Top Level Newsletter: Connected Vehicle

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Vol 31: This issue includes two articles/editorials on human interaction with self driving vehicles.
(1) Do We Really Wish Self-Driving Vehicles to Behave as Human Drivers?
(2) Driver Behavior in Intelligent Transportation Systems

General Notes

This series of newsletters is intended to provide the IEEE member with a top level briefing of the many different subjects relevant to the research, development and innovation of the connected vehicle.

The objective is to provide a platform for fast learning and quick overview so that the reader may be guided to the next levels of detail and gain insight into correlations between the entries to enable growth of the technology. Intended audiences are those that desire a quick introduction to the subject and who may wish to take it further and deepen their knowledge. This includes those in industry, academia or government and the public at large. Descriptions will include a range of flavors from technical detail to broad industry and administrative issues. A (soft) limit of 300 to 600 words is usually set for each entry, but not rigorously exercised.

As descriptions are not exhaustive, hyperlinks are occasionally provided to give the reader a first means of delving into the next level of detail. The reader is encouraged to develop a first level understanding of the topic in view. The emphasis is on brief, clear and contained text. There will be no diagrams in order to keep the publication concise and podcast-friendly. Related topics in the case of Connected Vehicle technology, such as 5G cellular and the Internet of Things will be included. The terms Connected Vehicle and Automated Driving will be used inter-changeably. Articles from other published sources than IEEE that add to the information value will occasionally be included.

This newsletter forms part of the regional Advanced Technology Initiative (ATI) of which connected vehicles form a constituent part. Technical articles solely from IEEE journals/magazines are referred to by their Digital Object Identifier (DOI) or corresponding https link. The link for each article is provided. Those readers who wish to delve further to the complete paper and have access to IEEE Explore (www.ieeexplore.ieee.org) may download complete articles of interest. Those who subscribe to the

relevant IEEE society and receive the journal may already have physical or electronic copies. In case of difficulty please contact the editor at kaydas@mac.com. The objective is to provide *top level guidance* on the subject of interest. As this is a collection of summaries of already published articles and serves to further widen audiences for the benefit of each publication, no copyright issues are foreseen.

Readers are encouraged to develop their own onward sources of information, discover and draw inferences, join the dots, and further develop the technology. Entries in the newsletter are normally either editorials or summaries or abstracts of articles. Where a deepening of knowledge is desired, reading the full article is recommended.

1. **Do We Really Wish Self-Driving Vehicles to Behave as Human Drivers? [Editor's Column], Ljubo Vlacic et al**

Published in: IEEE Intelligent Transportation Systems Magazine (Volume: 14, Issue: 3, May-June 2022) pp 3-4

Abstract: The Society of Automotive Engineers J3016 Level 5 (full driving automation) defines a specific capability to "drive the vehicle everywhere in all conditions". Such an ability transforms a vehicle to a self-driving vehicle, and it is meant to perceive and understand road traffic as humans do and, in response, make driving decisions and execute them accordingly. At this stage of development, we all are aware of the limitations and even shortcomings of self-driving technologies, and those weaknesses are not what I am discussing in this editorial, as they have been addressed in my other columns.

This time, I am focusing on decision-making capabilities of self-driving technologies, as autonomous vehicles are intended to share the road with human beings, both pedestrians and drivers. If so, then the question we need to answer is: Do we really wish self-driving vehicles to behave as human drivers? My immediate, decisive, and a simple answer is just no. My reasons are threefold, and they include the following:

1. Human error is the primary factor in the majority of traffic accidents. Thus, we do not need another driver on the road, i.e., a self-driving vehicle, that will contribute to or cause the same situation.
2. To realize the "zero-crashes vision," self-driving vehicles' decision-making capability should surpass that of human drivers, at least under typical circumstances.
3. Emotions impair human drivers' decision-making ability and thus affect driving safety. In the context of road traffic settings, human drivers are expected to demonstrate their ability to operate safely for their own sake and to avoid harming others. This means that self-driving vehicles would be expected to demonstrate the ability to do the following:

- recognize and manage own emotions
- recognize, understand, and influence the emotions of other traffic participants.

Let's be honest and admit that many of us have not yet achieved that level of emotional intelligence. At the same time, it is likely that almost all of us are trying to understand how emotional intelligence works and how it can be used to our advantage in the context of road safety. Consequently, it is no surprise to note that self-driving vehicles' emotional intelligence is yet to be distinctly defined and thereafter embodied. There is no doubt in my mind that autonomous vehicles' emotional intelligence will be accepted by our societies if and only if it surpasses that of human drivers. Therefore, I do not want self-driving vehicles to behave as human drivers. They must be more advanced, sophisticated, and of high decision-making intelligence and high emotional intelligence.

There is no doubt in my mind that autonomous vehicles' emotional intelligence will be accepted by our societies if and only if it surpasses that of human drivers.
I would like to encourage you to share with the *IEEE Intelligent Transportation Systems Magazine* readership the current findings from your research into this topic by way of submitting special issue/section proposals and/or a manuscript. I will welcome them (486 words)

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2. Driver Behavior in Intelligent Transportation Systems [Guest Editorial] Guofa Li et al)

Published in: IEEE Intelligent Transportation Systems Magazine (Volume: 14, Issue: 3, May-June 2022) pp 7-9

Abstract: Drivers are the center of road/air/sea transportation systems, and they can be either human beings or artificial beings. Inconsistency between human driver behavior and artificial driver behavior will lead to accidents and congestion in intelligent transportation systems (ITSs). To make future ITSs trustworthy for traffic safety and acceptable for travel efficiency, developing industrial ITS applications based on drivers' reliable behavioral and cognitive intelligence is essential. However, there are many challenges to be addressed, including real-time behavior prediction, reliable decision making, safe interaction among human and artificial drivers, and so on.

To tackle these difficulties, emerging technologies based on artificial intelligence and the Internet of Things are becoming increasingly popular in ITS communities [4], [5]. This special section aims to provide a platform for researchers, engineers, and policymakers to publish their latest findings and engineering experiences in developing and applying novel technologies to address challenges concerning driver behavior in road/air/sea ITSs.

Special Section Goals: we are interested in contributions focusing on how we can apply driver behavior-related knowledge and technologies in the development of ITSs to improve safety, efficiency, and stability. In particular, we focus on the following topics:

- real-time driver behavior detection, tracking, and prediction
- desired/expected driving behavior of artificial drivers
- interaction among human drivers and artificial drivers
- risk assessment of human drivers and artificial drivers
- adaptive and reliable decision making in various ITS scenarios
- human–machine collaboration
- cooperative driving among human drivers and artificial drivers
- traffic forecasting and management based on driver behavior
- driver behavior regulation strategies.

Special Section Summary: We received 28 submissions for this special section. After several rounds of rigorous reviews and revisions, we decided to publish four of them. The selected contributions, which represent the state of the art in the field, will be of great interest to ITS communities. Brief summaries of the contributions are provided in the following.

Driver anger is a significant challenge to safety in transportation systems, and its mitigation is essential for safety improvement. However, how the human–machine interface should be designed for this is still not clear. Li et al. propose an architecture for driver anger detection and regulation to help ease negative emotional effects in "Visual-Attribute-Based Emotion Regulation of Angry Driving Behaviors". They investigate the anger regulation quality of different visual presentation attributes, including colors, symbols, and expressions from drivers' subjective experience, behavior, and physiology. Their study provides evidence for design strategies in human–machine interaction to regulate driver anger.

Drivers' inappropriate and aggressive behavior leads to increased risk, especially in sudden and emergency scenarios (e.g., when another vehicle cuts them off), challenging safety in transportation systems. "Discretionary Cut-In Driving Behavior Risk Assessment Based on Naturalistic Driving Data," by Gao et al., proposes a risk assessment method based on a decision tree and support vector machine to identify driving risks in cut-in scenarios. To build a reliable database for model training and testing, wavelet transform technologies are employed to filter naturalistically collected driving data by incorporating the *k*-means approach. This can refine the high-risk profile to help improve the design of driving strategies for safety in ITSs.

Inconsistency between human driver behavior and artificial driver behavior will lead to accidents and congestion in intelligent transportation systems.

Based on assessed risk, driving decisions can be further inferred to avoid collisions. To this end, Zhang et al. propose an automated braking decision and control framework to intelligently avoid vehicle–pedestrian collisions in “Automated Braking Decision and Control for Pedestrian Collision Avoidance Based on Risk Assessment”. The proposed framework contains three parts: pedestrian collision risk assessment (CRA), automated braking decision making, and automated braking control. First, pedestrians with the highest risk levels are selected as the most dangerous collision objects from target sets. Second, fuzzy theory is used to develop an automated braking decision strategy based on road adhesion conditions, vehicle lateral stability, and driver intention constraints. Third, an inertial hysteresis braking response model is built based on real vehicle braking experimental data.

Most of the studies in ITS-related communities are for road transportation systems. To analyze drivers’ behavioral characteristics in sea transportation, Wu et al. investigate sailors’ navigation patterns for maritime collision avoidance in “Navigating Patterns Analysis for Onboard Guidance Support in Crossing Collision-Avoidance Operations”. A navigating pattern (conservative, moderate, or aggressive) is identified with respect to a CRA by interpreting data collected from GPS and automatic identification systems. The CRA is realized following the collision risk modeling concept of the closest point of approach. Then, a human-centered onboard guidance support system is developed according to the identified navigating pattern to facilitate decisions for collision avoidance. This is the first approach to put navigating patterns into potential industrial applications in sea transportation systems. (775 words).

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