Advanced Scientific Working
-Essay-
Energy efficient control of rail vehicles

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1   REFERENCE

Golovitcher, Iakov M. "Energy efficient control of rail vehicles." Systems, Man, and Cybernetics, 2001 IEEE International Conference on. Vol. 1. IEEE, 2001.

2   ABSTRACT

This paper describes an analytical method of computation of optimal controls which minimize the energy consumption by rail or any other fixed path vehicles. A specific aspect of this problem is that the external forces applied to the vehicle and the maximum allowable speed depend on the coordinate of the vehicle. The known analytical solutions

3   ESSAY

3.1   WHAT IS THE PAPER ABOUT?

- Analytical method for computation of optimal controls

- Minimize energy consumption for rail other fixed path vehicles

3.2   WHY IS THIS RELEVANT?

- Raising energy prices

- Environmental concerns

3.3   WHAT HAVE OTHERS DONE AND WHY IS THIS NOT SUFFICIENT?

- Classical numerical methods of optimization
    - Significant computation time
    - No real time calculations possible

- Applying analytical methods of optimal control theory
    - Simplified assumptions about tracks

- Set of optimal controls for a short section of track
    - Ignoring some constraints on velocity

3.4   WHAT HAVE THE AUTHOR'S DONE AND WHY IS THIS BETTER?

- Analytical solution of optimization problem

- No simplifications - Including steep climbs and descents

- Apply the maximum principle

- Use control-switching graphs to find a sequence of controls

3.5 HOW DID THEY EVALUATE THEIR SOLUTION?

- Computer simulation of calculated strategy

- Application of strategy on several known tracks and schedules

- Computed savings of 3% for subway lines not having any spare time

- Optimizing timetables for a long segment for local, intercity and freight traffic resulted in about 7% savings

3.6 SCIENTIFIC DEFICIT

- Computations not during runtime

- System parameters are assumed to be known apriori
    - Gao, Shigen, et al. "Approximation-based robust adaptive automatic train control: an approach for actuator saturation." Intelligent Transportation Systems, IEEE Transactions on 14.4 (2013): 1733-1742.
    - Shigen, Gao, et al. "Characteristic model-based golden section adaptive control for high-speed train." Control Conference (CCC), 2012 31st Chinese. IEEE, 2012.

- Not suitable for high speed lines
    - Sicre, Carlos, et al. "Modeling and optimizing energyâĂŘefficient manual driving on highâĂŘspeed lines." IEEJ Transactions on Electrical and Electronic Engineering 7.6 (2012): 633-640.
    - Sicre, C., A. P. Cucala, and Antonio Fernandez-Cardador. "Real time regulation of efficient driving of high speed trains based on a genetic algorithm and a fuzzy model of manual driving." Engineering Applications of Artificial Intelligence 29 (2014): 79-92.

3.7 SCIENTIFIC CONTRIBUTION

- Very efficient approach
    - Wang, Yihui, et al. "A survey on optimal trajectory planning for train operations." Service Operations, Logistics, and Informatics (SOLI), 2011 IEEE International Conference on. IEEE, 2011.

- Applicable for short distance lines
    - Sicre, C., A. P. Cucala, and Antonio Fernandez-Cardador. "Real time regulation of efficient driving of high speed trains based on a genetic algorithm and a fuzzy model of manual driving." Engineering Applications of Artificial Intelligence 29 (2014): 79-92.

– Sicre, Carlos, et al. "Modeling and optimizing energy‐efficient manual driving on high‐speed lines." IEEJ Transactions on Electrical and Electronic Engineering 7.6 (2012): 633-640.