Backpack Buddy

Emily Grob, Jeric Cuasay, Rahul Kajjam

ECE 445 Final Presentation
Spring 2023
Team #8
Professor: Arne Fliflet
TA: Zicheng Ma

Problem

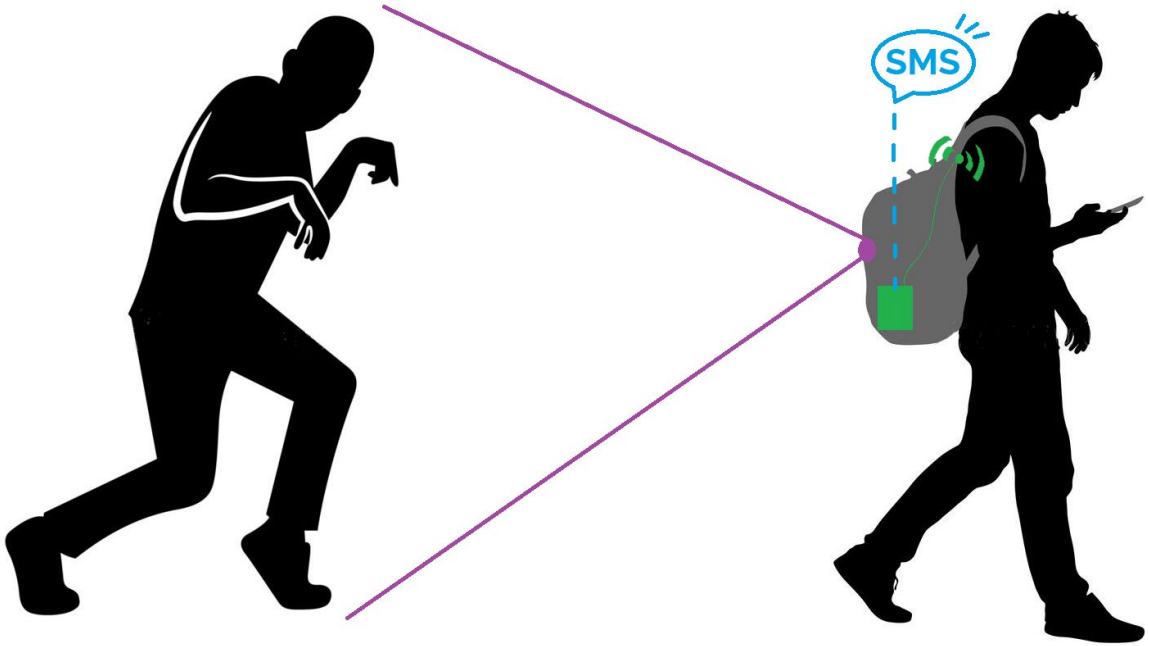
- For many people, walking home is unsafe at night
- Oftentimes, victims of harassment/assault have trouble noticing pedestrians following them

Solution and High Level Requirements

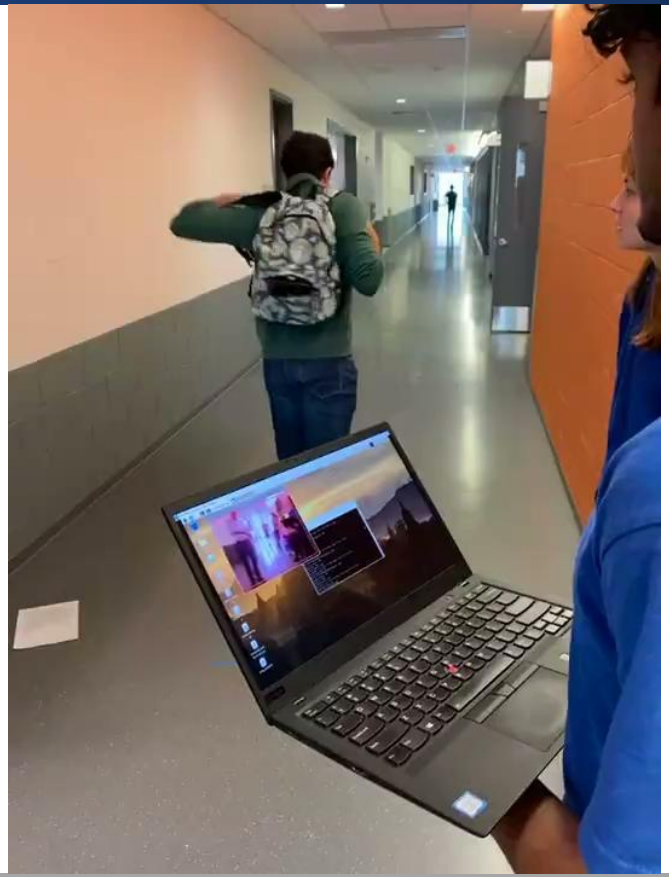
1) **Distinguish pedestrians from other moving objects at a rate of 4-6 frames per second**

2) **Alert the user with haptic feedback if a pedestrian is less than 3 meters away**

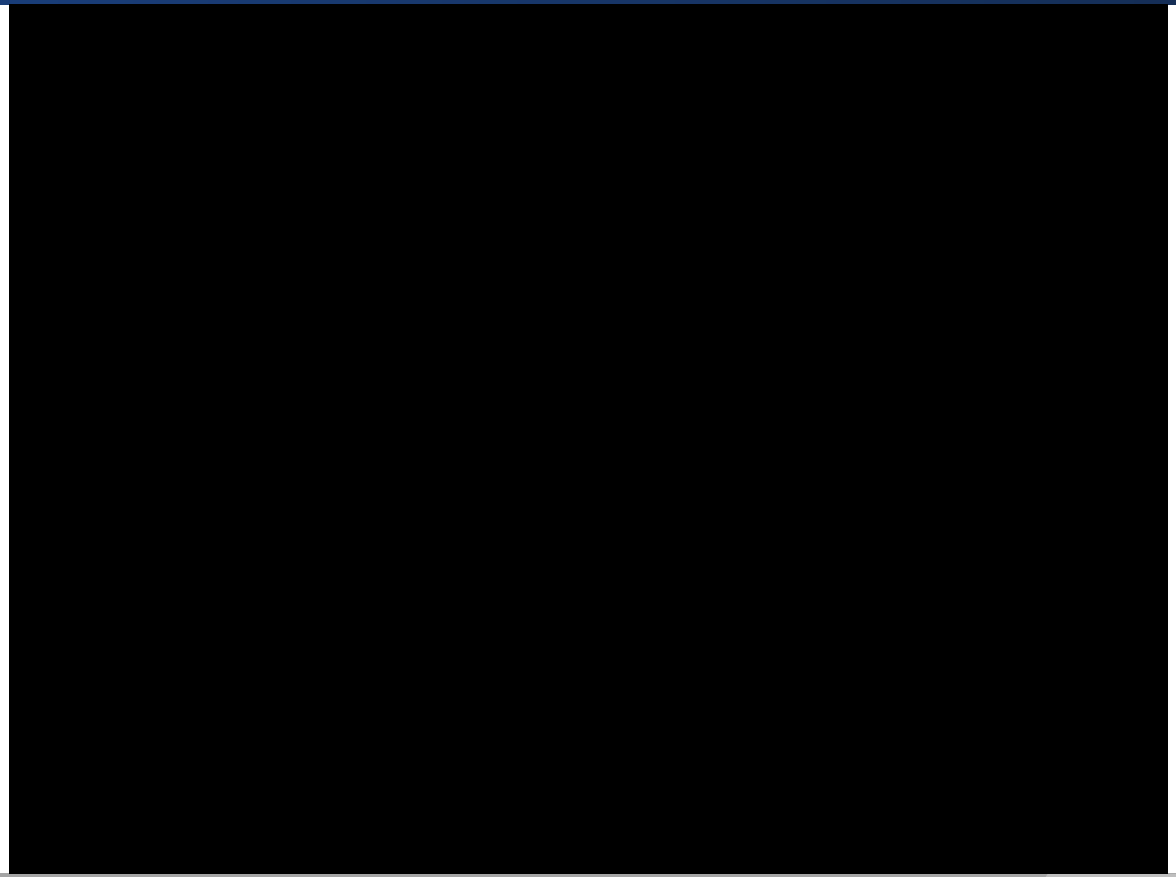
3) **Send emergency alerts to given emergency contact if a pedestrian is within 30cm**

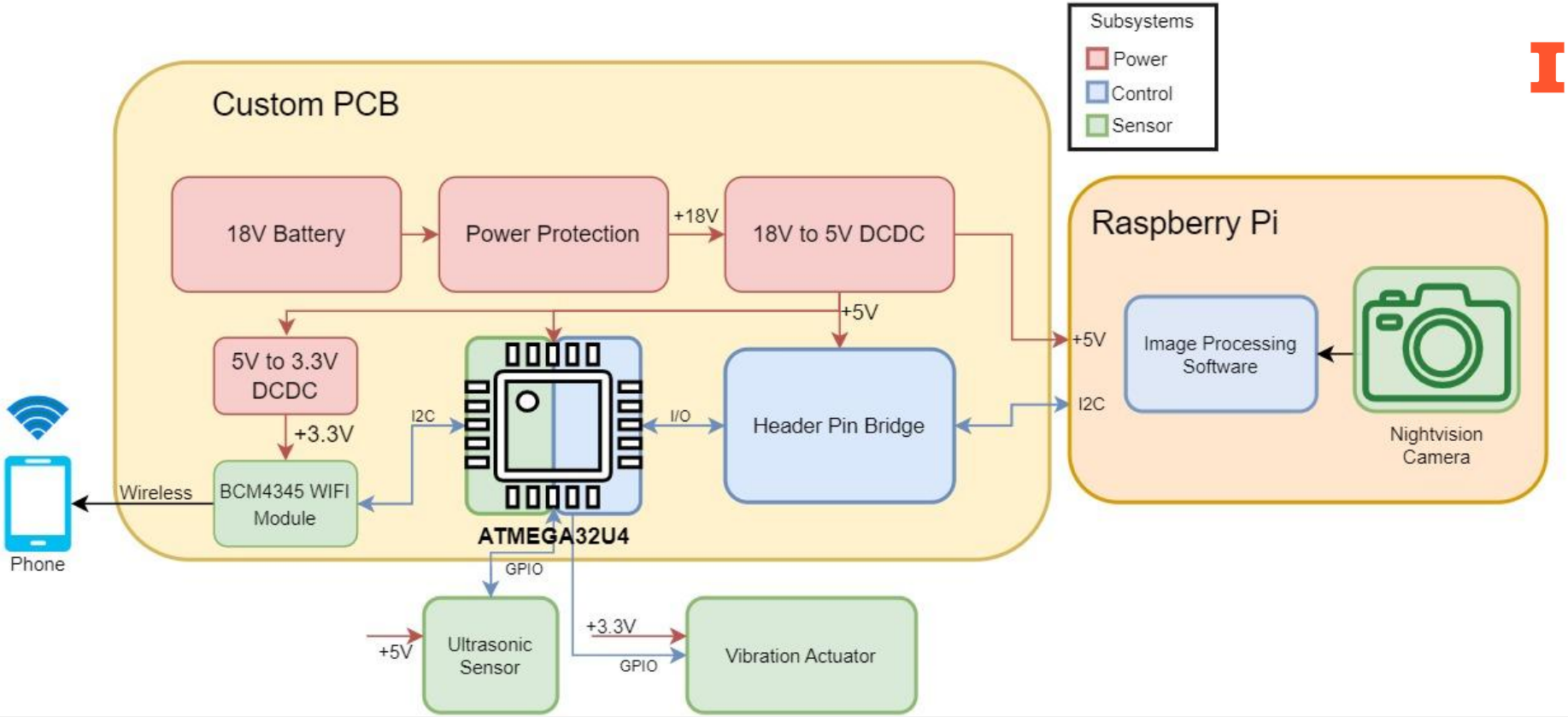


Demonstration



Demonstration (Night Time)

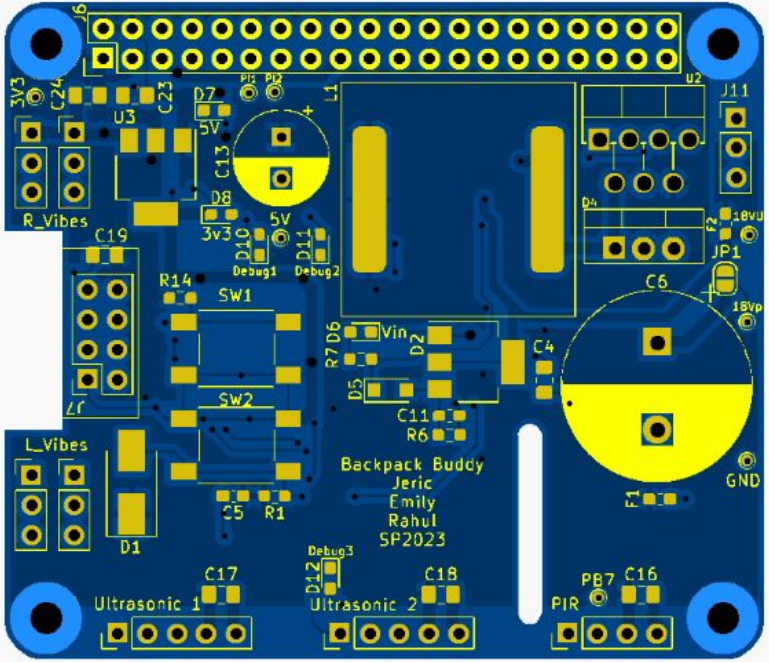




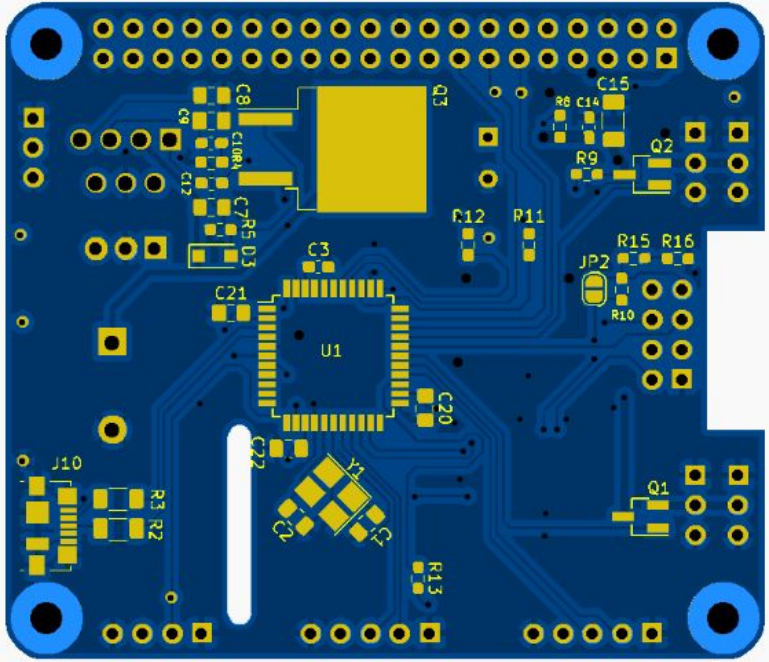
Block Diagram

PCB Design

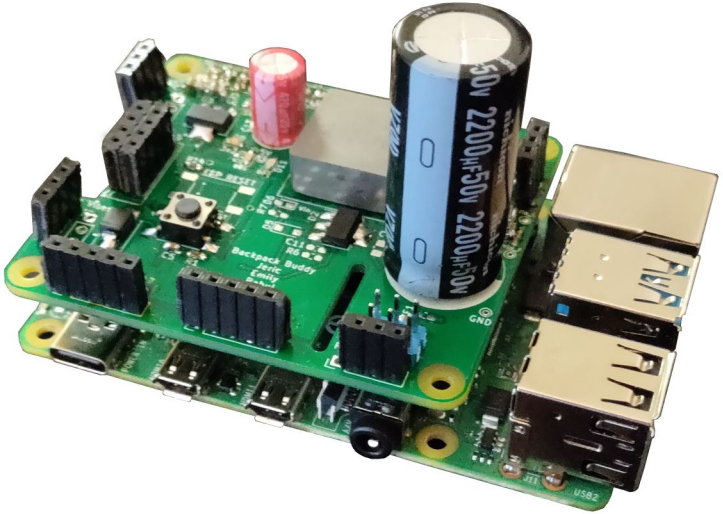
Top side



Bottom side

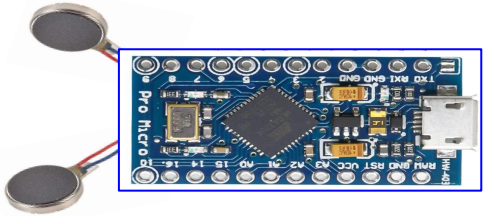


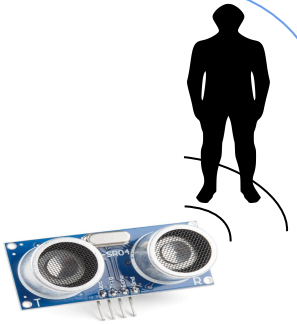
Final Product



Firmware Development

ATMEGA32U4





Actuates vibration motors based on location received. Constantly sends state of ultrasonic

If close proximity detected, send emergency signal to RPI

I2C

I2C

I2C

Raspberry Pi

Processes images, constantly sends location of person detected.

If emergency signal is received: Initiate GET request with emergency web page, using user's cellular hotspot

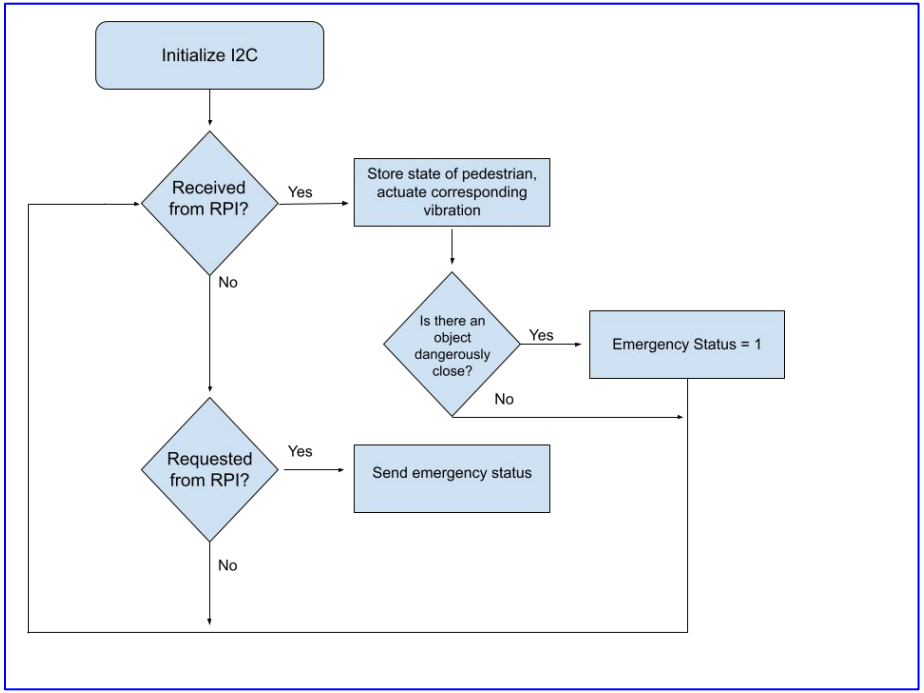
HTTP

Wifi

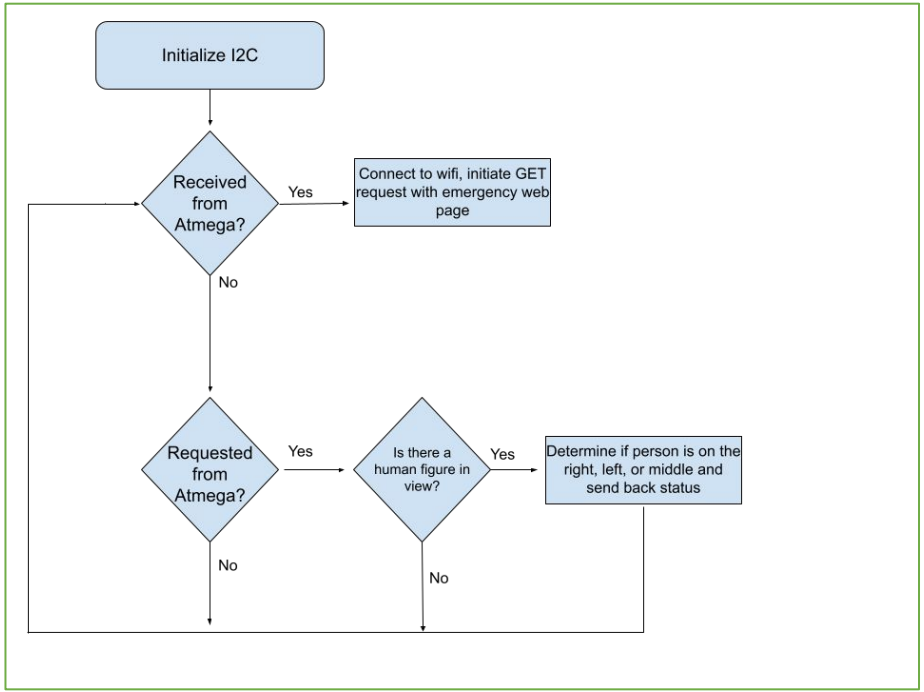
Send text to given number

SMS

Firmware Flowchart

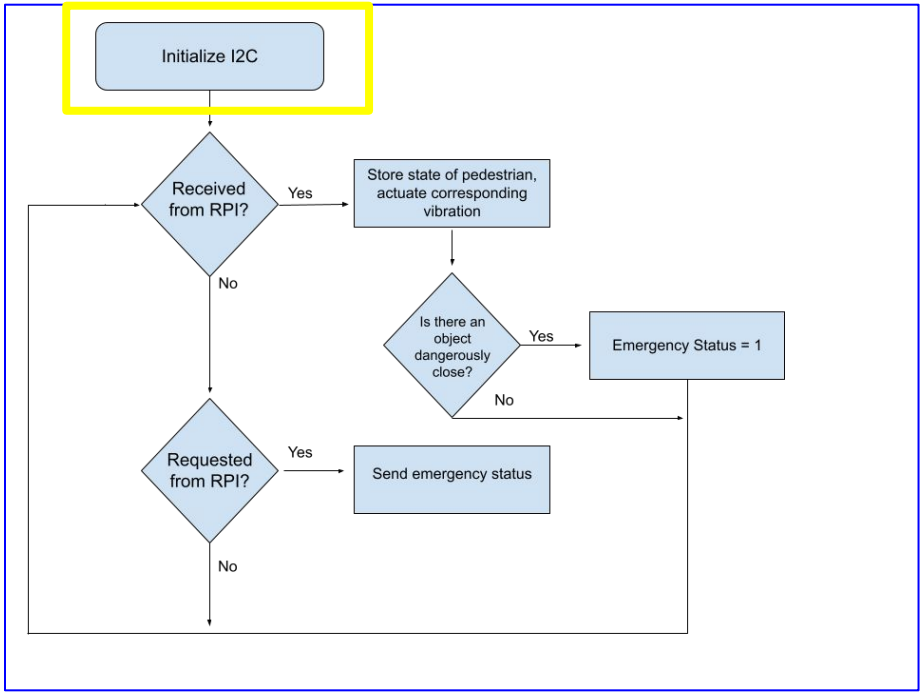


Atmega Flowchart



RPI Flowchart

Firmware Flowchart



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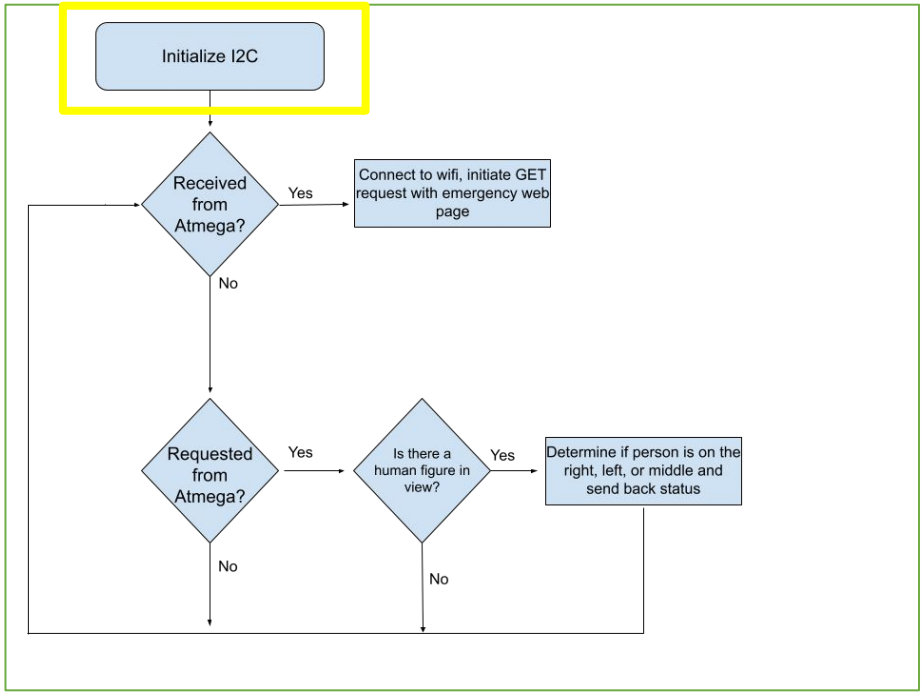
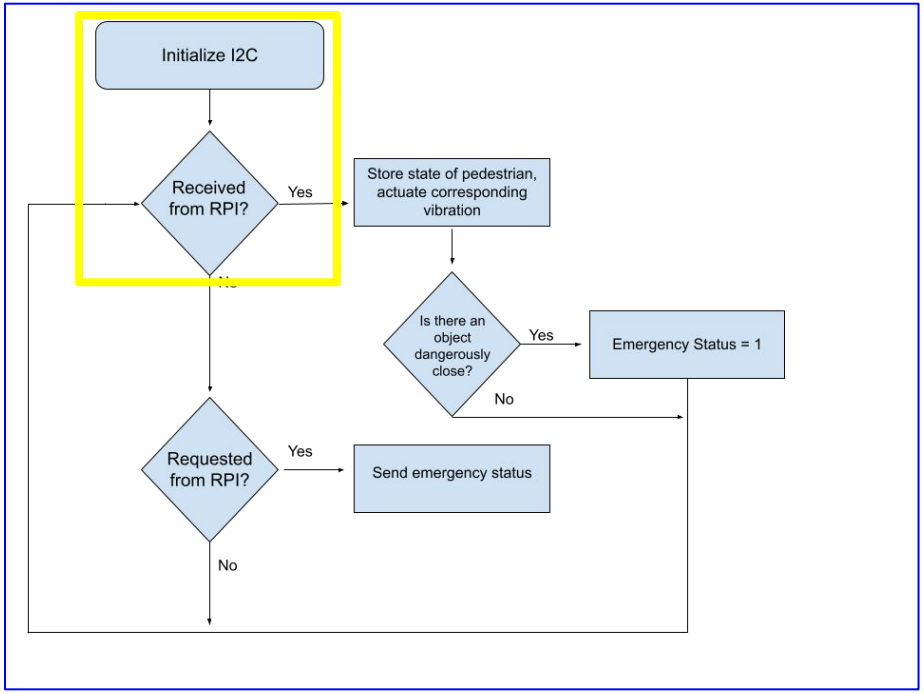


RPI Flowchart

Firmware Flowchart



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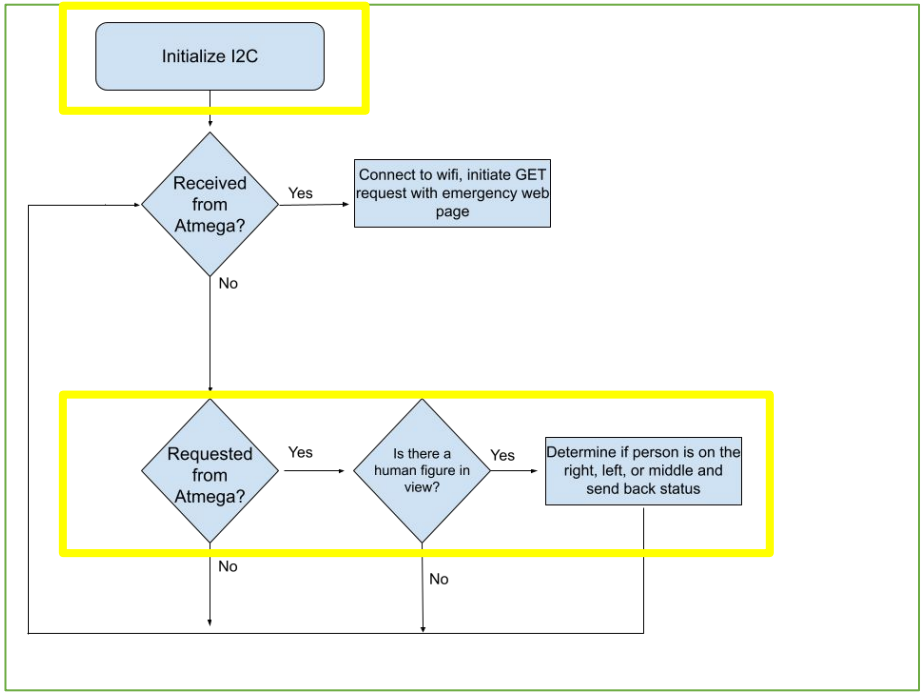
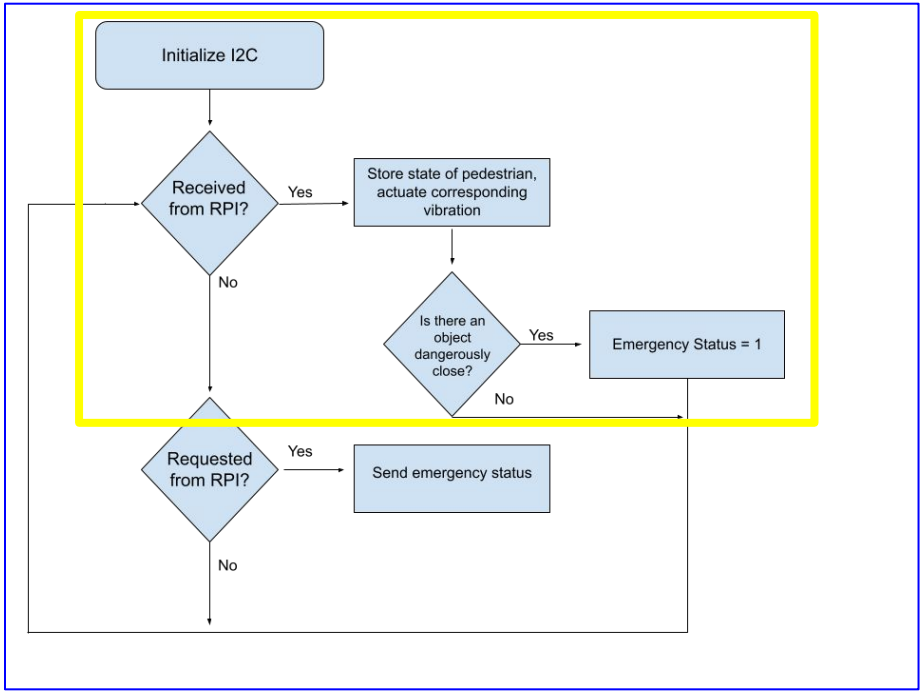


RPI Flowchart

Firmware Flowchart



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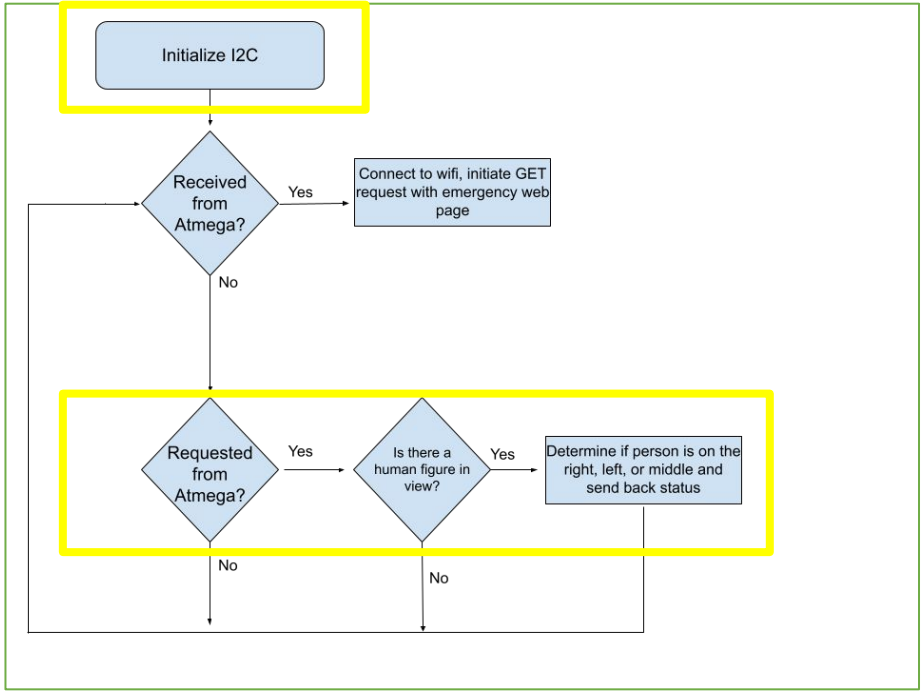
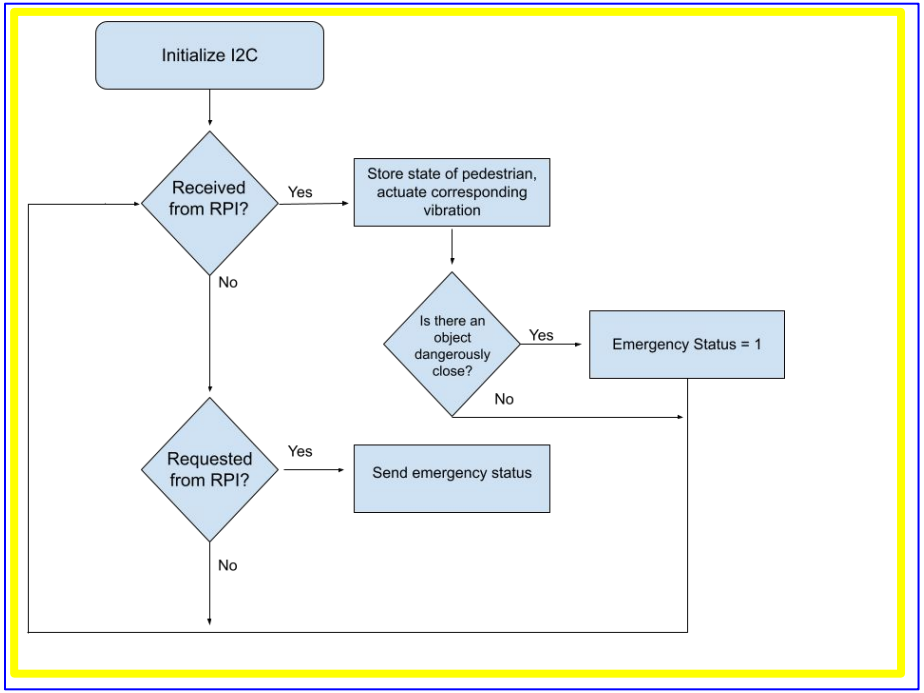


RPI Flowchart

Firmware Flowchart



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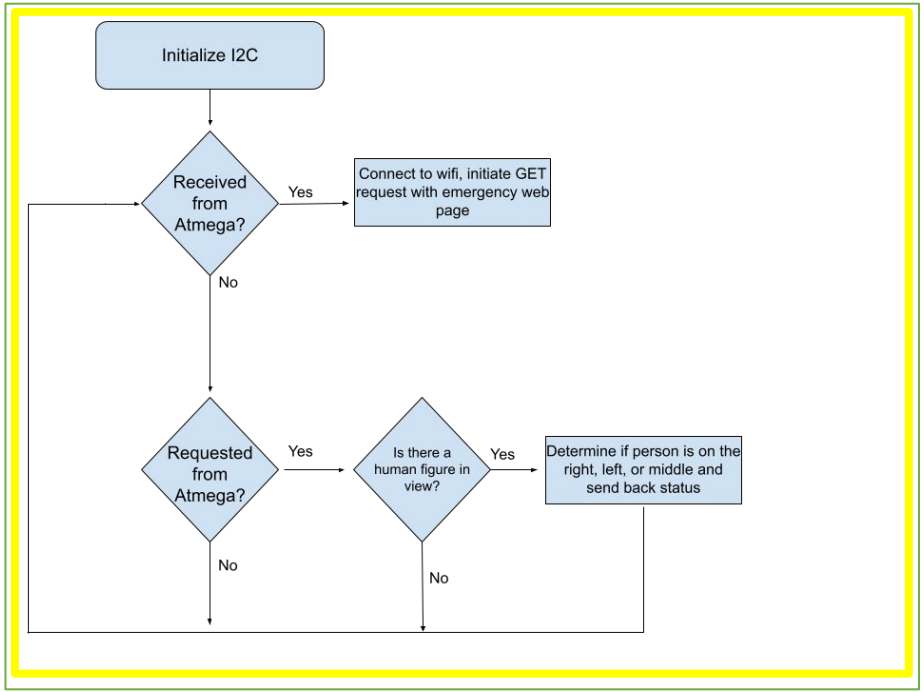

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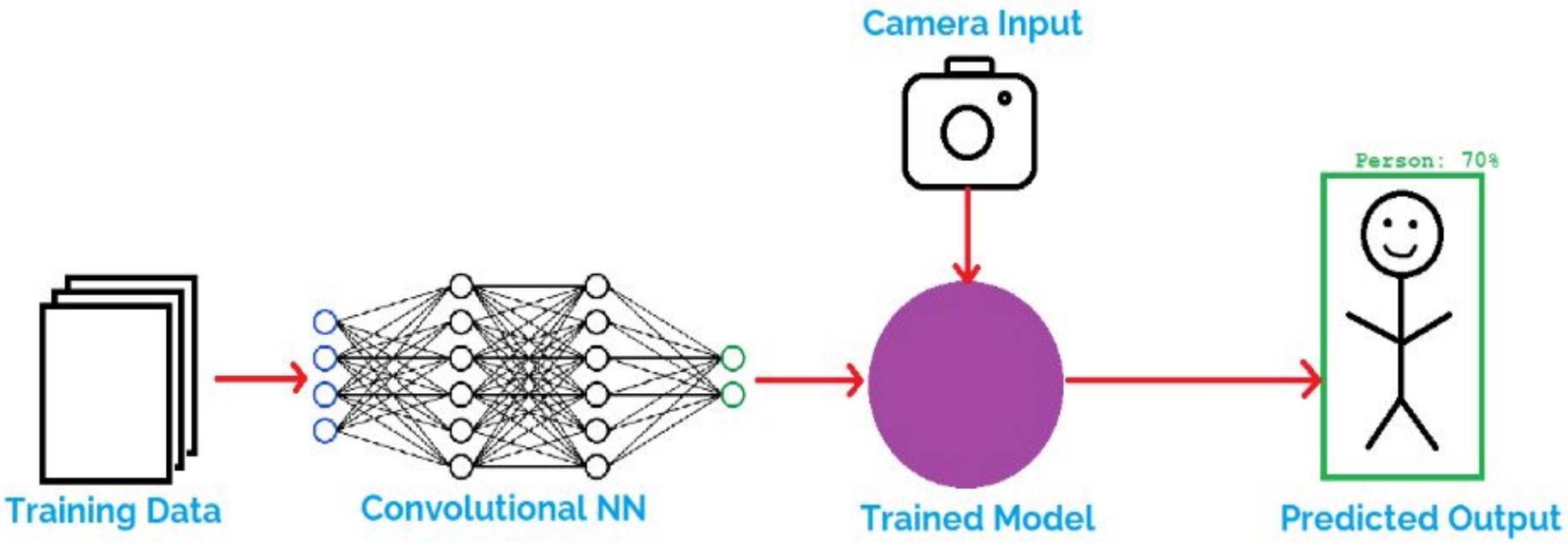


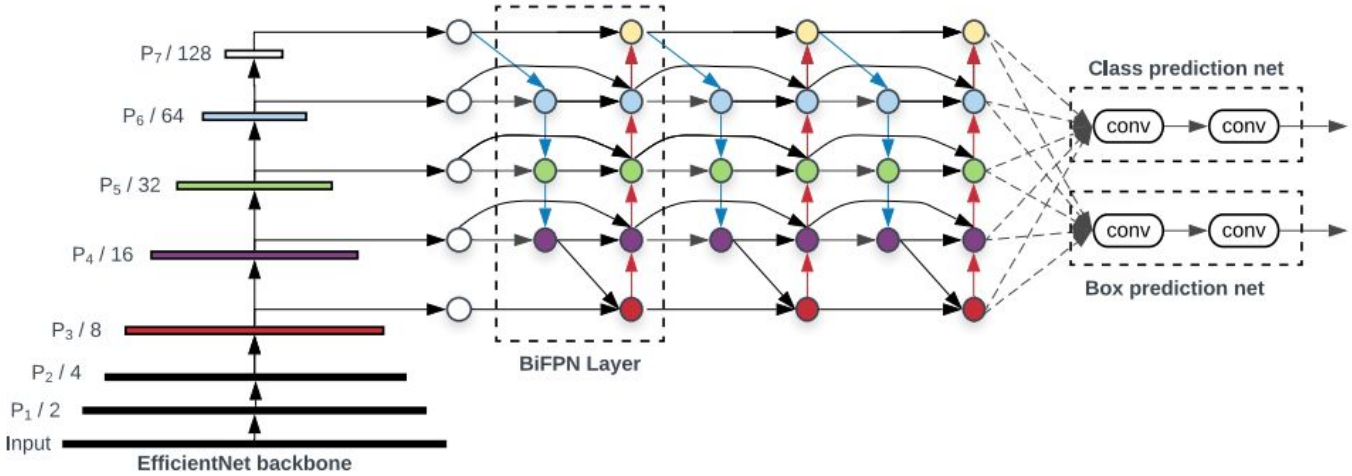
Image Processing Flow Chart

Image Processing: Gathering Training Data

- Gathered 500 images and labeled each person
- Example Images:

Image Processing: Using a Convolutional Neural Network

- Originally wanted to use YOLO algorithm for object detection
- Switched to EfficientDet0 architecture because it prioritizes speed



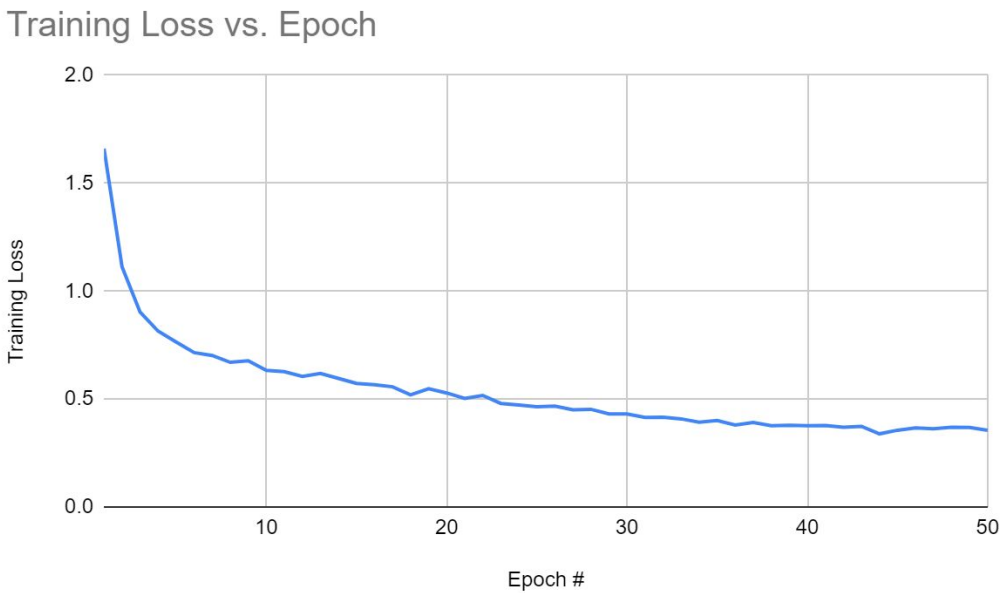
EfficientDet: Scalable and Efficient Object Detection (M. Tan, R. Pang, Q. V. Le) 2020

Image Processing: Model Parameters and Loss

Parameters:

- Number of Training Images = 500
- Number of Test Images = 100
- Epochs = 50

Model architecture	Size(MB)*	Latency(ms)**	Average Precision***
EfficientDet-Lite0	4.4	146	25.69%
EfficientDet-Lite1	5.8	259	30.55%
EfficientDet-Lite2	7.2	396	33.97%
EfficientDet-Lite3	11.4	716	37.70%
EfficientDet-Lite4	19.9	1886	41.96%

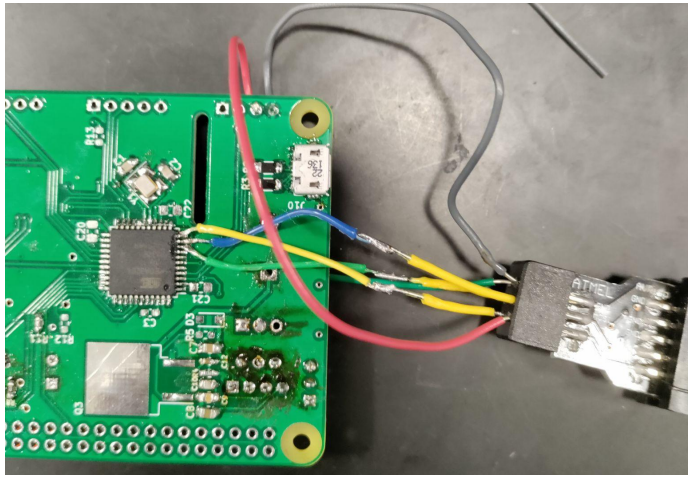


Our Average Precision = 27.44%

Image Processing: Camera Output

Challenges and Successes

- Challenges
  - Cellular hotspot has unique DNS resolution
  - Inconsistencies with batteries
  - Programming with USB
- Successes
  - Person detection works fabulously
  - Met high level requirements
  - Working PCB



Conclusions

- For wearable products, design must be:
  - Robust
  - User-focused
- Importance of incremental testing
- Productivity came from good communication, delegation

Recommendations for Future Work

- Save picture or video upon emergency signal detection
- Internal rechargeable power supply circuitry
- Ability to have multiple emergency contacts set up
- Market focused work

Urban Crew iSafe Backpack,
https://www.wired.com/2012/08/urban-crew-isafe-backpack-2/

Ethics

- Privacy is maintained during video capture (IEEE Code of Ethics I.1)
  - Divergence can be made in emergency
- Batteries with chemistry can be hazardous

Grainger College of Engineering

UNIVERSITY OF ILLINOIS URBANA-CHAMPAIGN