A Case for Feedback Control to Prevent Delay

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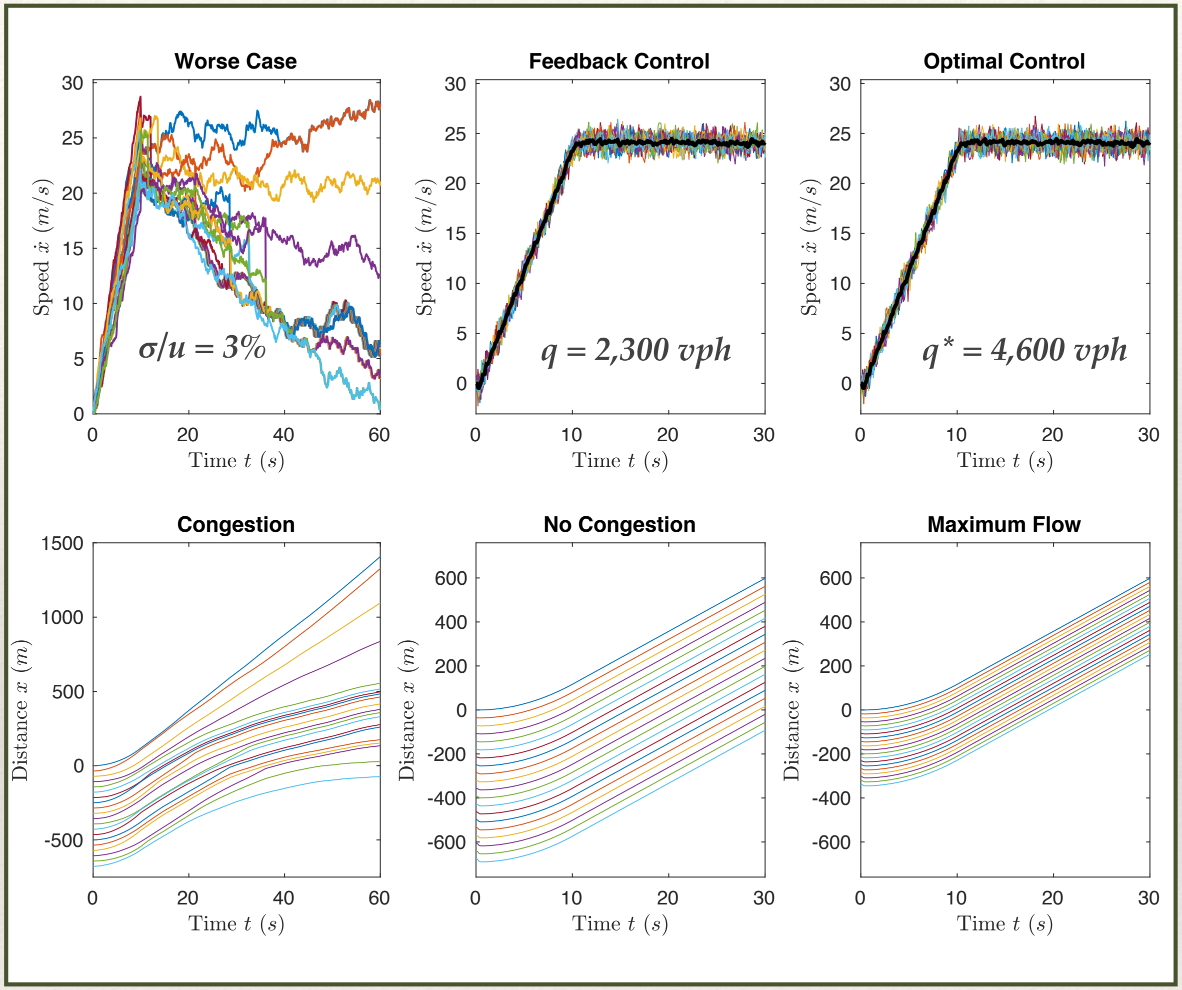
ABSTRACT

This study was motivated by the work of researchers who conducted field experiments on roadways with no bottlenecks. "Ring roads" or single-lane circular roadways where passing was restricted. All drivers, who took part in these field studies, promised to maintain the same constant speed. They were unable to do so. The field tests showed the importance in the variability in speed, "traffic noise." Like the field test, traffic noise plays a prominent role in this simulation study. In part one, the focus is on triggering traffic breakdown and queue formation. A stochastic car-following models are developed. They feature Brownian motion models that help explain the connection between driver behavior and traffic noise. In part two, the focus is on preventing traffic breakdown and queuing. State space modeling and feedback control using Kalman filtering are featured. Real-time noisy data are collected and recursively passed through a system that tracks a target, a target that is a function of time. All simulations in parts one and two of this study imitate the instructions given to the drivers in the ring road field experiments. The drivers start from rest, accelerate to the same constant speed, and then attempt to hold that speed through the duration of the experiment. In part one, the drivers fail. In part two, they succeed. To demonstrate the effectiveness of the feedback control approach, a worse case scenario is investigated. A ring road is assumed to operate at capacity thus, queuing and breakdown are expected. Testing and implementing the feedback control system in a "smart city" environment and its fate are discussed.

Keywords: Traffic breakdown, car following, congestion, control, Kalman filter, stochastic processes



https://github.com/PJOssenbruggen/cTMATLAB

SunFounder PiCar Kit for Raspberry Pi