Computer Networks 186 (2021) 107783

Contents lists available at ScienceDirect

Computer Networks

journal homepage: www.elsevier.com/locate/comnet

An AI-driven object segmentation and speed control scheme for autonomous moving platforms

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ARTICLE INFO

Keywords:
AMP
CNN
Image segmentation
Speed Range Analyser
K-Means
5G

ABSTRACT

In recent times, Autonomous Moving Platforms (AMP) have been a vital component for various industrial sectors across the globe as they include a diverse set of aerial, marine, and land-based vehicles. The emergence and the rise of AMP necessitate a precise object-level understanding of the environment, which directly impacts the functioning like decision making, speed control, and direction of the autonomous driving vehicles. Obstacle detection and object classification are the key issues in the AMP. The autonomous vehicle is designed to move in the city roads and it should be bolstered with high-quality object detection/segmentation mechanisms since inaccurate movements and speed limits can prove to be fatal. Motivated from the aforementioned discussion, in this paper, we present *ϑinspect* (velocity-inspect), an AI-based 5G enabled object segmentation and speed limit identification scheme for self-driving cars on the city roads. In *ϑinspect*, the Convolutional Neural Network (CNN) based semantic image segmentation is carried out to segment the objects as interpreted from the Cityscapes dataset. Then, object clustering is done using the K-Means approach based on the number of unique objects. The semantic segmentation is done over 12 classes and the model outshines concerning state-of-the-art approaches for various parameters like latency, high accuracy of 82.2%, and others. Further, K-Means clustering based Speed Range Analyser (SRA) is proposed to determine the acceptable and safe speed range for the vehicle, which is computed based on the object density of every object in the environment. The results show that the proposed scheme outperforms compared to traditional schemes in terms of latency and accuracy.

1. Introduction

In Industry 4.0, the automobile industries have been adopting automation in the manufacturing of vehicles and to incorporate the human senses such as perception and reflex action in the vehicles becomes a necessity. While partial and conditional capabilities in vehicles where human intervention may be required are expected to be achieved by 2020, full automation is still under development, wherein the AMP need to make a quick decision about the speed at which it should operate, the direction it should steer in, and when to put on the brakes to avoid collision. The primary task in AMP is object detection [1], segmentation [2], and identification [3], which can be achieved by using robust Artificial Intelligence (AI) and computer vision techniques to make the operation of autonomous vehicles flawless [4,5].

The urban streets consist of several objects such as trees, buildings, poles, bicycles, and cars, to name a few. The vehicle should be able to differentiate between each of these to obtain a clear traffic scene understanding. Also, it should be able to discriminate between roads and walkways to estimate the drivable region. Both roads and walkways have similar structures that can confuse the vehicle and lead to accidents [6]. To overcome such challenges, segmentation of the road scene is required, which can enable the AMP to define pixel-wise mask and clear boundaries of the objects [7]. This would give a more granular view of the surroundings to the vehicle.

AI and ML techniques provide feasible and efficient ways to segment the images and classify the segmented objects [8]. Automobile companies across the globe have been investing in AI and computer vision methods for developing fully self-driving cars. The global market value of self-driving cars was at 24.1 billion USD in 2019 and is forecasted to reach about 60 billion USD by 2030 in case AI mechanisms specified before can be integrated efficiently and securely in the vehicles [9]. Fig. 1 shows the expenses undertaken by various companies in 2019 towards the development of fully self-driving cars [10].

Automating the speed of self-driving vehicles can be a challenging task, especially when it comes to those AMP, which are operated on the city roads. The density of every street on which the AMP is expected to travel is variable. The roads found on the outskirts of the cities will usually have a lesser population and thus a lesser number of moving

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https://doi.org/10.1016/j.comnet.2020.107783
Received 15 October 2020; Received in revised form 26 November 2020; Accepted 24 December 2020
Available online 30 December 2020