

## Article

# Cooperative Control of Interconnected Air Suspension Based on Model Predictive Control

Ying Zhou <sup>1</sup>, Zhongxing Li <sup>1,\*</sup>, Wenhao Yu <sup>2</sup> and Yi Yu <sup>1</sup>

<sup>1</sup> School of Automotive and Traffic Engineering, Jiangsu University, Zhenjiang 212013, China

<sup>2</sup> School of Vehicle and Mobility, Tsinghua University, Beijing 100084, China

\* Correspondence: zli@ujs.edu.cn

**Abstract:** The suspension system is a significant part of a vehicle because it transmits the torque and force between the wheels and the frame, meeting the requirements of ride comfort. In this paper, a novel interconnected air suspension was introduced and a cooperative control between interconnected mode activation (IMA) and outsourced mode activation (OMA) was designed. To improve ride comfort in a bus at a minimal energy consumption, this cooperative control based on model predictive control (MPC) for computing the best force and the rule was defined to distribute the best suspension force generated by IMA and OMA. The simulation and experimental results showed that the proposed control strategy significantly improved ride comfort in different conditions. Compared with traditional control in the test vehicle, the RMS of the front-left sprung mass and unsprung vertical acceleration decreased by 24.2% and 14.5%, respectively, under a straight condition; the RMS of the sprung (unsprung) mass vertical acceleration reduced by 22.38% and 15.43%, respectively, under a bump condition.

**Keywords:** interconnected air suspension; model predictive control; cooperative control; ride comfort; interconnected mode

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## 1. Introduction

The suspension system is the transmission device connecting the wheels and the body, and mainly undertakes the sprung mass and ensures good contact between the tires and the road, as well as reducing uneven excitation from the road surface [1,2]. Air suspension is a typical semi-active suspension, which has the characteristics of variable stiffness and low vibration frequency, which can effectively improve vehicle handling and ride comfort [3]. Researchers have studied roll [4], pitch [5], elimination torsion [6], and stability [7] in the air suspension field. Moreover, air suspension consumes less energy than active suspension. Air suspension is considered to have broad application prospects [8].

Interconnected air suspension (IAS) is developed by using pipes to connect the air springs in a suspension system. There is an excellent performance in vibration isolation and adjusting the pitch and roll stiffness by switching the interconnected modes of the IAS. To improve vehicle performance, some scholars carried out several control strategies in ISA and received good results. Sun et al. [9] proposed a cooperative control strategy based on interconnection state logic switching and game control of distributed damping. The result showed that this coordinated system can significantly improve ride comfort and restrain the pitching motion. Hossein Nazemian et al. [10] developed an optimized hybrid fuzzy-PID to control the height and roll angle in a novel interconnected air suspension system. The result showed that the roll angle is improved compared with a passive case and conventional configuration. Kai Cao et al. [11] designed a PID transverse interconnected electronic control air suspension system controller based on a seeker opti-

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## **Table of Contents Research Papers On Air Suspension**

1. Understanding the eBook Research Papers On Air Suspension
  - The Rise of Digital Reading Research Papers On Air Suspension
  - Advantages of eBooks Over Traditional Books
2. Identifying Research Papers On Air Suspension
  - Exploring Different Genres
  - Considering Fiction vs. Non-Fiction
  - Determining Your Reading Goals
3. Choosing the Right eBook Platform
  - Popular eBook Platforms
  - Features to Look for in an Research Papers On Air Suspension
  - User-Friendly Interface
4. Exploring eBook Recommendations from Research Papers On Air Suspension
  - Personalized Recommendations
  - Research Papers On Air Suspension User Reviews and Ratings
  - Research Papers On Air Suspension and Bestseller Lists
5. Accessing Research Papers On Air Suspension Free and Paid eBooks
  - Research Papers On Air Suspension Public Domain eBooks
  - Research Papers On Air Suspension eBook Subscription Services
  - Research Papers On Air Suspension Budget-Friendly Options

6. Navigating Research Papers On Air Suspension eBook Formats
  - ePub, PDF, MOBI, and More
  - Research Papers On Air Suspension Compatibility with Devices
  - Research Papers On Air Suspension Enhanced eBook Features
7. Enhancing Your Reading Experience
  - Adjustable Fonts and Text Sizes of Research Papers On Air Suspension
  - Highlighting and Note-Taking Research Papers On Air Suspension
  - Interactive Elements Research Papers On Air Suspension
8. Staying Engaged with Research Papers On Air Suspension
  - Joining Online Reading Communities
  - Participating in Virtual Book Clubs
  - Following Authors and Publishers Research Papers On Air Suspension
9. Balancing eBooks and Physical Books Research Papers On Air Suspension
  - Benefits of a Digital Library
  - Creating a Diverse Reading Collection Research Papers On Air Suspension
10. Overcoming Reading Challenges
  - Dealing with Digital Eye Strain
  - Minimizing Distractions
  - Managing Screen Time
11. Cultivating a Reading Routine Research Papers On Air Suspension
  - Setting Reading Goals Research Papers On Air Suspension
  - Carving Out Dedicated Reading Time
12. Sourcing Reliable Information of Research Papers On Air Suspension
  - Fact-Checking eBook Content of Research Papers On Air Suspension
  - Distinguishing Credible Sources
13. Promoting Lifelong Learning
  - Utilizing eBooks for Skill Development
  - Exploring Educational eBooks
14. Embracing eBook Trends
  - Integration of Multimedia Elements

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