
Final Project Write Up

COMP4102A

Automotive Safety Suite

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Abstract

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1 Introduction

The Automotive Safety Suite (ASS) is a collection of safety features which try to solve distracted driving problems using computer vision. The ASS has three main components: Gaze Tracking, Pedestrian Tracking, and Road Sign Tracking. Gaze tracking determines where eyes exist in the driver's camera view and derives gaze in order to determine where it is the driver is looking. Pedestrian Tracking involves trying to identify pedestrians in the application's road view. This component is meant to identify where within the view pedestrians are if they exist. The last component is Road Sign Tracking where using the same road view as Pedestrian Tracking it detects and identifies where within the video frame road signs are if they exist. The main goal is to have a suite of features that work together to avoid distracted driving by notifying the driver whenever their gaze is not within an acceptable range of oncoming road signs or pedestrians.

2 Background

2.1 Gaze Detection and Tracking

Gaze detection and tracking has many positive implications for driver safety, namely to detect if a driver is distracted or drowsy. The US department of transportation found that in years 2011-2015 an overall 2.5% of fatalities were caused by drowsy driving [4], and for distracted driving in 2018 it was found that 8% of fatalities were distraction-affected [5]. Currently there are a wide variety of well-established and novel techniques for gaze tracking as found by a survey by Chenamma and Xiaohui [2].

2.2 Pedestrian Detection and Tracking

Pedestrian detection and tracking is an important aspect in driver safety. Drivers must be aware when one or more pedestrians are moving around their vehicle as to ensure their safety. Stimpson, Wilson, and Muelleman research into pedestrian fatalities shows that from 2005 to 2010 the fatality rate of 116.1 per 10 billion vehicle miles driven had increased to 168.6 in 2010 [7]. OpenCV includes an implementation of the Histograms of Oriented Gradients (HOG) which can identify a person within an image or video. This creates a basis for identifying pedestrians. The implementation details in terms of human detection are found in this paper[3]

2.3 Road Sign Tracking

Road signs are vital to road safety. Stop sign violations accounted for approximately 70% of all crashes.[6] In addition, in some areas, speed limits are lowered in unexpected areas pose great risk for a driver, even when they're striving to follow the speed limit. While much research into this area is focused on using machine learning, some computer vision exclusive implementation have been studied.[1]

3 Approach

4 Results

4.1 Gaze Tracking

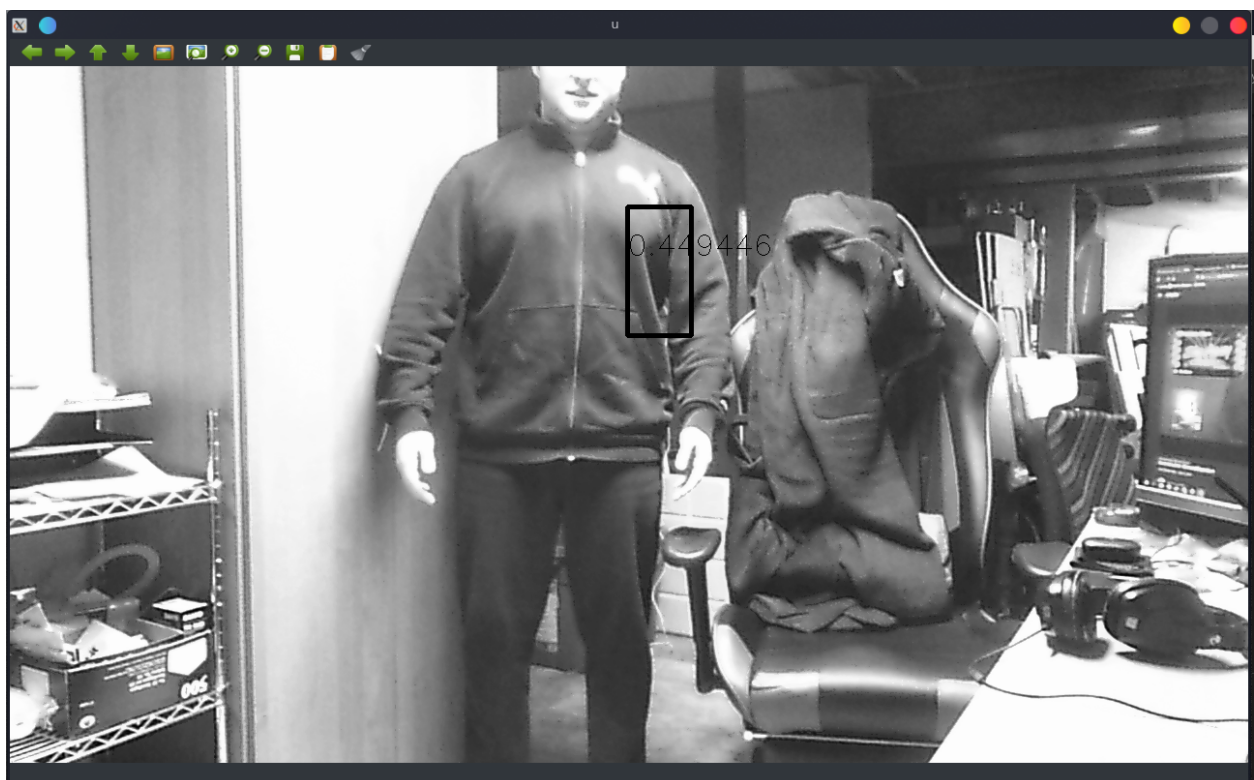
For our gaze tracking component, we investigated a few different approaches to gaze tracking as documented in the survey of gaze tracking performed by

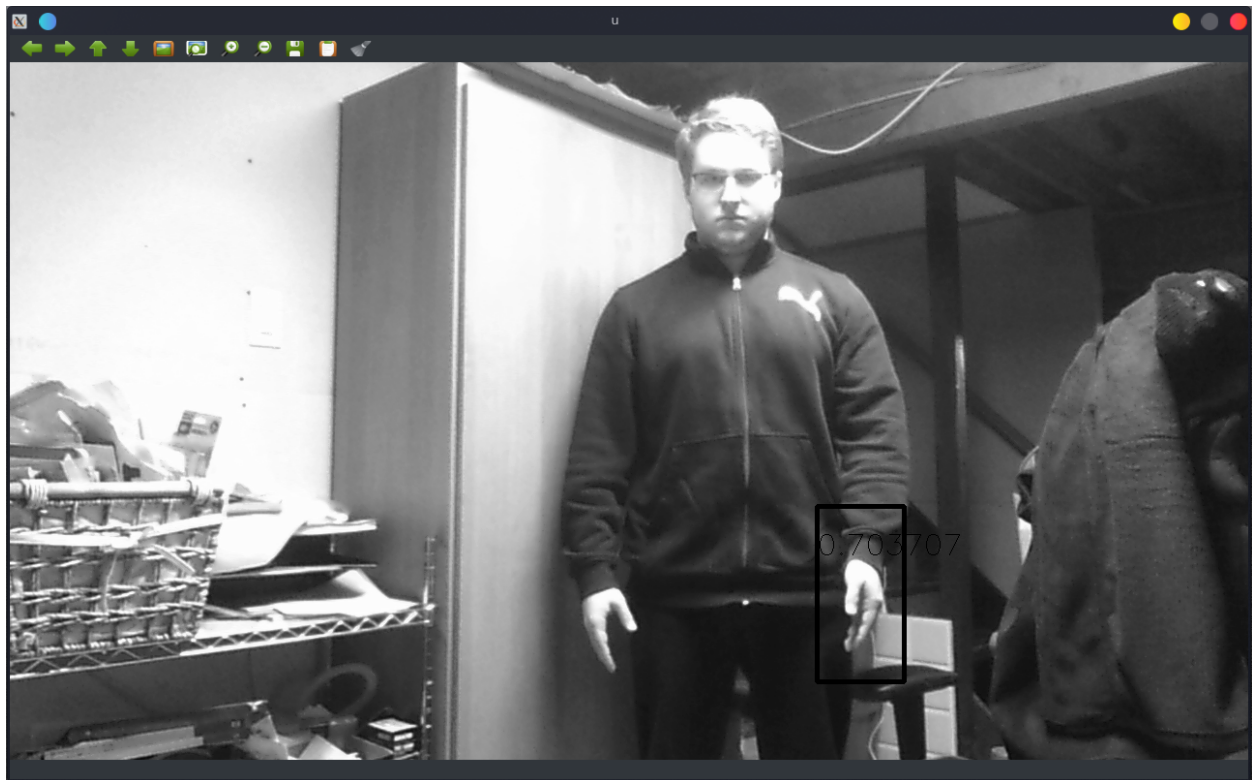


Figure 1: Gaze tracking, straight. In the top left-
Figure 2: Gaze tracking, right. In this example
hand corner of the window is the current eye
the left bounding box mistook the dark region
tracking state of hair as a pupil

4.2 Pedestrian Tracking

The original testing results when testing with a laptop camera were a little lackluster. For the most part, the use of the HOG descriptor using this webcam resulted in inaccurate readings of human objects within the frame. Mostly it would detect human-like objects in the negative space between objects. An example of this would be when someone was standing reasonably far away from the camera and the HOG descriptor would identify human-shaped objects in the armpits of the subject standing in front of the camera or in the surrounding spaces. Another example is when the subject was standing in front of the camera with their hand turned sideways. This issue arose because the quality of the camera used produced a significant amount of noise in each frame resulting in changes in gradients.





Later, testing started to use video files to be more in line with how we wanted to achieve this project. The video used was of a motorcyclist who had a camera attached to their helmet and was riding around while driving by careless pedestrians. When viewing the results of the video file, the accuracy of the HOG descriptor was much more in line with what we had hoped. Most if not all of the pedestrians were identified when within an acceptable range. Whenever the pedestrian tracking component produced a false negative, the cases that generated such errors were those where either a pedestrian was too far from or too close to the camera, and whenever the pedestrian was partially occluded. Both of these conditions are not out of the ordinary since being too close to the camera results in some occlusion since the pedestrian will be partially in frame. When too far away, the gradients in the HOG descriptor become harder to determine if they are human-shaped objects which is normal in nature. Partial occlusion of a pedestrian in the frame is also normal as parts of the gradient data is lost due to occlusion.

4.3 Road Sign Tracking

5 List of Work

6 GitHub Page

References

- [1] Tarik "Ayaou, Mourad Boussaid, Karim Afdel, and Abdellah Amghar". Improving road signs detection performance by combining the features of hough transform and texture. *arXiv preprint arXiv:2010.06453*, 2020.
- [2] HR Chennamma and Xiaohui Yuan. A survey on eye-gaze tracking techniques. *arXiv preprint arXiv:1312.6410*, 2013.
- [3] N. Dalal and B. Triggs. Histograms of oriented gradients for human detection. 1:886–893 vol. 1, 2005.
- [4] US Department of Transportation. Crash stats: Drowsy driving. *Traffic Safety Facts*, DOT HS 812 446, 2015.
- [5] US Department of Transportation. Research note: Distracted driving. *Traffic Safety Facts*, DOT HS 812 926, 2018.
- [6] Richard A. Retting, Helen B. Weinstein, and Mark G. Solomon. Analysis of motor-vehicle crashes at stop signs in four us cities. *Journal of Safety Research*, 34(5), 2003.
- [7] Jim P. Stimpson, Fernando A. Wilson, and Robert L. Muelleman. Fatalities of pedestrians, bicycle riders, and motorists due to distracted driving motor vehicle crashes in the u.s., 2005–2010. *Public Health Reports*, 128(6):436–442, 2013. PMID: 24179255.