Special Session: Technologies for Safe and Intelligent Transportation Systems

Track Co-chairs:
Samarjit Chakraborty, TU Munich, Germany,
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Abstract
Mobility is one of the biggest challenges of the future. There is an ever growing population, increasing concentration of people in cities, environmental concerns, and the growing aspirations of people towards vehicle ownership, especially in developing countries. All of these throw up myriad challenges to improve transportation systems -- in order to make them more efficient, increase their safety and comfort level, and reduce their negative impacts on the environment. This track, organized around two sessions, will feature a number of talks that highlight some of the technological questions and solutions to address these challenges.

Organizers’ Biographies
Samarjit Chakraborty (TU Munich, Germany) is a Professor of Electrical Engineering at the Technical University of Munich, where the holds the Chair for Real-Time Computer Systems. He also leads a research program on embedded systems design for electric vehicles at the TUM CREATE Centre for Electromobility in Singapore, where he serves as a Scientific Advisor. Prior to joining TU Munich in 2008, he was an Assistant Professor of Computer Science at the National University of Singapore from 2003 - 2008. He obtained his Ph.D. in Electrical and Computer Engineering from ETH Zurich in 2003. He works on various aspects of embedded systems and software design and has/had several funded projects from the industry such as from General Motors, Intel, Google, BMW, Bosch, Siemens and Audi, as well as from government funding agencies both in Germany as well as in Singapore.

S. Ramesh (GM R&D, US) is a Senior Technical Fellow at General Motors Global R&D, USA. He earned his B.E. degree in Electronics and Communication Engineering from Indian Institute of Science Bangalore and his PhD degree in Computer Science & Engineering from Indian Institute of Technology Bombay. At General Motors, he is responsible for providing technical leadership for research and development in several areas related to Electronics.

Invited Presentations in the Special Session

Intelligent Dynamic Toll Pricing for Highway Traffic Congestion Control
Anuradha Annaswamy

Abstract:
With the rapid growth and expansion of several large metropolitan centers in the last few decades, the problem of traffic congestion continues to grow and vex commuters, commercial drivers, city planners and officials, and environmentalists worldwide. Over 1 billion vehicles travel on the roads today, and that number is projected to double by 2020. Driving a car is an unavoidable choice for at least 65% of city populations, who rely on their vehicles to get to school or to work. The number of hours spent in traffic jam over a 5 day period, for the cities in
France, Honolulu, San Francisco, and Los Angeles are 35, 56, 60, and 64, respectively. Urban mobility and alleviation of traffic congestion in turn positively impacts many other metropolitan services of planning and operations in energy, transportation, and health care.

Of late, dynamic tolling has been investigated in several cities around the world as a method for alleviating congestion. The challenge in the design of the underlying toll pricing strategy is to reconcile infrastructure-wide metrics of traffic flow and maintenance with driver behavior. In this talk, a model-based approach to dynamic toll pricing that has been developed in our laboratory will be described. Key features of our approach are the derivation of a model that combines driver behavior and traffic flow, a model-based nonlinear control strategy, and a suitably designed target density. The approach is shown to result in a clear improvement over existing methods currently in place using simulation studies. Highlights of the approach as well as the results obtained will be presented.

Early Design Space Exploration and Architectural Synthesis for Automotive Embedded Systems
Krzysztof Czarnecki

Abstract: Cars are the most complex consumer products today: they contain a sophisticated electric/electronic (E/E) system comprising hundreds of sensors and actuators, 50-100 computers, several networks, and close to 100 million lines of code. High-volume OEMs such as GM derive the E/E systems for the wide range of vehicles they produce from a common E/E architecture. Such architectures take 5-6 years to develop and are exploited for 10-15 years. Thus, key challenges are shortening the development cycle and ensuring that the right scoping and design decisions are taken to enable high quality and successful exploitation of the platform during its lifetime. Addressing these challenges requires effective methods and tools for early exploration of hardware and software design decisions and their impact on qualities such as reliability and safety, cost, weight, energy efficiency and performance. In this talk, I will describe the modeling of E/E architectures, representation of its design spaces, and synthesis and exploration of optimal architectural designs. We have developed Clafer, a modeling language and associated tools, to support these tasks. The language design of Clafer is strongly informed by category theory, and its underlying tooling relies on multi-objective combinatorial optimization, using a range of solvers. I will illustrate E/E architectural modeling and synthesis using a power window case study, report on our progress in architectural synthesis, and identify the main research challenges that need to be addressed to make it practical.

The Challenges of Certification in the Automotive Industry
Alan Wassyn

Abstract:

Over the past few years the automotive industry has changed dramatically. We now see between 500 thousand and 1 million lines of code in a modern car. Software controls the engine, brakes, steering, infotainment, chassis features and more in the common car. Even more in hybrids and electric vehicles. And, of course, we have all the active safety systems: lane warning, lane control, blind spot detection, adaptive cruise control, etc. Next we are going to see connected car features and autonomous vehicles. All of this has the potential for ushering in a much safer and easier driving experience for the average person. It also has the potential for ushering in catastrophic events through systemic errors, feature interactions, incomplete requirements, and flawed implementations. Building dependable, secure and safe automobiles is already an incredible challenge – it is going to get even more difficult. Most people’s idea of certification is something that is done after development, to demonstrate in some way that the system that was built satisfies key properties – like safety. Some of us believe that this is not the way to success. Most companies with good safety records have always known that safety and dependability are planned before development ever starts – and that incremental changes are carefully evaluated to determine how they may jeopardize the record of current successful products. This is how we view certification. It starts before development, is planned in detail, helps to build safe, secure and dependable products, and builds the certification demonstration in parallel with development. This talk will build on this theme, and why it is difficult to achieve, in the context of automotive manufacturing.
Architecture for Remote Diagnostics of Automotive Systems
Rahul Mangaram

Abstract:

Software issues related to automotive controls such as cruise control, anti-lock braking system, traction control and stability control, account for an increasingly large percentage of the overall vehicles recalled. As software verification and testing is done entirely at design time and the vehicle condition changes over the long lifetime, this research addresses the need for post-market remote diagnostics. We have developed AutoPlug an automotive Electronic Controller Unit (ECU) architecture between the vehicle and a Remote Diagnostics Center. The AutoPlug architecture diagnoses post market control system faults, applies system identification to reformulate the controller to the changed plant model, executes firmware over air updates, and conducts runtime verification of the updated controls software. We are developing a new direction for remote diagnostics and runtime verification for control systems across plants with evolving uncertainty.