Position Statement

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I am a PhD candidate from the school of Civil Engineering at Purdue University. I am writing the position statement to apply for the workshop on Cyber-Physical Systems (CPS) which is highly related to my research and dissertation topic. I have special interest in and am working on delivering a coordinated transportation system in urban areas, integrating connected vehicles and smart infrastructures.

In the past three years of graduate studies, I mainly focused on the area of traffic control under the connected vehicle (CV) environment. CV environment is a recently developed concept owing to the development of wireless communication technology, especially the development of Dedicated Short Range Communications (DSRC). DSRC has great potential in the area of intelligent transportation system (ITS), as it enables the wireless exchange of information between vehicles (i.e., Vehicle-to-Vehicle, V2V), as well as between vehicles and roadside infrastructure (i.e., Vehicle-to-Infrastructure, V2I). Acknowledging the potential, the intelligent transportation system program of the U.S. Department of Transportation (DOT) emphasizes CV research in the ITS Strategic Plan (2010-2014). Though CV has not been implemented in the real world transportation system yet, many auto companies are expending significant efforts to produce vehicles with communication features. In addition, many test beds are ongoing in US, Europe, and Japan. Recent advances in CV environment offer useful technologies in detection and acquisition of high fidelity data that can be used for more efficient traffic control strategies. In the previous studies, I have worked on the following three types of traffic control strategies under the CV environment: *(1) Signal control* (Zhu et al., 2013; Zhu et al., 2014). We have proposed several learning based algorithms to optimize the timing settings at signalized intersections. *(2) Speed limit control* (Zhu & Ukkusuri 2014a). Though it is not received much attention, we find that dynamic speed limit control is a highly effective strategy in terms of alleviating traffic congestion and reducing emissions. *(3) Dynamic toll* (Zhu & Ukkusrui 2014c). We have proposed a dynamic tolling scheme based on distance travelled. The tolling scheme is readily implementable through managed lanes in the real world.

Currently I am working on the modeling of integrated transportation system in the vehicular ad hoc network (VANET) environment. In particular, one challenging research question with VANET is how to efficiently propagate the information flow, i.e., how to efficiently utilize the bandwidth and dynamically adapt the transmission rate to varying channel quality in the IEEE 802.11-based wireless network. This is also known as the rate adaptation problem. The rate adaptation problem is crucial in the system performance of VANET due to the low transmission capacity of the network. Low transmission capacity is the well-defined characteristic of the IEEE 802.11-based wireless network. At the present

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stage of the ongoing research I aim to develop an online-learning based algorithm to solve the rate adaptation problem then validate the performance of the algorithm on an integrated simulation platform coupling a road traffic simulator and a wireless network simulator.

To sum up, I have been continuously working on delivering the most efficient, safe, and sustainable integrated transportation system by incorporating the most advanced technologies (e.g., wireless communication technologies) into the on-road vehicles and roadside infrastructures. The well-defined integrated transportation system could be a notable example of CPS due to its threefold contribution to the real world. (1) *Safe*. The concern of safety is the straightforward driving force of developing the Vehicle-to-Vehicle (V2V) communication technologies. (2) *Efficient*. The research findings from the studies of signal control (Zhu et al., 2013; Zhu et al., 2014), speed limit control (Zhu & Ukkusuri 2014a), and dynamic tolling (Zhu & Ukkusuri 2014c) have confirmed that the integrated traffic system has great potential in the alleviation of traffic congestion in urban areas. (3) *Sustainable*. The research findings from the studies of signal and speed limit control (Zhu et al., 2014; Zhu & Ukkusuri 2014a) have also confirmed that the Vehicle-to-Infrastructure (V2I) feature of the integrated transportation system is of great help in reducing vehicular emissions. Imaging the world with zero crash rates on the road, no more wasting time in front of intersections, no trouble of finding parking spots, no worries of spending unnecessary energy, I am glad to devote myself to delivering such a smart and human-friendly integrated transportation system in the near future.

The workshop on CPS is no doubt a great opportunity for me to keep updated with the state-of-art in the field and to interact with others to explore more. I sincerely hope to be accepted and get the chance to exchange ideas and learn new concepts from the workshop.

References:

Publications:

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Manuscripts:

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