Wednesday, February 27, 10:30-11:45 AM, H242

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No more stop-and-go-traffic: Bilateral Cruise Control

Abstract

Traffic throughput on highways is limited at high densities by instabilities variously called "phantom traffic jams" or "stop-and-go traffic." We are all familiar with these annoyances, but did you know that they are an "emergent behavior" of a large dynamical system where each component implements normal human driving behavior? That is, each driver does what seems sensible locally in following the car ahead, yet collectively this leads to instabilities which greatly reduce throughput, increase travel times, waste fuel, add CO_2 to the atmosphere, and create a need for more, wider roads. So-called "adaptive cruise control" or "advanced cruise control" (ACC) systems implement the same control strategy as the human "car following model" (CFM), and thus are subject to the same instabilities (just with different parameters, and at different control system gains).

Traffic flow instabilities can be suppressed using bilateral cruise control (BCC), where, counter-intuitively, information about the car behind is used as much as information about the car ahead. A simple mechanical analog shows that perturbations will travel in both directions, but also be rapidly damped out. Importantly, bilateral cruise control does not require full autonomy (which may be years away) and is very different form "platooning" where cars follow a "leader" in lock-step fashion as carriages do a locomotive in a train. It is more "democratic" in a sense that each car contributes to the smoothness of flow and is not subject to commands from a central authority. Communication between vehicles (V2V), or with the infrastructure is not required (and hence does not present a problem when it fails).

The beneficial effects of BCC have been shown mathematically, in simulation, and recently using a set of robot cars build by high school students in Maine. Cars using BCC "play well" with human driven cars with the benefits increasing as the fraction of cars using BCC increases. In current work we are showing that the probability of accidents (using inverse time-to-contact as a proxy) goes down as the mixing ratio goes up. Similarly, passenger comfort increases (fewer moments of high acceleration and of high "jerk"). So, what is holding up the introduction of this simple, yet highly beneficial technology?

Speaker

Professor Berthold K.P. Horn

Dr. Horn is a Professor of Electrical Engineering and Computer Science at the Massachusetts Institute of Technology (MIT). He received the B.Sc.Eng. degree from the University of the Witwatersrand in 1965 and the S.M. and Ph.D. degrees from MIT in 1968 and 1970, respectively. He is the author, coauthor or editor of books on the programming language LISP and machine vision, including Robot Vision and Shape from Shading.

Dr. Horn was awarded the Rank Prize for pioneering work leading to practical vision systems in 1989 and was elected a Fellow of the American Association of Artificial Intelligence in 1990 for significant contributions to Artificial Intelligence. He was elected to the National Academy of Engineering in 2002 and received the Azriel Rosenfeld Lifetime Achievement Award from the IEEE Computer Society for pioneering work in early vision in 2009. His current research interests include machine vision, computational imaging and intelligent vehicles.