Pre-uploaded image analysis

Pre-uploaded video analysis

Live video/camera analysis

- Imports:
  - Tkinter for GUI
  - Cv2 for image processing
  - General: Subprocess, time, os, etc

- Setup base GUI Window, dynamically updates GUI display based on which sensors are selected

To capture and analyze live video or image:
- Use rpi cam command to obtain footage
- Initialize hog detector, cv2 analysis data
- hog.detectMultiScale
- Update label + Draw boxes

Camera Sensing Operation Flow Diagram

Thermal Sensing:

System uses an 8×8 thermal sensor (AMG8833) to detect people in real time. An adaptive threshold algorithm identifies warm clusters above ambient temperature. Detected people are counted and visualized on a live heatmap.
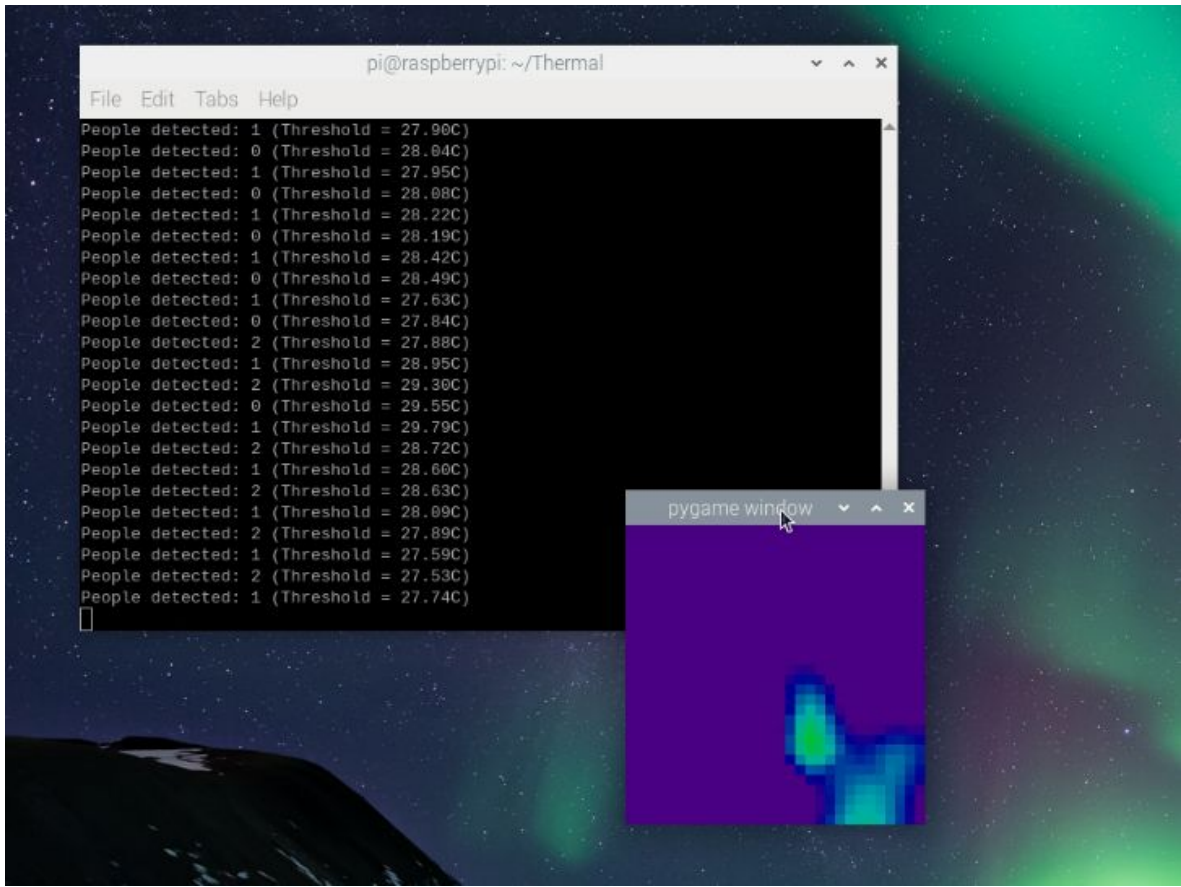
Thermal Sensor HeadCount Results

Thermal Sensor → Temp grid → Clustering → HeadCount → Heatmap
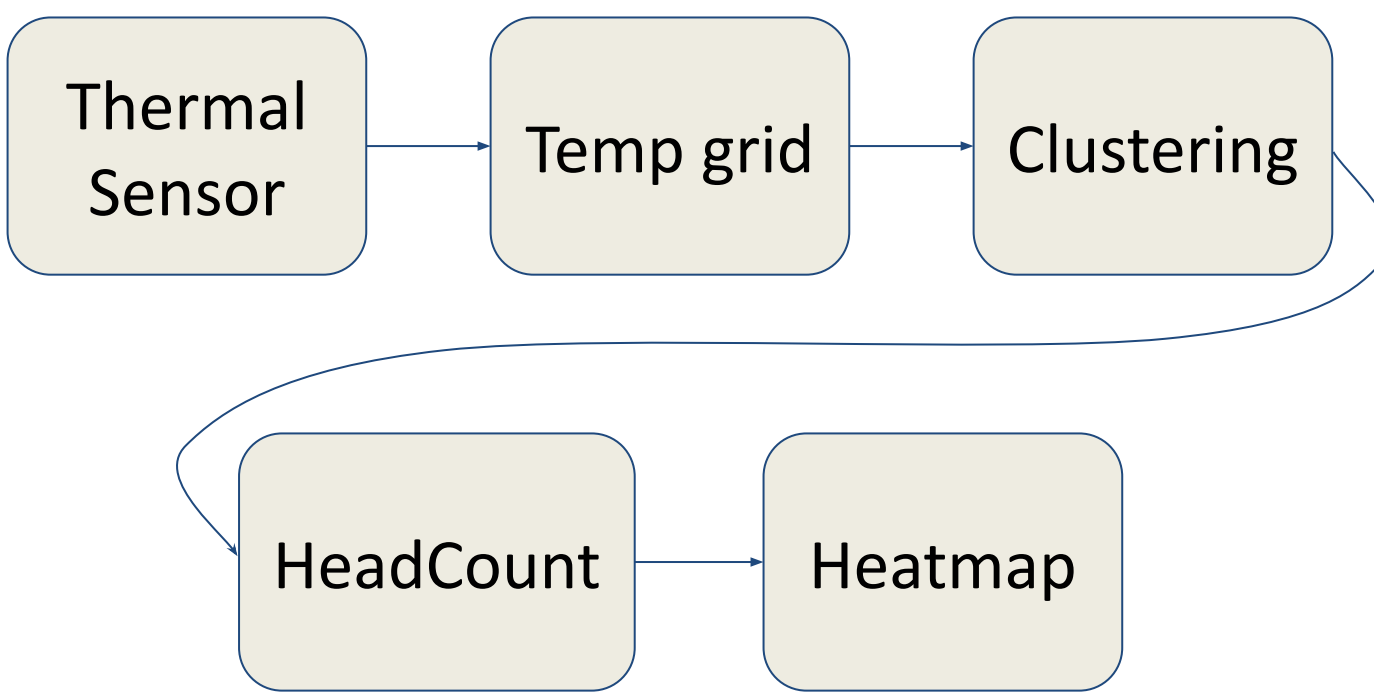
Thermal Sensing Operation Flow Diagram

Impact

Key deliverables:

➔ Camera Detection: live video feed with bounding boxes

➔ Thermal Detection: heatmap-based analysis for people clusters

➔ GUI Functionality: sensor selection, image/video upload, and live headcount updates

ABET Criteria

➔ Health and safety: alerts in potentially dangerous situations (ex. exceeding room occupancy levels)

➔ Ethics: only counts individuals, does not record faces

➔ Manufacturability: design is modular and scalable

Future Work

Next steps:

1. Test in varied room sizes and environments
2. Expand to include LiDAR
3. Account for outdoor environments
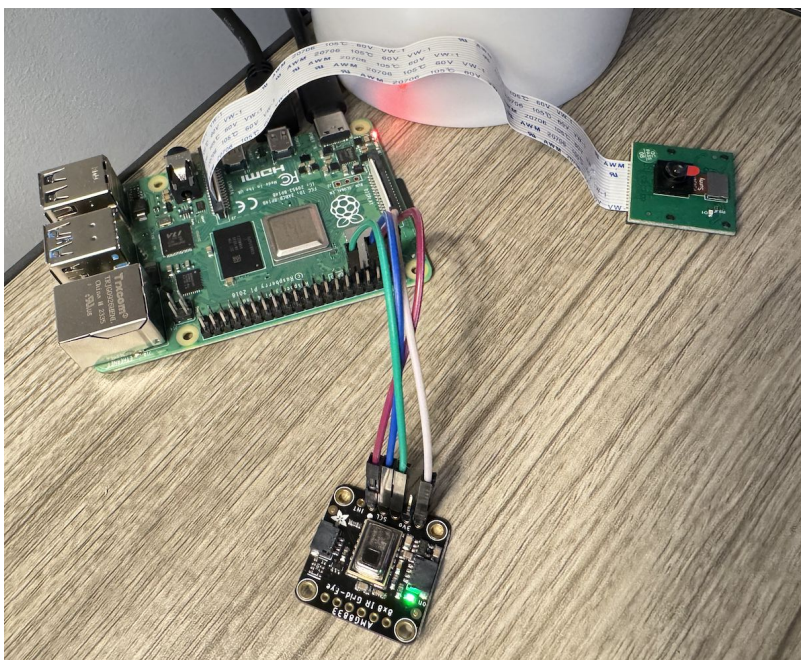
Current hardware setup

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