بسم الله الرحمن الرحيم

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AIN SHAMS UNIVERSITY

FACULTY OF ENGINEERING

Computer and Systems Engineering

3D Object Detection for Autonomous Driving using Deep Learning

A Thesis submitted in partial fulfilment of the requirements of the degree of

Master of Science in Electrical Engineering

(Computer and Systems Engineering)

by

Mohamed Khaled Gamil Ismail Hussein

Bachelor of Science in Electrical Engineering

(Computer and Systems Engineering)

Faculty of Engineering, Ain Shams University, 2017

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Date: 8 May 2022

Statement

This thesis is submitted as a partial fulfilment of Master of Science in Electrical Engineering, Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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Abstract

3D Object detection is one of the most important perception tasks needed by autonomous vehicles to detect different road agents like other vehicles, cyclists, and pedestrians which is required for driving tasks like collision avoidance and path planning. State of the art 3D Object detection deep learning models take as input point clouds from very expensive LIDAR sensors because it provides accurate depth information. Another alternative is using cameras which are far cheaper but lack accurate depth information which causes a huge gap in average precision from LIDAR models vs camera models. In this thesis, our work is focused on 3D Object Detection for car class from stereo images without LIDAR supervision neither during training nor during inference and the challenging task of running 3D Object Detection on an embedded target Nvidia Jetson TX2 by modifying Stereo R-CNN model and reducing the model size to approximately one third the size of the original model to be more suitable for embedded targets. Experiments on KITTI dataset showed that our model's inference time is 1.8 seconds and its' average precision for moderate car class is 17% on the test set. Our model decreases training and inference time by approximately 60% with a 13% drop on the test set which is an expected trade-off when decreasing the number of parameters inside the model.

Keywords: 3D Object Detection, Stereo Vision, Autonomous Driving, Embedded Systems

Thesis Summary

In this thesis, we explore 3D object detection using deep learning using stereo images as the only input during both training and inference. Our main contribution is also running 3D object detection on an embedded target Nvidia Jetson TX2 to test the performance of existing model Stereo R-CNN on it and proposing a new model Mobile Stereo R-CNN which is more suited to embedded targets that has faster inference time and less memory footprint with the expected sacrifice in accuracy due to decreasing the model size.

The thesis is divided into 5 chapters, along with a list of figures, a list of tables, a list of abbreviations, and a bibliography.

- In Chapter 1, we introduce the topic of 3D Object Detection and its' importance in the context of Autonomous Driving
- In Chapter 2, we review deep learning and object detection theoretical concepts and we do a literature review for different methods and models used for 3D Object Detection using deep learning
- In Chapter 3, we describe the new proposed model and the modifications made to our base model to make the new model suitable for running on an embedded system device
- In Chapter 4, we describe the experiments made and their results and compare our proposed model with our base model
- In Chapter 5, we give a summary of the work done in this thesis and proposals for future work

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