Crosswalk Guardian

Team A0
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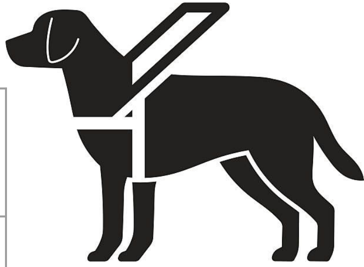
Introduction

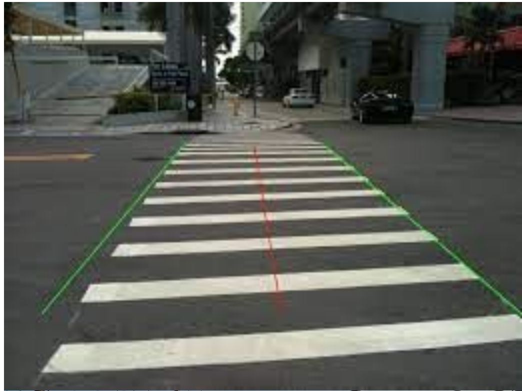
- General lack of safety measures for visually impaired people trying to cross the road

	Walk Sign Detection	Crosswalk Detection	Price	Availability
Audible Tones	Yes	No	~$800	Poor; Not accessible on quiet streets, rural areas
Walking canes	No	No	~$20	Good; easily purchasable
Guide Dogs	No	Yes	~$50,000	Poor; Expensive to train, expensive to adopt



Use Case

- a wearable camera system that detects:
    - Walks signs, when they are on and off
    - A person’s alignment with the crosswalk when they’re crossing the street
- Gives auditory feedback to:
    - Indicate whether it is safe to cross (walk sign is on)
    - Give person directions if they are misaligned with, or off the crosswalk



<u>ECE Areas:</u> Software Systems, Signals and Systems

Use Case Requirements

- Detection Range: **<= 15m**
  - Must cover the length of the crosswalk
- Feedback Latency: **< 1s**
  - Must provide feedback relatively quickly, to ensure person has enough time to cross, and can steer themselves within the crosswalk while walking
  - Minimalistic, simple feedback: “Go”, “Wait”, “Steer left”, etc.
- (walk sign) Accuracy: **>95% total accuracy**
  - **< 5% false negative rate**: Telling person to wait when walk sign on
  - **< 1% false positive rate**: Telling person to go when walk sign off
- (crosswalk) Accuracy: **>90% accuracy**
  - The person crossing should be spending **>90%** of their time within the edges of the crosswalk
- Battery life: **10 hours**
  - Should have enough battery life for a whole day
- Weight: **<1kg**

Technical Challenges

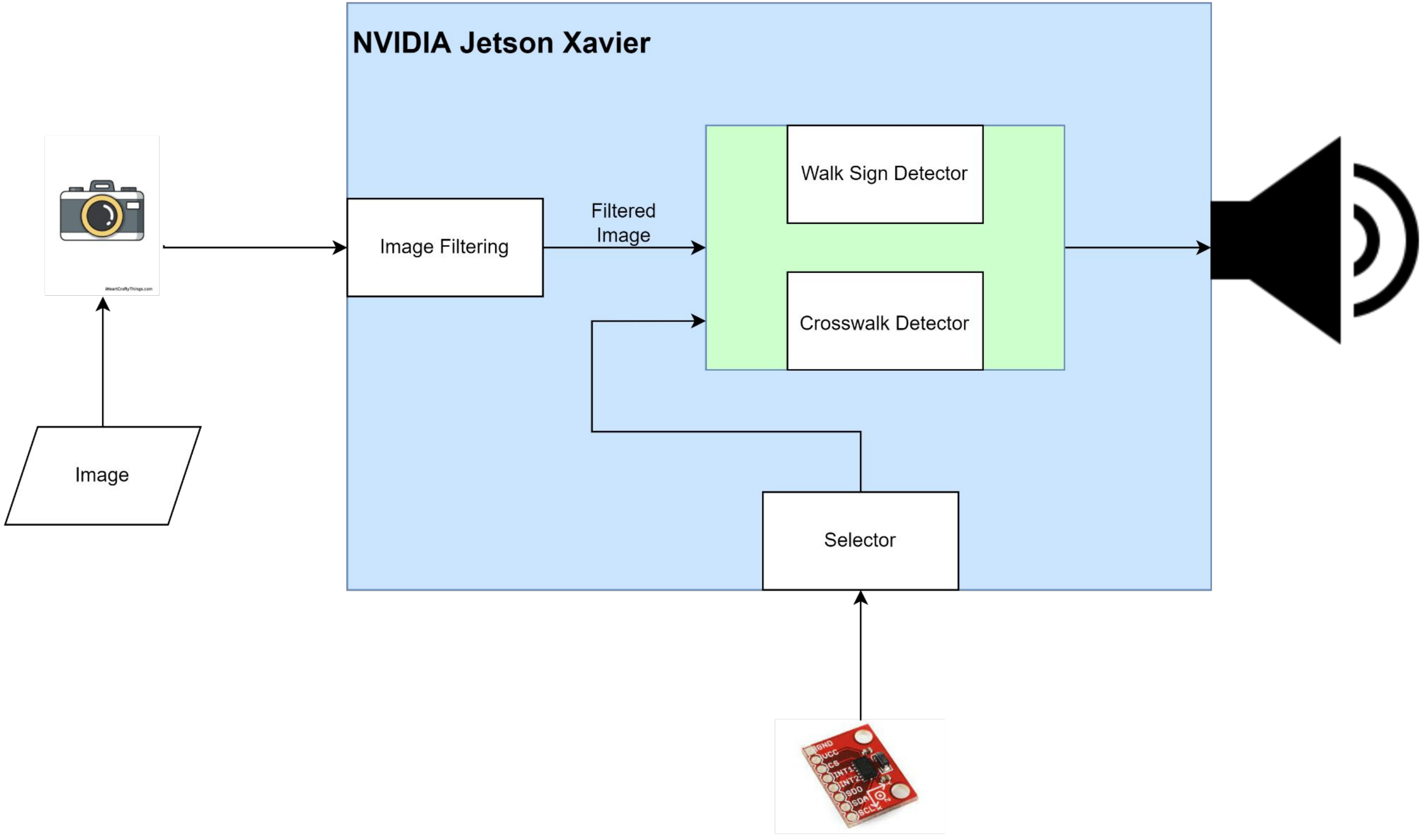
- How to track crosswalks with blurry/faded lines
- Applicability across different intersections, different weather conditions
- Minimizing power usage
    - No estimate of how much power this will take yet
- Keeping the system lightweight
- Need to train images for walk signs, no online datasets found yet
    - We have chosen Bayard St + Morewood St for training and testing purposes

Solutions Approach

- **Software**
  - OpenCV using Python to detect walk signs, edges of crosswalks and user’s current alignment w/ crosswalk
  - ML model training to predict if walk sign is on

- **Hardware**
  - An NVIDIA Jetson with OpenCV installed to perform image processing.
  - An accelerometer to determine if person is still (walk sign detection) or moving (crosswalk detection)
  - camera capable of streaming images to the Jetson
  - speaker to notify the user when to cross and what direction to walk in.

Solutions Approach, Cont.



Video introduction to testing location

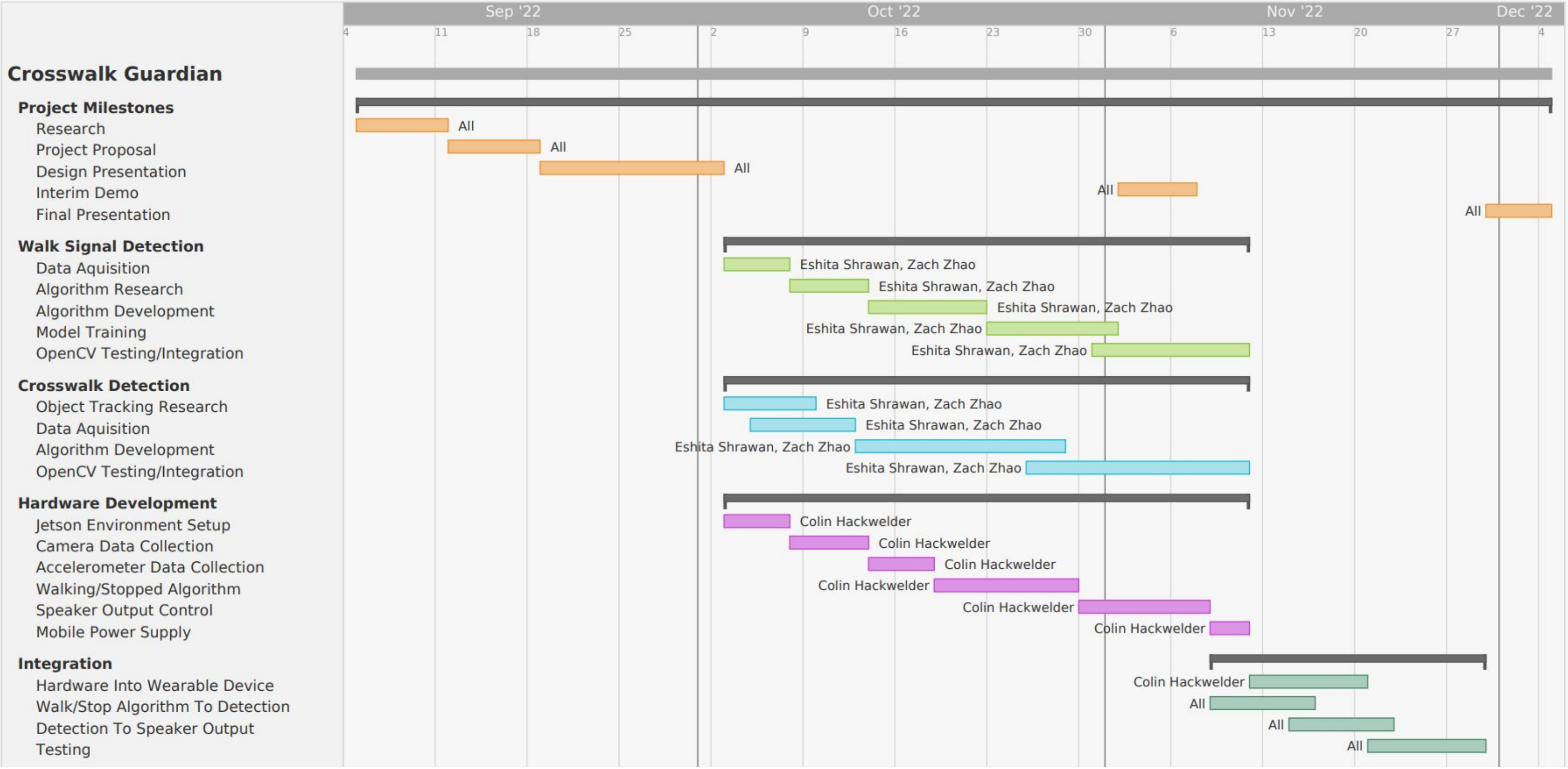
Testing, Verification and Metrics

- **Testing of CV algorithm correctness and robustness**
    - Walk Sign Test Dataset: Multiple angles, granularity/distances
    - Crosswalk Test Dataset: Multiple angles, different types (striped, edges, slanted)
    - Walking/Stopped Algorithm Testing
    - Different weather conditions (sunny, cloudy, rain, snow, night)
    - Latency testing:
        - Walk sign: how long does feedback take after walk sign is turned on
        - Crosswalk: how long does feedback take when walking at a misaligned angle
- **User testing**
    - Will not test with actual visually impaired people
    - Instead, will test individually within team members
    - Will test in real settings; ie. Bayard and Morewood

Tasks and Division of Labor/Schedule

Task	Eshita	Zachary	Colin
Data collection: taking pictures of signs	x	x	
CV/algorithm training and development of signal detection	x	**x**	
Crosswalk detection algorithm	**x**	x	
Equipment procurement			x
Hardware Assembly			x
Assembly: Integration of software and hardware	x	x	x

Schedule


Sep '22
Oct '22
Nov '22
Dec '22
4
11
18
25
2
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16
23
30
6
13
20
27
4
Crosswalk Guardian
Project Milestones
Research
All
Project Proposal
All
Design Presentation
All
Interim Demo
All
Final Presentation
All
Walk Signal Detection
Data Aquisition
Eshita Shrawan, Zach Zhao
Algorithm Research
Eshita Shrawan, Zach Zhao
Algorithm Development
Eshita Shrawan, Zach Zhao
Model Training
Eshita Shrawan, Zach Zhao
OpenCV Testing/Integration
Eshita Shrawan, Zach Zhao
Crosswalk Detection
Object Tracking Research
Eshita Shrawan, Zach Zhao
Data Aquisition
Eshita Shrawan, Zach Zhao
Algorithm Development
Eshita Shrawan, Zach Zhao
OpenCV Testing/Integration
Eshita Shrawan, Zach Zhao
Hardware Development
Jetson Environment Setup
Colin Hackwelder
Camera Data Collection
Colin Hackwelder
Accelerometer Data Collection
Colin Hackwelder
Walking/Stopped Algorithm
Colin Hackwelder
Speaker Output Control
Colin Hackwelder
Mobile Power Supply
Colin Hackwelder
Integration
Hardware Into Wearable Device
Colin Hackwelder
Walk/Stop Algorithm To Detection
All
Detection To Speaker Output
All
Testing
All

Conclusion: Summary

- Two problems
  - Detection of walk signs
  - Detection of crosswalks
- Solving both problems provides visually impaired people with the safest environment possible while crossing the road
- Reduces a visually impaired person’s dependence on inaccurate/inconsistent factors to know when/where to cross the road
  - Sounds of cars and people around them