Launch Vehicle Linear Dynamic Inversion and Trajectory Estimation

- Aerodynamic control surface and TVC
- Vehicle Attitude Control

Abstract

What is LDI?

Objectives

Why LDI

Key takeaway

Project Plan

What is LDI?

1. LDI (Linear Dynamic Inversion) directly computes the control input needed to achieve a desired acceleration or rate of change in the system states.
2. It assumes the model is accurate and linear (or linearized), and is often used for fast, responsive control like in aircraft attitude or missile guidance.

Why LDI

1. LDI provides near-instantaneous response by directly computing control inputs to match desired accelerations or angular rates.

2. Rocket dynamics (at least locally) can often be well-modeled and linearized, especially for attitude control during specific flight phases.

Objectives

1. Design the space mission and define mission requirements based on the mission.

2. Design and Simulate LDI controller of Launch Vehicle based on the mission requirements.

3. Apply controller model into subscale model to verify its performance and compare with other traditional control methods (ex. PID).

Key takeaway

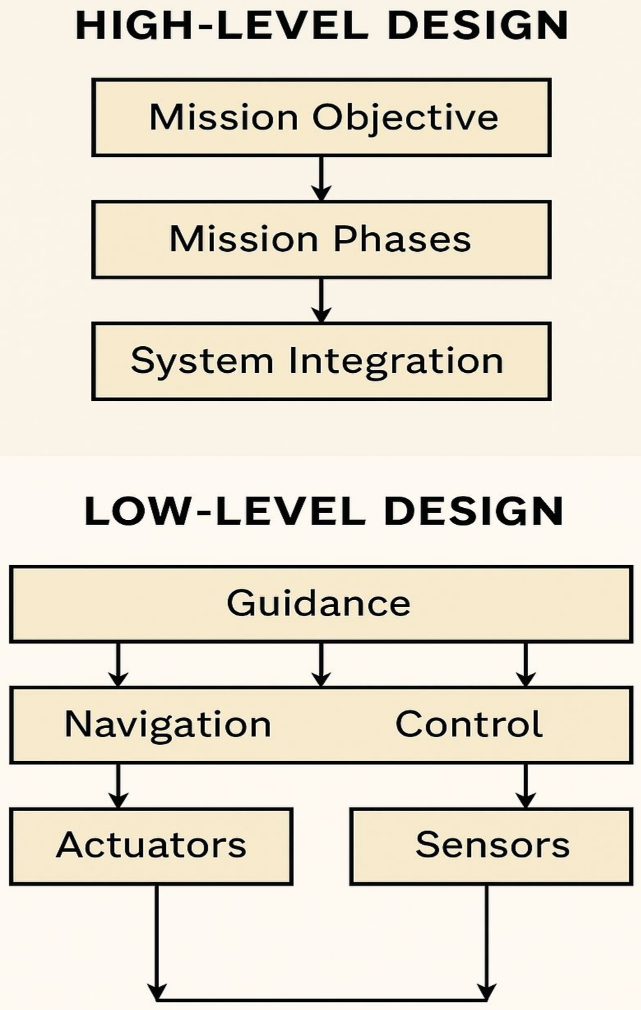
Control and Robotics

1. The value of understanding system dynamics rather than treating the plant as a black box.
2. How control performance depends on model accuracy.
3. Introduction to other model-based control methods (ex. MPC, NDI)

Key takeaway

High/Low-level Design

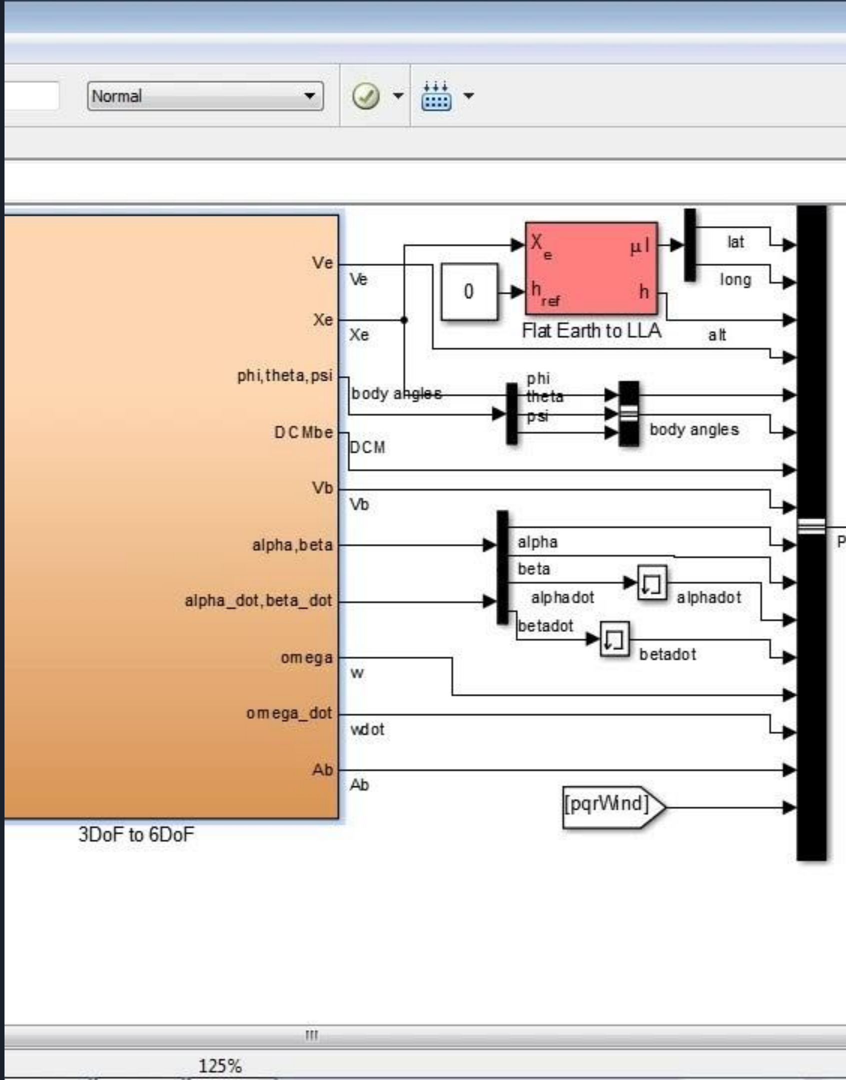
1. Mission-driven thinking
2. System integration
3. Phase-based control logic



Key takeaway

Space/Flight Vehicle Dynamics

1. Advanced knowledge of spacecraft/flight vehicle dynamics
2. Linearization and State-Space Modeling
3. Frames, Transformations, and Kinematics



Project Plan

- Step 1: Project research and mission profile decision
- Step 2: Control objective Identification
- Step 3: Actuation system selection
- Step 4: Modeling dynamics of vehicle and environment
- Step 5: Controller Design
- Step 6: Simulation or Hardware-in-the-loop test