Assessing the emission impacts of autonomous vehicles in metropolitan freeways

Ricardo F.Tomás, Paulo Fernandes, Eloísa Macedo, Jorge M. Bandeira, Margarida C. Coelho
Department of Mechanical Engineering / Centre for Mechanical Technology and Automation (TEMA)
University of Aveiro, Portugal
ricardotomas@ua.pt; paulo.fernandes@ua.pt; macedo@ua.pt; jorgebandeira@ua.pt; margarida.coelho@ua.pt

***Abstract*— Road transport was in 2016 responsible for 74% of the 33% energy consumed by the transport sector [1]. Passenger cars accounted for 41% of the transport greenhouse gases (GHG) in the European Union countries, in 2016 [2].**

Intelligent Transport Systems (ITS) have been supporting the autonomous vehicles (AVs) technology, that offer numerous benefits such as to allow for more productive use of time spent in vehicles, reduce energy use and land use [3].

AVs have shown promising results at both social and economic levels but there is no consensus about their environmental benefits in a context of traffic context. Thus, this research assessed the environmental and traffic performance impacts of the AVs in an urban freeway corridor in a metropolitan area. The proposed methodology resorted to VISSIM tool to code and assess traffic operations [5]. Vehicular emissions were estimated using the Vehicle Specific Power (VSP) and EMEP/EEA methodologies [6;7].

The case study is based in the city of Porto (Portugal), which according to data from 2016 from TomTom, was the second city in the National ranking where drivers spent more time in traffic (~31 minutes) [8]. The candidate freeway is a stretch (~9km in length) of the Via de Cintura Interna (VCI), 8 interchanges, 3-4 lanes by travelling direction, 80 km/h speed limit and an average daily traffic ranged from 113 680 to 149 520 [9].

Three different AV penetration rates based on long-term market prediction (10%,20% and 30%) for through traffic along VCI were implemented [10]. These scenarios were compared in terms of emissions (carbon dioxide, carbon monoxide, nitrogen oxides and hydrocarbons) and traffic performance (travel time and stop-and-go situations) against current situation – conventional vehicles (CVs) only. Emissions and traffic performance scenarios were assessed on three levels: 1) overall study domain; 2) corridor; and 3) impact of AVs on CVs.

Results confirmed that impacts of AVs were not statistically significant for penetration rates below 30% in the overall study domain (reductions up to 2% for pollutants emissions and average travel time). Corridor-level analysis showed that a decrease of 5% on emissions can be expected with AVs technology, but travel time is penalized up to 13% for both AVs and CVs, comparing to the actual situation. Furthermore, results showed that the increase of AV rates may result in higher travel times for CV, although stop-and-go situations decreased.

In summary, this research sought to contribute for better understanding of future AV penetration rates scenarios for both traffic performance and carbon dioxide, carbon monoxide, nitrogen oxides and hydrocarbon emissions on congested freeways. Also, it provides solid knowledge of the differences in traffic-related impacts between AV and CV, and of the incorporation of eco-routing algorithms to govern AV operations.

Keywords—Autonomous Vehicles; Mixed Traffic; Freeway Corridors; Emissions.

TOPIC

"2) Technologies for the Wellbeing – b. Innovative technologies for Smart Cities".

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