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# A Unified Design Method for FOPID Controllers in Active Suspension Systems

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Sujay Kumar Dolai ; Arindam Mondal ; Prasanta Sarkar All Authors

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## Abstract

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- II. Active Suspension System Performance Metrics
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### Abstract:

This study explored the use of fractional order PID (FOPID) controllers for active vehicle suspension, addressing the challenges of discretization for real-time application. Simulations on a quarter-car model were conducted to compare the performance of a novel direct delta domain FOPID (delta-FOPID) with traditional z-domain FOPID and continuous time FOPID implementations. The results indicated that the delta-FOPID outperformed the other methods, especially at very low sampling times, where the z-domain FOPID showed numerical instability. The delta-FOPID's improved accuracy and stability, achieved by closely approximating continuous time control behavior as the sampling time (delta) approaches zero, led to significant enhancements in ride comfort, road handling, and suspension deflection. These findings underscore the potential of fractional order control and direct delta domain discretization for creating advanced and robust active suspension systems.

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### I. Introduction

Vehicle suspension systems are essential components that connect the wheels to the vehicle body. They serve to isolate the vehicle chassis from road disturbances, such as bumps and potholes, ensuring passenger comfort and safety [1], [2]. A well-designed suspension system effectively mitigates these disturbances, preventing them from transmitting excessive forces and vibrations to the vehicle structure. Moreover, suspension systems play a crucial role in maintaining tire contact with the road, which is essential for steering, braking, and overall vehicle stability.

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### Authors

Sujay Kumar Dolai

Dept. of Electrical Engineering, Institute of Engineering & Management and University of Engineering and Management Kolkata, Kolkata, India

Arindam Mondal

Dept. of Electrical Engineering, Dr. B C Roy Engineering College, Durgapur, India

Prasanta Sarkar

Dept. of Electrical Engineering, NITTTTR Kolkata, Kolkata, India

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