Project Brief

Project Title: Pedestrian Assistant: Computer Vision to Help the Visually Impaired

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Phrase 1:

Visually impaired pedestrians are at a high risk for getting into accidents because they lack the ability to see cars or other obstructions in front of them.

Phrase 2:

The overall aim of this project is to create a vision system for visually impaired people that would recognize pedestrian traffic lights and tell them when it is safe to cross.

Background:

[Explain the context of the project and why is it needed (i.e. the problem statement, research question, or need statement).]

Visually impaired pedestrians are at a high risk for getting into accidents because they lack the ability to see cars or other obstructions in front of them. Because of this, there is a need for an effective system that will allow visually-impaired pedestrians to know when it is safe to cross and to detect cars and other obstructions in front of them. Generally, while walking outdoors, visually-impaired people use canes in order to know if they are about to hit something. However, this can be dangerous to other pedestrians in the area who may trip over the cane and fall down. A computer vision system would be a more effective solution to this problem, because it would alert the person of any obstructions or people in the area without potentially causing injury to others in the area.

Blind and visually-impaired pedestrians frequently get into accidents. In a survey conducted on visually impaired pedestrians by the American Council of the Blind, 8% of respondents reported that they had been hit by a car at an intersection, and 28% of respondents reported that their canes had been run over (Accessible Pedestrian Signals). A study showed that blind pedestrians found crossing the street at intersections to be much more difficult than those with full vision (Federal Highway Administration, 2019).

Another problem commonly faced by visually impaired pedestrians is knowing when it is safe to cross the street. Currently, in order for a pedestrian traffic light system to be accessible to pedestrians, it needs to have an audible signal that plays when the light is green. (Pedestrian Signal Timing). However, this comes with many problems. One potential problem is that pedestrians may hear the sound of a bird chirping and think that it is safe to cross. Another problem is that sometimes pedestrians hear the sound from a different intersection and think that it is safe to cross. Based on research done since 1988, the audible signals caused pedestrians to make incorrect signals about which street had the green light. Many pedestrians had difficulty in remembering which sound corresponded with each direction. They also often didn't know which direction they were traveling. They would also often mistake the chirping of birds for the pedestrian light sound, which caused them to cross at incorrect times. (Barlow). The audible traffic lights are also very inconsistent between different lights, because different areas may play different sounds during green lights. For example, some areas play a ticking sound that plays many times per

second, some places use cuckoo sounds, and some places play a peep-peep sound (Kistler 2015). Further, not all pedestrian lights play these sounds. Audible signals are not required by law at pedestrian intersections. Cities generally add audible signals to intersections when people request them (Barlow 2005).

Project Definition:

[Provide a succinct summary of the main aim of the project, objectives, and intended outcomes. A statement of purpose] The overall aim of this project….

The overall aim of this project is to use convolutional neural networks to create a vision system for visually impaired pedestrians that would recognize pedestrian traffic lights and avoid obstructions. It would utilize a camera, either on the user's cell phone or on a Raspberry Pi computer, to detect pedestrian traffic lights and alert the user of red and green lights, allowing the user to know when it is safe to cross the street. The Raspberry Pi will have a convolutional neural network, which will run and process data from a camera located on the computer. The neural network will be trained on a laptop with labeled images of pedestrian traffic lights. It will use TensorFlow object recognition to do live detection and recognition while the person is walking. The neural network will also be trained in the same way to detect pedestrians, poles, and other potential obstructions on the road. The neural network will also be transferred to an android application using TensorFlow Lite, which will allow the device to run directly on the user's cellphone, rather than require a separate device.

Experimental Design/Research Plan Goals/Timeline:

Major Parts of the Project (rough outline) will continue to evolve over time and should be updated frequently. Make sure the goals are SMART oriented.

- Learn how to use tensorflow to train a convolutional neural network by October 25th
- Find (or create if there is nothing available) a dataset containing images of pedestrian traffic lights by November 3rd
- Learn how to use tensorflow to do live object recognition with a convolutional neural network by November 10th
- Find or create a dataset containing obstructions, humans, and street signs by November 20th
- Train the neural network to detect and classify pedestrian traffic lights by November 30th.
- Tune hyperparameters on the traffic light neural network for optimal accuracy by December 10th.
- Train the neural network to detect obstructions, humans, and street signs by December 20th.
- Tune hyperparameters on the obstruction neural network by December 31st.
- Create an app (Android, IOS if time) that will run the CNN as well as a Raspberry Pi Zero W by January 15th.

Procedure:

The first step in this project is to learn how to train a convolutional neural network (CNN). This will be accomplished by using the official tutorials on Tensorflow's website on how to train them, Next, images for training will be obtained using a javascript command run in the console on google images, which automatically downloads a Comma-separated Values (CSV) file containing the links to all these images. The FastAI python library can then take this CSV and download the images into a folder. The next step is to learn how to train a neural network for live object detection in tensorflow, which will also be accomplished using online tutorials. Then, the neural network will be trained on the downloaded data (images) and trained for live object detection. Once this has been accomplished, the model will be converted into a Tensorflow Lite model for use in an Android application. The application will allow the user to run the neural network from their cell phones. After this has been finished, the neural network will

be transferred to a Raspberry Pi computer, which would allow users without Android cell phones to be able to use it.

Data/Conclusions:

The intended outcome of this project is to create a set of neural networks that assists visually impaired pedestrians in navigating outdoors. The first neural network should detect pedestrian traffic lights and alert the user of red and green lights. The second neural network should be trained to detect other pedestrians in order to prevent collisions. The third neural network should detect other common objects on streets, such as poles, street signs, and buildings. The neural networks should have a validation/test accuracy of at least 80%. Hyperparameters such as the number of layers, initialization of the layers, and size of each layer will be adjusted in order to maximize the accuracy of the neural networks, and more data will be used if these methods are not sufficient. One potential hazard with this project is that the neural network might lead a pedestrian into thinking that a light is green when it is red, which could lead to an accident. This could be prevented by only allowing it to say that a light is green when the confidence is greater than a certain amount, such as 80%, rather than 50%. This way, the neural network will only tell the user that it is safe to cross when it is certain that the light is green, which will usually occur if the user is close enough to the light and the camera has a clear view of the traffic light.

Timeline: (with action steps identified- sub-deadlines will continue to evolve):

Rough timeline of major phases. As these phases get established, specific tasks under these phases will be defined further.

Learn how to train a CNN in tensorflow with data - 11/4
Find/create a dataset of pedestrian traffic signals - 11/9
Train the CNN on the dataset (with optimal epoch count, batch size, and # of layers) - 11/20
Get object recognition running on the raspberry pi camera - 11/30
Train the neural network to work on humans and street signs - 12/10
Create the Android app's user interface- 12/30
Create the Android App's functionality - 1/15

Background Knowledge Goals:

Date	**Topic**	**Completed Date**
9/29/19	How to train a convolutional neural network in tensorflow	10/12/19
9/29/19	How to do live object detection (in tensorflow)	
9/29/19	How to create an app using the flutter software development kit (or regular Android Studio if there's not enough time).	

Potential Roadblocks:

- One or both of the neural networks has a very low accuracy
    - Increase or improve the dataset and retrain the model to try to improve the accuracy
    - Further tune hyperparameters to see if it helps to improve the accuracy
    - Add layers to the neural network or remove layers from it.
- Object Recognition does not work properly
    - Research how to make object recognition work properly
    - Ask a professional for help
- Not enough time to create a mobile application
    - Focus on getting it to run on a Raspberry Pi, then use the remaining time to focus on getting the app as developed as possible (prioritizing functionality over UI design).

Want to use to Develop Further?	Why?	Assumptions Making with this idea	How can these assumptions be challenged?
Differentiate controlled fires from out of control	Helps to prevent false alarms caused by normal kitchen flames being detected as fires.	There is a consistent noticable difference between controlled and uncontrolled fires.	There is no consistent or visual difference between the two.
Make it possible to turn off the device easily	Allows user to prevent it from going off when they are expecting a fire for whatever reason/save battery	People have a need to turn off the device for any reason (possibly involved in cooking)	People don't really have any need for this device/there is no easy way to make it turn off (probably not true)
Find patterns in false alarms	Makes it easier to find a way to prevent them.	There will be a pattern in false alarms which can be prevented	The false alarms are pretty random and there isn't a way to look for a pattern and block it.

Decision Matrix

	K-Nearest Neighbors Classifier	Convolutional Neural Network	Color sensor	Use an API to find intersections
Criteria				
Accurate				
Runs quickly				
User-Friendly				
Easy to Create				
Easy to Obtain Data				
Works Offline				

References

Accessible Pedestrian Signals (APS). (n.d.). Retrieved from https://acb.org/content/accessible-pedestrian-signals-aps

Barlow, J. M., Bentzen, B. L., & Bond, T. (2005, October 01). Blind Pedestrians and the Changing Technology and Geometry of Signalized Intersections: Safety, Orientation, and Independence. Retrieved from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC2799902/

Kistler, S. E. (2015, September 17). Why do intersections have different audible crosswalk signals? Retrieved from https://www.dispatch.com/article/20150911/NEWS/309119629

Pedestrian Safety Strategic Plan - Safety: Federal Highway Administration. (n.d.). Retrieved from https://safety.fhwa.dot.gov/ped_bike/pssp/background/app5.cfm

Pedestrian Signal Timing. (n.d.). Retrieved from http://pedbikesafe.org/PEDSAFE/countermeasures_detail.cfm?CM_NUM=47

Research on problems of blind pedestrians. (n.d.). Retrieved from http://www.apsguide.org/appendix_c_research.cfm