Influential Subspaces of Connected Vehicles in Highway Traffic

SYMPOSIUM CELEBRATING 50 YEARS OF TRAFFIC FLOW THEORY

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Traffic congestion costs are rising...

Source: Texas Transportation Institute (TTI) 2012 Urban Mobility Report
...and avenues for infrastructure expansion are diminishing...

% increase (1985-2006)*

- New roadways added: 5%
- Vehicle miles traveled: 100%

Analytical Prediction of Self-Organized Traffic Jams as a Function of Increasing ACC Penetration

Kshitij Jerath and Sean N. Brennan

Abstract—Self-organizing traffic jams are known to occur in medium-to-high density traffic flows, and it is suspected that adaptive cruise control (ACC) may affect their onset in mixed human–ACC traffic. Unfortunately, closed-form solutions that predict the occurrence of these jams in mixed human–ACC traffic do not exist. In this paper, both human and ACC driving behaviors are modeled using the General Motors fourth car-following model and are distinguished by using different model parameter values. A closed-form solution that explains the impact of ACC on congestion due to the formation of self-organized traffic jams (or “phantom” jams) is presented. The solution approach utilizes the master equation for modeling the self-organizing behavior of traffic flow at a mesoscopic scale and the General Motors fourth car-following model for describing the driver behavior at the microscopic scale. It is found that, although the introduction of ACC-enabled vehicles into the traffic stream may produce higher traffic flows, it also...
Influential subspaces have not yet been studied...

- J. Monteil et al., Cooperative highway traffic: multi-agent modeling and robustness assessment to local perturbations, 92nd Annual meeting of the TRB, 2013
- S. Shladover, et al., Effects of cooperative adaptive control on traffic flow, PATH program, 2009
So what are influential subspaces?

Problem setup

**Problem:** Can connected vehicles positively influence traffic flow, i.e. lead to faster jam dissipation?

**Assumptions:**

- Communication between vehicles occurs instantaneously.
- Vehicles have limited control options (can only slow down to a pre-determined speed).
So what are **influential subspaces**? Let’s run a thought experiment…
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[Diagram with regions and concepts labeled]
Why should we care about influential subspaces?
Fundamental diagram of traffic flow
Traffic system **returns to free flow at different times** as connected vehicle’s location changes.
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Time to return to free flow helps establish range of influential subspace

Analytical expressions for event and null horizons can be found in upcoming article titled:

*Event Horizons and Influential Subspaces of Connected Vehicles*
Communication between connected vehicles must occur across several kilometers

Result from unpublished work presented in

*Event Horizons and Influential Subspaces of Connected Vehicles*
Questions?

Communication between connected vehicles must occur across **several kilometers** to affect traffic flow.