Network Design for Autonomous and Connected Truck Platoons to Improve Energy and Pavement Sustainability
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**Objective**

Network design framework to support autonomous and connected truck (ACT) platooning technology to enhance efficiency and sustainability of highway-based freight transportation by minimizing:
(i) truck fuel consumption due to air drag and traffic congestion, (ii) vehicle depreciation due to deteriorated pavement condition, and (iii) pavement life-cycle cost for rehabilitation activities.

**Pavement LCC**

\[ c_{\text{pav}} = \frac{c_1}{\sum_{i=1}^{N} \left( 1 + r \right)^i} + \frac{c_2}{\left( 1 + r \right)} \]

- Simulate pavement damage under arbitrary platoon positions onto pavement service life.
- Wander 2D model (Gungor and Al-Qadi, 2020).
- Optimize pavement rehabilitation schedule to minimize rehabilitation cost and user cost

**Fuel consumption due to air drag**

\[ c_{\text{drag}} = \sum_{i=1}^{N} \frac{c_1}{\left( 1 + r \right)^i} + \frac{c_2}{\left( 1 + r \right)} \int \frac{\rho C_D a^2}{2} \sum_{i=1}^{N} R(\theta_i) \]

- Computational fluid dynamics analysis (ANSYS Fluent) to simulate effect of truck positioning onto drag force.
- Validation with field test data.
- Extrapolation model to predict fuel consumption.

**Network Design Model**

- ACT platoon based on V2I communication.
- Dedicated lanes exclusively for platooning.
- Platoon configuration guidelines specified by agency

**Results and Findings**

- Proper design of truck platooning lanes allow compact and aligned traffic, which provides a good balances between fuel consumption and pavement life-cycle cost.
- Pavement rehabilitation cost could be subsidized by platoon lane users through toll fees.
- Societal cost of platoon traffic is generally lower than that on regular lanes, and channelized network flow show benefits under even low daily demand.

**Acknowledgments**

The financial support from CCAT for this study is greatly appreciated. This study is built upon collaborative teamwork conducted in cooperation with Profs. Imad Al-Qadi, Jeffery Roesler, Hadi Meidani, Hasan Ozer, and graduate students Erman Gungor, Egemen Okte, Sachindra Dahal, Aravind Ramakrishnan, Ashrat Alrajhi at the University of Illinois at Urbana-Champaign and Arizona State University.