Open invited track proposal

Connected and Autonomous Vehicle Applications: Estimation Perspectives

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Technical committees:
CC7 Transportation and Vehicle Systems
1. **TC7.1: Automotive Control**
2. **TC7.5: Intelligent Autonomous Vehicles**

CC2 Design Methods
1. **TC2.1: Control Design**
2. **TC2.2: Linear Control Systems**
3. **TC2.3: Non-linear control Systems**

Abstract
The objective of this open invited track proposal for inclusion in IFAC world congress 2023, which will be held in Yokohama, Japan, July 09-14th, 2023, consists in inviting contributions on the role of estimation in connected and autonomous vehicle (CAV) applications. The aim is to bring together experts on estimation theory, CAV researchers, and experts of deep-learning, computer vision, and artificial intelligence, to conduct discussions on the recent advances and identify novel research directions in this multidisciplinary field. This open invited track could be the source of inspiration for innovative work from the fusion of classical control theory, computer vision and artificial intelligence.
Keywords: Estimation; observer design; nonlinear systems; computer vision; deep-learning based methods; artificial intelligence.

Description
The development of controllers with high performance and reliability for connected and autonomous vehicles (CAVs) will require real-time measurements or estimates of many variables on each vehicle. Examples of variables that are needed for feedback include: longitudinal distances, velocities, and accelerations of other nearby vehicles; lateral position of the vehicle in its own lane; vehicle yaw angle; slip angle; yaw rate; steering angle; lateral acceleration; and roll angle. There are also environmental variables which need to be measured such as tire-road friction coefficient, snow cover on road, and the presence of unexpected obstacles. Measurement of all the above variables requires significant expense. Indeed, some of the sensors above, such as slip angle and roll angle, can be extremely expensive to measure, requiring sensors that cost thousands of dollars. For example, the "*Datron*" optical sensor for measurement of slip angle has a price over 10k€. In addition, several variables cannot be measured due to unavailability of sensors (at any cost).

Furthermore, a CAV requires highly reliable sensors and actuators. Failure of any one sensor or actuator, due to faults, cyber-attacks, or denial of service, can cause a disastrous accident. Hence reliable fault diagnostic and fault handling systems are also needed. Such systems cannot be based on hardware redundancy which requires many extra copies of the same sensors. Instead, they need to rely on estimation algorithms and analytical redundancy. For all the above reasons, the development of intelligent estimation algorithms is highly important for autonomous vehicles.

Throughout this open invited track session, we propose recent and original ideas on estimation by using sophisticated techniques. The session focuses on fundamental challenging estimation issues encountered in CAV systems. It aims to provide conference attendees with the opportunity to experience state-of-the-art solutions and tools to address any estimation problem related to CAV.

Topics include, but are not limited to:

- Estimation of inter-vehicle variables;
- Estimation in Adaptive Cruise Control systems;
- Estimation for Cyber-attack detection in connected vehicles;
- Vehicle tracking in highway and urban traffic roads;
- Rollover prevention systems;
- Estimation in lateral and longitudinal models
- Vehicle platooning.
- Computer vision based estimation
- Artificial intelligence
- Deep-Learning