CamVisors: A Low-Cost Smart Glass System Utilizing Computer Vision for the Blind

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Introduction

Problem:

- Over **40 million** individuals in the world suffer from blindness and over **300 million** suffer from severe vision loss
- Traditional approaches have flaws

Current Innovations:

- Difficult to **control**
- **Expensive** and **inaccessible**
- Bulky, heavy, and **uncomfortable**

Engineering Goal:

- To develop a machine learning model system to improve the affordability, accessibility, and comfort of life-improving technology to support blind and visually impaired individuals.

World Health Organization. (n.d.). World Report on vision. World Health Organization. Retrieved February 13, 2023, from https://www.who.int/publications/i/item/9789241516570

Kim, Dae, et al. "Travel in Adverse Winter Weather Conditions by Blind Pedestrians: Effect of Cane Tip Design on Travel on Snow." *Journal of Visual Impairment & Blindness*, vol. 110, no. 1, 2016, p. 53,

Methods

User-computer Interface:

- Direct communication tool between user and assistance system
- Use voice commands to communicate with a computer, smartphone, or microcontroller

ML Model Training:

- The obstacle detection model using the COCO dataset and a Google Street View Dataset.

Testing:

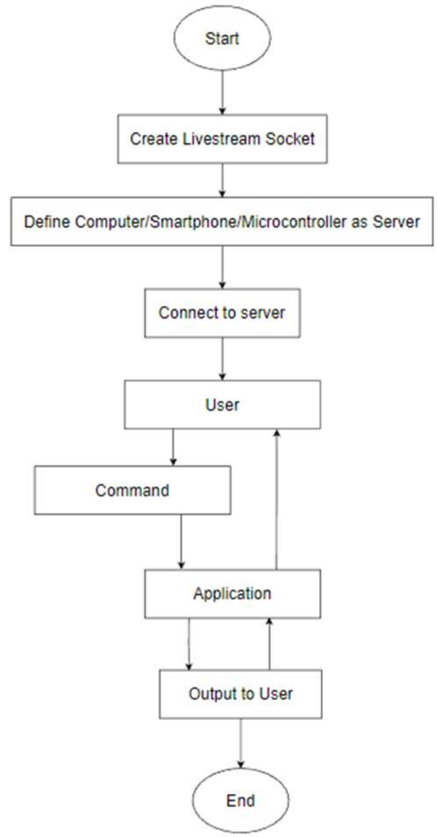
- Machine learning models were tested using sample data not in training set
- System was tested in 15 different locations with varying obstacles, including people, in 50 tests.

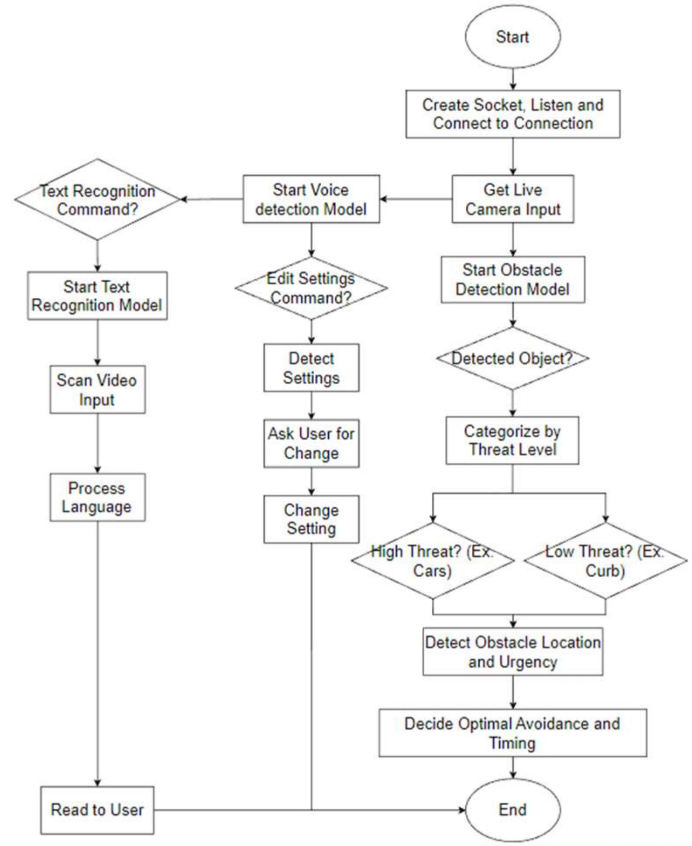
Steaming Camera Data to Models

Lin, T., Maire, M., Belongie, S., Bourdev, L., Girshick, R., Hays, J., Perona, P., Ramanan, D., Zitnick, C. L., & Dollár, P. (2014). Microsoft COCO: Common Objects in Context. *ArXiv*. /abs/1405.0312

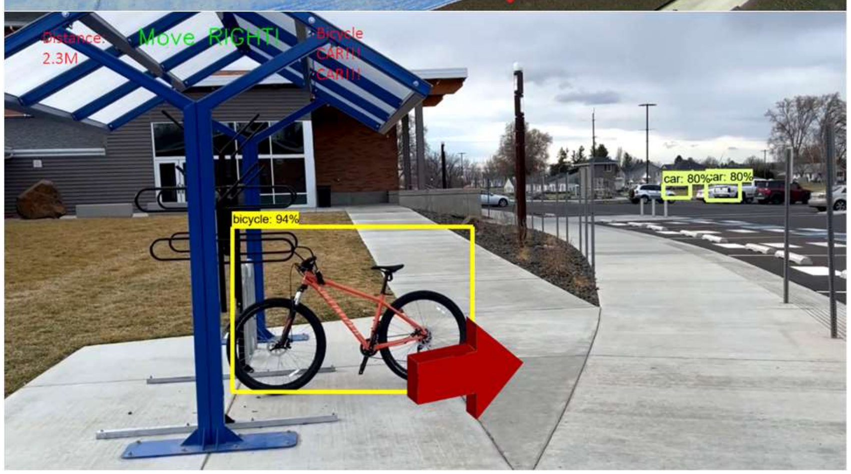
Lis, Krzysztof & Honari, Sina & Fua, Pascal & Salzmann, Mathieu. (2020). Detecting Road Obstacles by Erasing Them.

Methodology





Methodology (cont.)



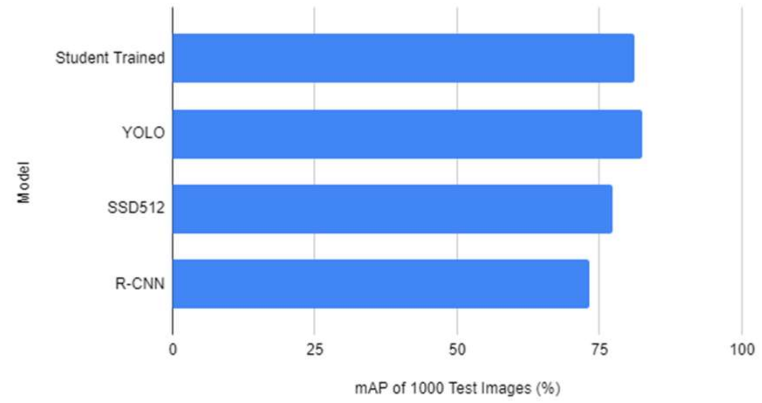
All information is read to the user, these are visualizations of the models for demonstrative purposes

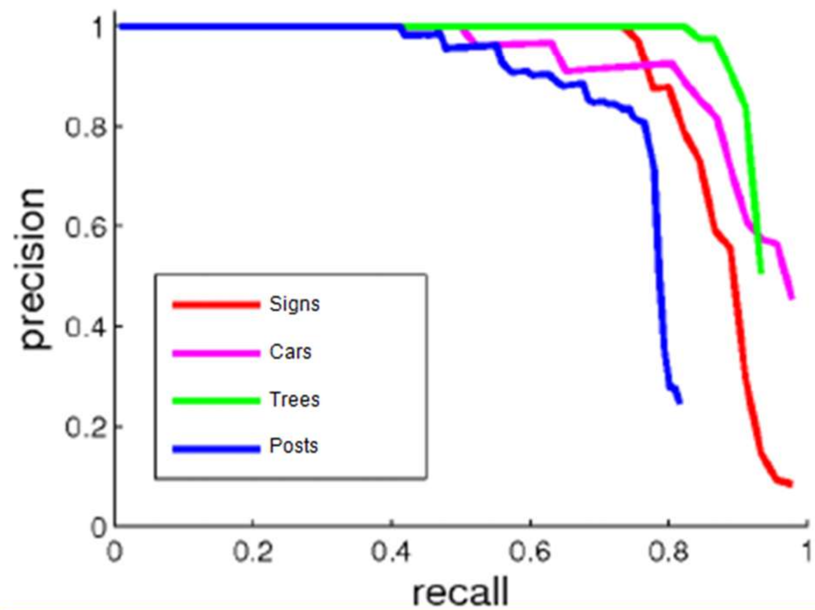
Results

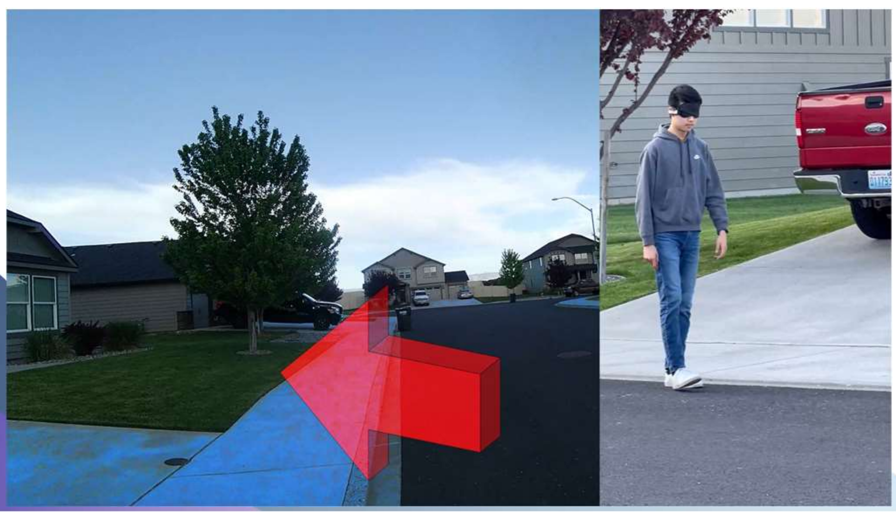
Features and Costs:

- Real-time obstacle and threat detection with directions to avoid the obstacle based on categorized threat levels
- Highly accurate text and depth recognition
- Complete voice assistant to activate text recognition and change settings
- 2-ounce camera for increased comfort
- Total cost of less than $200 per system
- Completely compatible with white canes

Fig 1: mAP of 1000 Test Images vs. Model







Conclusion

- The engineering goal was achieved and produced exceptional results
- The system costs 5-10% of the cost of current technology
- The wearable camera weighs only 2 ounces, which is significantly more comfortable to wear than the current technology at 7-9 ounces.
- Accuracy of all machine learning models was over 90% for all tests
- System can give detailed information about a user's surroundings, nearby threats, and evasion of obstacles, along with text-recognition

Future Applications and Research

- Affordable, accessible, and comfortable assistance system
- Can easily be mass manufactured and distributed in South Asia and Africa
- Potential to impact the lives of over 32 million blind individuals and over 200 million visually impaired individuals in South Asia and Africa
- Add more features such as navigation, currency counting, and touch-enabled commands