Roll Control for LV2.3

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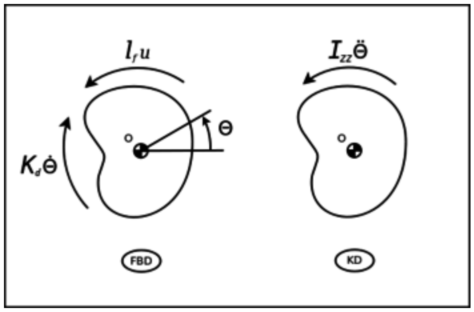
Introduction

The roll control system for the current generation of launch vehicle (2.3) has more or less not been functioning properly since Launch 8. (Nate: explain here some of the problems with previous incarnations of the roll control system). In June of 2014, another attempt at designing a roll control system was initiated. The purpose of this report is to document the process of re-developing the roll control system.

State space model

In this section we set out to develop a state space model for the roll dynamics of the rocket.

Equations approximating the motion of the rocket are derived from free-body diagrams (FBD) and kinetic diagrams (KD), as taught in a mid level mechanical engineering dynamics course. Developing equations in this manner is known as developing from first principles because basic Newtonian principles $F = ma$ are used to derive them. [1] The diagrams are shown below:



From this diagram we get the following differential equation
$I_{zz}\ddot{\theta} = l_f u - K_d\dot{\theta}$ [1]

Modern control theory is founded on the state space approach. Therefore, we will review and discuss important terminology that pertains to developing our state space model.

The **state** of a dynamic system is the smallest set of variables (called *state variables*) such that knowledge of these variables at $t = t_0$, together with knowledge of the input for $t \geq t_0$, completely determines the behavior of the system for any time $t \geq t_0$. [2]

The **state variables** of a dynamic system are the variables making up the smallest set of variables that determine the state of the dynamic system. If at least n variables $x_1, x_2, ..., x_n$ are needed to completely describe the behavior of a dynamic system (so that once the input is given for $t \geq t_0$ and the initial state at $t = t_0$ is specified, the future state of the system is completely determined), then such n variables are a set of state variables. [2]

If n state variables are needed to completely describe the behavior of a given system, then these n state variables can be considered the n components of a veto $\mathbf{x}$. Such a vector is called a **state vector**. A state vector is thus a vector that determines uniquely the system $\mathbf{x(t)}$ for any time $t \geq t_0$, once the state at $t = t_0$ is given and the input $\mathbf{u(t)}$ for $t \geq t_0$ is specified. [2]

The n-dimensional space whose coordinate axes consist of the x_1 axis, x_2 axis,..., x_n axis, where $x_1, x_2, ..., x_n$ are state variables, is called a **state space**. Any state can be represented by a point in the state space. [2]

In state-space analysis we are concerned with three types of variables: input variables, output variables, and state variables.

Blahblah

References

[1] Portland State Aerospace Society, Roll Control Wiki `http://psas.pdx.edu/rollcontrol/`

[2] Katsuhiko Ogata *Modern Control Engineering, Fifth Edition* Prentice Hall, Boston, MA, 2010