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Towards Smart Traffic Planning by Traffic Simulation on Microscopic Level

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ABSTRACT

In this paper the consequences of road closures considering the introduction of a smart city solution, namely traffic simulation on micro level, are analyzed. The use-case comes from the city of Maribor in Slovenia with about 100 thousand inhabitants. To perform the analyses, the open source road traffic simulation package SUMO (simulation of urban mobility) has been employed to analyze the effects of the introduction of traffic regulations in real environment. Using it by experts in a plan-do-check-act loop, multiple scenarios with lesser impact of traffic regulations, as opposed to ad-hoc scenarios usually employed (e.g., for road works, events, etc.), can be considered and the best one chosen, leading to a smart city solution.

KEYWORDS

Microscopic Simulation, Road Traffic, Smart City, SUMO

INTRODUCTION

By 2050, 67% of the world population is expected to live in cities and other urbanized areas. In more developed regions, the expected share is even higher, up to 86% (Mattias & Josefin, 2014). Rapid urban growth is causing the increase in traffic congestion that affects many aspects of our lives. Travel delays and road accidents due to traffic congestions, stress levels of drivers, increasing air pollution and greenhouse gas emissions, as well as huge transportation cost determined economic losses every year are some of the most significant negative consequences of traffic increase (Eluru, 2010; Sekhar, 2014). The transportation sector plays an important role in air pollution and noise emissions and is the main contributor to anthropogenic pollutant emissions (Baldasano, Gonçalves, Soret & Jiménez-Guerrero, 2010). Up to 88% of total emissions are caused by road transport (Stanley, Hensher & Loader, 2011). As a result, the traditional transport systems will no longer be able to ensure road safety, meet emission limits, and prevent its growing negative impact on the environment (Wang, Hussain, Bhutta & Cao, 2019).

The right answer to the problems associated with the growing population in cities could be the concept of a smart city (Hu, Feng, Sun, Gao & Tan, 2019). The concept is closely related to traffic, as one of the objectives of implementing a smart city is to improve the traffic situation in cities. Therefore, smart transportation or, more precisely, an intelligent transport system is one of the

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main components of any smart city - including smart grid, intelligent infrastructure, smart energy, smart healthcare, intelligent technology and smart governance (Mohanty, Choppali & Kougianos, 2016; Xiong, Sheng, Rong & Cooper, 2012; Zanella, Bui, Castellani, Vangelista & Zorzi, 2014). The advantages of intelligent transportation can improve traffic situation in various ways (Yin, Lam & Ieda, 2004) and are not limited to the cheapest, shortest or fastest route, but can also reduce greenhouse gas emissions by reducing congestions (Manville, Cochrane & Cave, 2014; Mohanty et al., 2016). While some authors use the term smart mobility instead of smart transportation (Geotab, 2018; Lennert & Volkery, 2017), according to (Yigitcanlar & Kamruzzaman, 2018) a smart city is considered: "efficient, technologically advanced, green and socially inclusive city". Sustainability and ICT support are the most common additional attributes usually associated with smart cities (Mattias & Josefin, 2014). In contrast to traditional cities, smart cities are safer, faster, friendlier and above all – greener (Mohanty et al., 2016; Xiong et al., 2012; Zanella et al. 2014). Due to all technology associated with the emerging smart cities, more and more data is being collected. This data provides a knowledge base for the analysis of urban ecosystems (Nagy & Simon, 2018).

In order to change the traditional transport system and establish intelligent transport in a city, there are small steps that can help. To reduce traffic, it is very important to have a clear picture of the actual transport flows (Bieker, Krajzewicz & Leich, 2016). For the proper functioning of such systems, the data selected and processed accordingly are very important. Information on all elements of the transport system at micro-level is needed, including information about all transport participants (Xiong et al., 2012). It is also important to know what changes can be made in traffic regulations to reduce traffic (Bieker et al., 2016), as some positive changes on one side of the city could have negative effects on the other side. Moreover, any change in the traffic situation could cause disapproval and confusion and even lead to road accidents with fatal consequences. Before a change is implemented in the real world, it is important to analyze all consequences of the change with the help of a suitable computer model (Kotusevski & Hawick, 2009).

According to Geotab (2018) smart cities are looking for ways to reduce traffic and its negative consequences. A very simple and cost-effective improvement is to encourage people to use public transport and to walk or cycle to their destination. Another proposed action is to use technology to help avoid traffic congestions. Finally, shared vehicles and the use of public transport may lead to considerable reduction in CO_2 emissions (Lennert & Volkery, 2017).

In the past few years, the smart city concept has developed into one of the fastest growing trends worldwide. Researchers from different disciplines are engaged in in-depth analysis and research on the implementation of various intelligent services in a real urban environment. As many cities around the world are joining this trend to become a smart city, it is extremely important to examine the changes that this trend is bringing considering the well-being of residents and visitors. By building a consistent and coherent model of a smart city, we can model these changes and predict their impact on real-life, allowing us to make better decisions to meet the requirements for a smart city.

The main objective of this paper is to demonstrate the potential of computer simulation in the process of making controlled changes in urban traffic management and in the process of introducing new traffic-oriented components of a smart city.

METHODOLOGY

A consistent and coherent transportation model is necessary to improve the traffic situation in a city (Krajzewicz, 2010a). A suitable way to building such a model is by computer simulation (Krajzewicz et al., 2005). Traffic simulation can contribute to the analysis and forecasting of traffic and human behavior in traffic (Fernandes & Nunes, 2010).

Network simulation on the traffic overlay network of the central European city of Maribor in northeastern Slovenia represents the basis of this research. In network simulation, individual entities are created and placed at an origin point and then routed through the network to their destination