

Abstract:

" Mathematical Study of Motion and Control of Low Earth Orbit Satellites Under the Effect of Earth's Zonal Harmonics and Atmospheric Drag"

This thesis delves into the intricate dynamics and control mechanisms governing low Earth orbit (LEO) satellites amidst the influences of Earth's zonal harmonics and atmospheric drag. It begins with a comprehensive review of celestial mechanics, tracing its historical evolution and pivotal milestones, highlighting its profound impact on modern space exploration. The significance of artificial satellites in contemporary society is elucidated, emphasizing their crucial roles in communication, navigation, Earth observation, scientific research, and national security. Control theory emerges as a fundamental framework for analyzing and influencing the behavior of dynamical systems, providing insights into its historical development, key concepts, and wide-ranging applications.

Motivated by the critical need for precision in satellite motion control, the thesis scrutinizes the challenges posed by nonlinear dynamics, uncertain environments, and resource constraints. Through a nuanced exploration of controllability analysis and trajectory optimization, it endeavors to enhance our understanding and capabilities in ensuring the reliability, longevity, and adaptability of satellite-based systems. The thesis is structured into two parts, with the initial segment laying the foundational principles of celestial mechanics, artificial satellites, control theory, and the imperative driving the research. The subsequent part delves into the mathematical modeling of satellite motion, exploring controllability analysis and trajectory optimization under the influence of Earth's zonal harmonics and atmospheric drag.

In summary, this thesis represents a seminal contribution to the discourse on satellite motion and control, offering profound insights into the mathematical intricacies and practical challenges of managing satellites in LEO. By embracing innovative methodologies and leveraging cutting-edge advancements in control theory, it aspires to propel our capabilities towards ensuring the efficacy, resilience, and sustainability of satellite-based systems in an ever-evolving technological landscape.