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

Custom PCB
- 18V Battery
- Power Protection
- 18V to 5V DCDC
- 5V to 3.3V DCDC
- +3.3V

ATMEGA32U4
- BCM4345 WIFI Module
- I2C
- GPIO

18V to 5V

Header Pin Bridge
- +5V
- I/O

Raspberry Pi
- Image Processing Software
- Nightvision Camera
- +5V

Phone
- Wireless

Ultrasonic Sensor
- +5V
- GPIO
- +3.3V

Vibration Actuator
- +3.3V
- GPIO

Subsystems
- Power
- Control
- Sensor
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

**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

**Wifi**
- Send text to given number

**SMS**
- HTTP
Firmware Flowchart

Atmega Flowchart

RPI Flowchart
Image Processing Flow Chart
• Gathered 500 images and labeled each person
• Example Images:
• Originally wanted to use YOLO algorithm for object detection
• Switched to EfficientDet0 architecture because it prioritizes speed
Parameters:

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

<table>
<thead>
<tr>
<th>Model architecture</th>
<th>Size(MB)*</th>
<th>Latency(ms)**</th>
<th>Average Precision***</th>
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Our Average Precision = 27.44%
Image Processing: Camera Output

Live Frames Per Second

(6.11 FPS)

Accuracy (79%)
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
• 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/
• Privacy is maintained during video capture (IEEE Code of Ethics I.1)
  • Divergence can be made in emergency
• Batteries with chemistry can be hazardous