

CS455 Final Project

Julia Abdel-Monem

March 31, 2025

Abstract

1 Introduction

Background

Tailgating

According to the NHTSA in 2022, speeding accounted for 29% of accident related fatalities, and 7.8% of all fatalities involved at least one distracted driver [5]. While there are strategies to avoid crashes with an inattentive or aggressive driver, three studies released by the highway loss data institute (Subaru EyeSight, Kia Drive Wise, and Honda FCW/LDW) demonstrate that crash avoidance features may reduce the number of collision claims made, with young drivers experiencing the most benefit [1, 3, 2]. While the elderly population must still be considered, this trend in age may be explained by overall trends [5]. Newer cars are more expensive, so the goal of this project is to develop an app to help lower the financial barrier of entry from a modern car to a relatively recently made smartphone.

Semantic Segmentation

Semantic segmentation was chosen since it provides an accurate width, without being overly complex to use. An object detection model such as YOLO would be useful in finding which cars are in front of the camera, but an accurate width requires an accurate edge to read

against. instance detection may be useful for this, but it may have more overhead compared to semantic segmentation, where individual cars can be isolated by the width of the lane.

Neural Network: Design and Training

The SegFormer

The SegFormer is a neural network designed to use vision transformers in semantic segmentation, using multiple transformers using an efficient self attention algorithm and a simple MLP decoder [6]. It builds upon the original patch transformer encoder as described in "An Image is Worth 16x16 Words" [4]. This hierarchical transformer encoder extracts both coarse and fine features. The original SegFormer paper provides five different levels of pre-configured hyperparameters, each one taking more computational power but resulting in a higher IoU.

Intersection over Union

Dice Loss

hyperparameters

2 Methods

Neural Network

Implementation Details

Training

Dataset

3 Results

3.1 Binary CrossEntropy, Binary IoU, B0

Dice Loss, Binary IoU, no axis set, B0

Dice Loss, Binary IoU, Downscaled images, B5

4 Conclusion

References

- [1] Impact of Subaru collision avoidance features on insurance losses by rated driver age. *Highway Data Loss Institute*, Vol. 36, No 25, 2019.
- [2] Impact of Honda Accord collision avoidance features on claim frequency by rated driver age. *Highway Data Loss Institute*, Vol. 38, No. 13, 2021.
- [3] Impact of Kia Drive Wise collision avoidance features on insurance losses by rated driver age. *Highway Data Loss Institute*, Vol. 38, No. 14, 2021.

- [4] Alexey Dosovitskiy, Lucas Beyer, Alexander Kolesnikov, Dirk Weissenborn, Xiaohua Zhai, Thomas Unterthiner, Mostafa Dehghani, Matthias Minderer, Georg Heigold, Sylvain Gelly, Jakob Uszkoreit, and Neil Houlsby. An image is worth 16x16 words: Transformers for image recognition at scale. *CoRR*, abs/2010.11929, 2020.
- [5] National Center for Statistics and Analysis. Overview of motor vehicle traffic crashes in 2022. *Traffic Safety Facts Research Note. Report No. DOT HS 813 560*, 2024.
- [6] Enze Xie, Wenhai Wang, Zhiding Yu, Anima Anandkumar, José M. Álvarez, and Ping Luo. Segformer: Simple and efficient design for semantic segmentation with transformers. *CoRR*, abs/2105.15203, 2021.