Ngigi, R. W., Pislaru, Crinela, Ball, Andrew and Gu, Fengshou

Review of control strategies used in modern railway vehicles

Original Citation


This version is available at http://eprints.hud.ac.uk/id/eprint/13496/

The University Repository is a digital collection of the research output of the University, available on Open Access. Copyright and Moral Rights for the items on this site are retained by the individual author and/or other copyright owners. Users may access full items free of charge; copies of full text items generally can be reproduced, displayed or performed and given to third parties in any format or medium for personal research or study, educational or not-for-profit purposes without prior permission or charge, provided:

- The authors, title and full bibliographic details is credited in any copy;
- A hyperlink and/or URL is included for the original metadata page; and
- The content is not changed in any way.

For more information, including our policy and submission procedure, please contact the Repository Team at: E.mailbox@hud.ac.uk.

http://eprints.hud.ac.uk/
Review of control strategies used in modern railway vehicles

Student - Roy W. Ngigi
Supervisors - Dr C. Pislaru, Prof A. Ball, Dr F. Gu
The Centre for Diagnostic Engineering, Computing and Engineering

ABSTRACT
Control systems are being developed in the railway industry to maintain good steering, stability and comfort. Although, these systems are in operational, there are prospects of fully implementing mechatronic principles through an integrated control system. This poster is intended to provide various aspects of control systems that are incorporated in modern railway vehicles and to give illustrative examples of where particular control objectives have been met. Its main contribution is to identify opportunities for further research in this field.

INTRODUCTION
The use of railway vehicles worldwide has increased and thus, more and more trains are being produced. This trend is unlikely to change anytime soon. Therefore, there is a need to develop trains that provide safe and comfortable transportation, and at the same time have minimal impact on the environment. The challenge is to develop vehicles that can satisfy these conflicting requirements. One of the steps in achieving this is the use of mechatronic subsystems that employ sensors, actuators and control systems. There are several control strategies which have been developed to automate various operations within the railway vehicle. Only the ones that are well established will be reviewed.

CONTROL STRATEGIES

1. Tilt control

- Maximizes the use of poor running conditions.
- Improves the ride quality.
- Stability at high speeds.
- Improves curving abilities and wheel-rail wear reduction.
- Adhesion control concept:
- Maximizes the use of poor running conditions.

Tilt control concept:
- Enables trains to curve at higher speeds.

Adhesion force control based on field oriented vector control [4]

2. Active lateral suspension control

- Low Pass Filter # 2
- Skyshook damping control [1]

Primary suspension control concept:
- Stability at high speeds.
- Improve curving abilities and wheel-rail wear reduction.
- Adhesion control concept:
- Maximizes the use of poor running conditions.

3. Active primary suspension control

- Active stability and steering control of wheelset [2]

4. Wheel slip control

- Bogie configuration for a high speed train

5. Wheel slip control

- Adhesion force control based on field oriented vector control [4]

REFERENCES

CHALLENGES
- The level of integration of various aspects (traction, braking, suspension) is high, whereby more sophistication in designing a controller.
- The use of the contact patch between the wheel and rail for the designing of an integrated control scheme.
- The difficulty in accommodating all of the dynamical features.

CONCLUSIONS
- The benefits of incorporating such systems in an ‘asset’ (railway vehicles) has been remarkable. One of the key contributions is the increased dynamic performance which was scarce when trains had only passive elements.
- It is clear that the electromechanical control systems within the railway industry is well developed and will continue to do so as more opportunities arise especially in the field of mechatronic systems.
- Most of these control systems are designed individually but there is a possibility of an optimal controller.
- Suspension, braking, propulsion and guidance force acting on the railway vehicle are related by the wheel and rail contact point. This is one of the avenues for further research in establishing if it is feasible.