Chapter 10
Issues, Challenges, and Progress of Autonomous Robotic Platoons

Alex Gunagwera
Istanbul Sabahattin Zaim University, Turkey

Aydin Tarik Zengin
https://orcid.org/0000-0002-0860-4509
Istanbul Technical University, Turkey

ABSTRACT

The number of vehicles on the roads worldwide grows annually. With the increase in the population of on-road vehicles comes the increase in traffic-related problems such as emissions, traffic accidents, traffic jams, and increased fuel consumption, to mention but a few. The field of robotics presents the autonomous robotic platooning concept, which presents a very promising future for the transportation industry in general and intelligent transportation industry, in particular. With autonomous platooning, efficient road usage, reduced fuel consumption and emission are possible. This promising field, however, faces issues and challenges barring the deployment of autonomous platoons. In this chapter, the authors introduce the user to the concept of autonomous platooning, present the current state-of-the-art of autonomous robotic platoons and issues that they still face, and ultimately, discuss their progress and future trends.

INTRODUCTION

Owing to urbanization, the tremendous improvement in the automobile industry, and related fields such as communication, the number of vehicles on the roads is growing at a very rapid rate nowadays. More than 50 million cars have been being produced annually since 2010 with a total of approximately 1 billion cars running the streets of the world today, (Worldometer, 2019). With the increase in vehicles throughout the world comes a significant number of challenges and problems. These range from traffic

DOI: 10.4018/978-1-6684-5381-0.ch010

congestion, air pollution, increased fuel consumption, traffic accidents to efficient road usage regardless of the nature of the environment in which we use the vehicles.

The field of autonomous robotic platoons, in general, presents promising solutions to the problems culminating from the increase in the number of vehicles in the world today. The concept of autonomous robotic platoons further presents enhancements to the transportation industry. Autonomous robots may interchangeably be referred to as autonomous vehicles in this literature for more specific scenarios or applications. Autonomous Vehicular Platoon Systems (AVPS), (Su & Ahn, 2016), have attracted the attention of not only researchers or automotive industries but also the attention of governments worldwide. A group of two or more Autonomous Vehicles (AVs) traveling safely at small inter-vehicular gaps, and at high speed together as one entity is referred to as an AVPS. Details on AVPS are provided in subsequent sections. AVPS are the most promising innovation likely to pragmatically either solve or substantially alleviate most of the problems facing the transport industry today, (Chang et al., 1993; Tsugawa et al., 2001). Off-the-shelf solutions like constructing wider roads and flyovers to mitigate traffic congestion are costly, and require extra manual, mechanical and technical labor. In this chapter, the history, vivid definition, progress, and future works concerning AVPS are presented.

The topic of autonomous robots, in general, has gained a lot of attention nowadays from academia, the military, national governmental bodies, to mention but a few. Autonomous vehicles include autonomous land, underwater or aerial vehicles with vast applications ranging from but not limited to robotic academic laboratories, military, industrial, health facilities, and intelligent transport system-oriented applications. Given its cross-disciplinary nature and the significant potential the field of autonomous vehicles possesses, researchers have carried out many studies in the autonomous vehicles field, in general and autonomous vehicle platoons, in particular. Autonomous vehicle platoons, a subset of autonomous vehicles, are not only a promising solution to many of the problems facing the transport department globally but also a great development in general. Extensive research suggesting improvements to these developments, solutions to the problems, novel application ideas, and so much more have been and are being made at a fast rate. However, there is less literature review to summarize the up-to-date state of the art comprehensively. It is with this motivation that this literature review is presented.

Despite the main focus of this study being projected towards autonomous land vehicle platoons, the concepts discussed in this literature have got a cross-disciplinary reach. Thus, the researchers, students, and practicing engineers in related academia and industrial fields such as computer science in general, electrical, and automobile engineering interested in intelligent transport systems, control theory, robotic swarms and autonomous vehicle platoons, in particular, will find them helpful.

Previous related surveys include (Tong, Hussain, Bo, & Maharjan, 2019), whose literature mainly focuses on studies that utilize artificial intelligence to solve problems facing the vehicle to everything bases systems. (Kuutti et al., 2018) review and evaluate the localization techniques used in autonomous vehicles and their applications, whereas (Marina Martinez et al., 2018) go through the driving style recognition studies for intelligent vehicle control. (Sawade & Radusch, 2015) review automated driver assistance systems and further tries to categorize them. (Jia et al., 2015) surveys platoon vehicle cyber-physical systems and their related works. (Kavathekar & Chen, 2011) review literature on vehicle platoons published in the range of 1994 to 2010 inclusive.

The rest of this chapter is organized as follows: The Autonomous Vehicles section covers autonomous vehicles; brief history and levels of vehicle automation. In the Platoon Driving section, the concept of platoon driving is discussed. Communication is tackled in the communication section followed by a discussion on energy consumption in the Energy section. Then the benefits, issues and challenges faced