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APPLICATION PLATFORM FOR INTELLIGENT MOBILITY – RESEARCH FACILITY FOR INTELLIGENT MOBILITY SERVICES

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ABSTRACT

Traffic can be seen as a multi-dimensional field of research. Traffic can be best described as a socio-technical system which brings about new challenges for the design of future transportation systems. With its Application Platform for Intelligent Mobility (AIM), the German Aerospace Center (DLR), together with the state of Lower Saxony, the city of Braunschweig and other partners, is creating a unique way of linking up research, development and applications for intelligent transportation and mobility services. This new platform addresses the challenges of traffic research as a multi-dimensional field of research. In the near future AIM will enable users from science, research, development and industry to study a wide range of topics from the highly complex, interlinked world of transportation. For this reason the German Aerospace Center is currently implementing AIM as a toolbox for traffic-related research and design activities. AIM has a wholistic approach towards transportation research which seeks to reduce the gap between simulation and reality, broaden the scope of simulation towards the future of co-operative transportation systems as well as to close the loop towards a more efficient approach of traffic management. As an open and flexible platform AIM targets synergies between different research institutions.

INTRODUCTION

Traffic research - a multi-dimensional field of research

Traffic is a complex phenomenon and can be seen as a socio-technical system. From this perspective three major implications can be drawn:

- The social side of traffic: Humans have an intrinsic demand for mobility. Every day humans perform different activities at different locations. Each transition between activities implies mobility. Furthermore we all are influenced by cultural expectations as well as patterns of relationships. With respect to traffic research social sciences seek to identify the factors which bring forward our demand for mobility. By means of intense empirical investigations origins and destinations of trips within a regional area can be identified. This knowledge can be used for prediction of mobility demand which may result in traffic if suitable means of transportation are on hand.
- The technical side of traffic: For more than the last two millennia humans have invented many different technologies to increase their mobility. After the industrial revolution the pace of technical development has increased drastically and has brought forward new technical systems with an ever-increasing (technical) complexity. One example of this increasing complexity is the emergence of mechatronics multidisciplinary field of engineering which different "classical" engineering disciplines such as mechanical engineering, electronic engineering, computer engineering, software engineering as well as control engineering. This increasingly multi-disciplinary approach towards the design of technical systems implies that for unambiguous technical specifications terminological convergence of currently heterogeneous terminologies is urgently required [MSS 2010] [SSS 2010]. A second aspect of the increasing complexity is the emergence of cooperative systems (car-to-infrastructure communication as well as car-to-car communication).
- Humans interact with technical systems: In the design of technical systems their acceptance by the end user has to be taken into consideration. This can be seen a classical task of ergonomics and human factor engineering (HFE). The benefits of automation can only be achieved if they are accepted by the user.

These three aspects of traffic are co-existing and are closely interrelated. The multitude of interdependencies between human and technology are referred to as emergence in systems theory. As different subsystems interact new qualities emerge which could not be observed when looking at isolated subsystems. With respect to the design of advanced driver assistance systems (ADAS) systems theoretic thinking has been successfully applied to the domain of traffic engineering [DS 2010]. In order to understand the full complexity of traffic and mobility a

broad range of tools is required – the Application Platform for Intelligent Mobility addresses this and provides a range of services which can be applied in different research projects. The following section provides an overview of the technical scope of the Application Platform for Intelligent Mobility (AIM) and the underlying paradigms which are taken into consideration for its design.

AIM – A COMPREHENSIVE PORTFOLIO OF RESEARCH FACILITIES

The Application Platform for Intelligent Mobility (AIM) provides a comprehensive portfolio of specialized research facilities. Depending of the particular area of interest several parts of the overall system can be combined to address the respective area of research.

The first underlying paradigm in the design of AIM is the correspondence between simulation and reality. In order to achieve this correspondence simulations are closely coupled with (existing) laboratory equipment as well as the existing traffic management infrastructure in the city of Braunschweig. The simulations cover the full spectrum of urban mobility. Available simulations cover both the microscopic and the macroscopic level [DS 2010] as well as all modes of transportations.

- On the microscopic level test persons can participate in driving studies in a virtual environment resembling the city of Braunschweig. In order to do this specific system properties of motorized individual traffic as well as rail-bound public transportation systems are reflected in dedicated simulation environments (so called virtual reference tracks). These virtual reference tracks have their real-world equivalent in the city of Braunschweig.

- On the macroscopic level AIM integrates a traffic flow with the real traffic management infrastructure in the city of Braunschweig. This integration of real-world data allows for the analysis of urban mobility in a larger scale. By using existing data of the traffic management system approximately one million inhabitants contribute to the available data with their mobility behavior. AIM taps into this data pool and creates a new tool chain for the investigation of new traffic management scenarios. A traffic data platform collects and combines data from different sources (e.g. floating car data, floating object data). This aggregated data is fed into a traffic flow simulation. Simulation parameters can be changed by means of a virtual traffic management center. This tool chain allows to conduct predictions of traffic flow in the near future. Knowledge gathered by means of this tool chain can be used for a wide range of different applications which range from the prediction of future traffic flow to the valid prediction of arrival times of public transportation vehicles.

The second underlying paradigm is the coupling of simulations. The connection of different simulation instances allows for the investigation of test persons in cooperative scenarios. By doing this the future of road traffic can be analyzed. The next generation of driver assistance system can be put under test in this environment before performing field tests. AIM not only focuses on road traffic – it also allows for the investigation of cooperative scenarios across the boundaries of the different modes of transportation. AIM allows to anticipate future interactions between non-motorized individuals (pedestrians and cyclists) as well as a cooperation between trams and cars in the street or cars and railway vehicles at level crossings. By coupling these simulations psychological studies can be performed and system performance in terms of safety can be improved significantly be means of human-centred design.

The third leading paradigm is to close the loop of traffic control In order to do this AIM also introduces new equipment in the city of Braunschweig. This equipment comprises a broad range of sensors as well as actuators (stationary communication equipment) and mobile units which react according to the information they obtain from the roadside systems:

- Sensors to detect and classify vehicles are a further part of the research facilities introduced with AIM. The “research intersection” allows for the investigation of complex situations for a longer period of time. Powerful sensors and algorithms allow for the detection and classification of vehicles with their trajectories. This allows to draw conclusions about critical situations in road traffic (e.g. accidents and „near misses“). This allows to reconstruct critical situations from recorded data. This data can be used for the design of future driver assistance systems (e.g. intersection assistance) or the evaluation of on-board sensors and their algorithms in the automotive domain. Key elements of the research intersection are a multi-radar-system (MRS) and the multi-camera-system (MCS) which will be implemented in 2012. These sensor systems allow give access to both raw data as well as object data and thus provide a research facility for the development and test of future algorithms for sensor data evaluation and data fusion. After completion of the “research intersection” the technical concept will be transferred to a “research level crossing” to improve safety on this “accident hot-spot”.

- A reference track for the development and prototypical test of cooperative driver assistance systems is currently introduced. The reference track features communication equipment of the IEEE 802.11p standard. In the first months of the project five intersections have been equipped with communication equipment. This equipment is ready for use in research projects. In the near future the reference track will be further expanded in terms of its functional and geographical scope. An example of the increased functional scope is the addition of a wireless local area network according to the IEEE 802.11 b/g/n standard. This additional communication equipment allows to include road users not (yet) equipped with the 802.11p standard.

- The stationary infrastructure has – of course – its correspondence in mobile devices. In 2012 a fleet of vehicles will start to operate in the field and collect data for different purposes. The vehicle platform currently developed has a modular architecture which allows to add sensors to whatever is required by a specific test campaign. As mentioned earlier AIM goes beyond just looking at motorized individual traffic. Pedestrians and cyclists will be included in cooperative scenarios. In order to achieve this a wireless local area network according to the IEEE 802.11 b/g/n standard will be introduced to allow for communication with other types of mobile devices (e.g. smart phones and laptop computers). By doing all road users will be included and can obtain data of the traffic light controllers. A backend solution is currently prepared for flexible adaptation of the equipment (e.g. exchange of software) to the needs of different research projcets.

AIM – AN OPEN AND FLEXIBLE PLATFORM

AIM is an open and flexible research platform. As such AIM has been designed with longevity and sustainability in mind [BBR 2009]. Unlike previous approaches involving individual, topic-based test areas in different cities, AIM allows the test infrastructure to be reused to address a range of problems.

- AIM therefore considerably reduces the investment requirement for each project as the equipment is already in place an can be used by many projects. As financial and technical resources are consistently grouped together, users enjoy a more extensive portfolio of methods and technologies, which reduces lead times and investment costs.
- AIM helps to increase the pace of research. As the equipment is in place and all permits have been obtained no time has to be spent for negotiations with the local authorities.

AIM uses an entire region and its real traffic infrastructure as a research area. This makes it possible to study extremely complex phenomena, for instance the issue of how the transportation of persons and goods can be managed more efficiently using a combination of different means of transportation. AIM is primarily a research platform for transport-related applications. In addition, AIM helps bring together regional transport research activities in Lower Saxony. For instance, AIM complements the activities of the Automotive Research Centre of Lower Saxony (NFF), the Technical University of Braunschweig and other industry and research partners.

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