George Dimitrakopoulos

Current Technologies in Vehicular Communication

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Preface

This book covers all aspects relevant to vehicular communication technologies in one place. It classifies all relevant standards, protocols, and applications, so as to enable the reader to gain a holistic approach towards the extremely intriguing subject of vehicular communications.

The book's purpose is to become the unique place where a reader can turn to study everything that is related to vehicle to vehicle (V2V) as well as vehicle to infrastructure (V2I) technologies, classified appropriately and in a unique manner, so as to facilitate understanding.

Particular interest is placed on state-of-the-art research and development results in the field as well as research areas envisaged to attract immense research effort.

The book's main methods lie in algorithmic processes and simulation results as well as in trying to simplify all relevant technologies through a careful classification.

The book is structured as follows.

Chapter 1 provides the motivation for getting involved in the vehicular communications field, through presenting transport drawbacks and challenges.

Chapter 2 contains an extensive overview of the commonly used (and researched) standards and protocols related to V2V and V2I communications.

Chapter 3 provides a description of the context in which V2V and V2I communications operate, namely smart cities, as well as explains why smart cities are in need of novel sustainable vehicular communications. Indicative case studies give an overview of related applications in the field.

Chapter 4 focuses on Advanced Driver Assistance Systems (ADAS), presenting their main focus areas as well as including a number of case studies for exemplifying the operation of ADAS solutions.

Chapter 5 focuses on the management functionality that is researched, in the context of ADAS, focusing on the related algorithms commonly utilized.

Last, Chapter 6 gives an overview of the earlier as well as the latest trends in the field of automated and autonomous driving, providing also an outlook on the future, with some interesting perspectives for future research.

Athens, Greece George Dimitrakopoulos

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Chapter 1
Introduction: The History of Vehicular Communications

1.1 Goals

- To make the reader familiar at a high level with the concept of transport and the requirements and trends of urban mobility.
- To distinguish between the various transport modes in terms of their requirements and potentials.
- To explain the latest trends in the various transport modes in terms of the utilization of Information and Communication Technologies (ICT).
- To introduce the reader to the book and its logic behind.

1.2 Motivation: Transportation and Its Drawbacks

Economic growth has been strongly associated with urbanization, overwhelming cities with vehicles since transportation generally and infrastructure in particular are large segments of the economy. By 2030, it is expected that around 60 % of the global population will live in urban areas[1] charting the growing contribution of cities both to the world economy and to carbon emissions. Cities are also key drivers of global energy demand and greenhouse gas emissions, accounting for around 70 % of both, according to the International Energy Agency (IEA).

This incurs a series of negative outcomes, such as:

1. Environmental/natural resource degradation (smog, polluted waterways, increased energy consumption, and CO_2 emissions).

[1] Bertaud, A. and Richardson, A.W (2004), Transit and density: Atlanta, the United States and Western Europe, Figure 17.2 on p.6, available at http://courses.washington.edu/gmforum/Readings/Bertaud_Transit_US_Europe.pdf

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2. Socioeconomic (enormous losses of time in congestions, accidents, and degradation in life quality/deaths).
3. Technical consequences (safety compromises, accidents).[2]

These facts reveal inefficiencies related to urban transport, as identified by research communities of both public agencies and private industry.[3]

1.3 Overview of Latest Advances in Transportation Research

In response to the aforementioned challenges, this section provides a holistic view upon transportation, describing the latest advances associated with its various means, namely rail, road, air, sea, and multimodal transport.

1.3.1 Transport Mode Rail

The trends in rail vehicle development focus on lightweighting and increased use of advanced polymer composite materials and lightweight alloys. This is because rail vehicles have got heavier over the past 30 years as passengers expect a better travel experience and vehicles incorporate more ancillary equipment to enhance passenger comfort (internet access, power points, air-conditioning, noise and temperature insulation, etc.). Increased safety is also an issue of development work which, apart from the bodyshell crashworthiness integrity, also concerns new designs to mitigate terrorist action (survivability after an on board explosion) and new materials to counter fire spread. In addition, development work is undertaken on safe interiors to minimize passenger injury in case of a collision.

Advanced driver aids are also an area of development which concerns both development of automated systems to override the driver if an impending collision is likely, as well as measures to counter driver fatigue, as well as detect and enhance driver attention span (Fig. 1.1).

Other developments include the implementation of sensor technologies and electronic engine and suspension management systems (e.g., the development of mechatronic boggies, induction brakes, and energy recovery systems). Such systems aid reliability, vehicle control, vehicle efficiency, and safety and will require maintenance procedures and staff knowledge well above the current state.

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[2] Erika Fille Legara, Christopher Monterola, Kee Khoon Lee, Gih Guang Hung, "Critical capacity, travel time delays and travel time distribution of rapid mass transit systems", Physica A: Statistical Mechanics and its Applications, Volume 406, 15 July 2014, pp. 100–106.

[3] V. Corcoba Magaña, Muñoz-Organero, M., "Discovering Regions Where Users Drive Inefficiently on Regular Journeys", IEEE Transactions on Intelligent Transportation Systems, vol.16, iss.1, 2015, pps. 221–234.