

# Modeling, simulation, and control of the spacecraft attitude dynamics

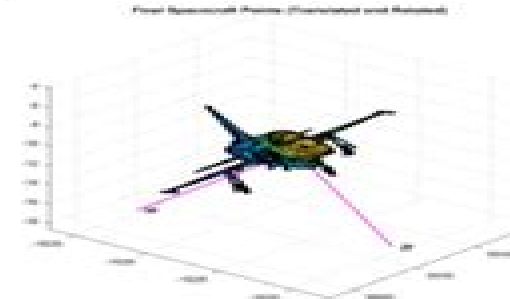
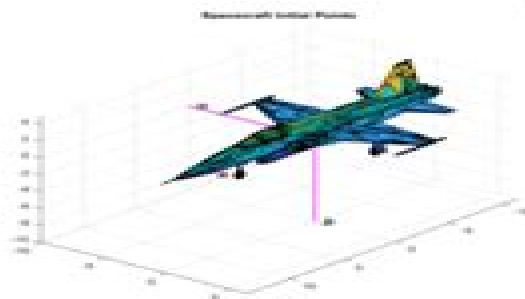
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## Abstract

*Based on the three-dimensional dynamics of a rigid body and Newton's laws, the simplified dynamics of a spacecraft is studied and described through the systematic representation, mathematical modeling and also by a block diagram representation, to finally simulate the spacecraft dynamics in the Matlab programming environment called Simulink. It is paramount to be able to identify and recognize the attitude (often represented with the Euler angles) and position variables like the degrees of freedom (DOF) of the system and also the linear behavior. All this to conclude up about the non-linear behavior presented by the accelerations, velocities, positions and Euler angles (attitude) when those mentioned are plotted against time. In addition to this, the linearized system is found in order to facilitate the control analysis and stability analysis, at using linear analysis tools of Simulink and concepts like controllability and observability, reaching the point of determining under the previous concepts to proceed with the control design phase. Lastly, an uncertainty and sensitivity analysis is realized, by means the Monte-Carlo and the Linear regression method (in Simulink too), to find the torque like critical model input, since it has the greatest effect on the response variables in the system; and thus finally, to implement the Linear Quadratic Regulator (LQR) controller, at using the `lqr` Matlab function.*



**Keywords:** Attitude; mathematical model; block diagram; simulation; linearization; stability; controllability and observability; uncertainty and sensitivity; linear and angular momentum conservation; Euler angles; Monte-Carlo Method; Linear Quadratic Regulator; Simulink.

## I. INTRODUCTION

**I**n this research, the dynamics of a spacecraft is studied, it is based on the dynamics of a rigid body in three dimensions, this through the laws of conservation of angular and linear momentum,

to then acquired with these, information about the attitude (Euler angles) and about the position to have finally information about the 6DOF (Degrees Of Freedom), that is, about the three rotations ( $\phi$ ,  $\theta$ ,  $\psi$ ) and the three translations ( $x$ ,  $y$ ,  $z$ ). Therefore, motivated to apply and articulate what

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