Design of attitude determination and control system for KIWISAT amateur satellite.

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Abstract

This thesis is to present the design of “ADAC” system for “KiwiSat” cube satellite. An array of sensors were used: CMOS low resolution camera, sun sensor, earth horizon sensors, 3 axis magnetometer. The control of satellite rely on magnetic coils installed orthogonally to each other. Implementation of this system is essential to achieve the full control of the satellite when it reaches the lower orbit.

Solution for the pitfall such as: the lack of torque of the satellite when it’s parallel to the earth magnetic field, was also designed. Attitude estimation is nonlinear due of kinematics and the reading of above sensors.

Both a proportional-derivative controller and a linear quadratic regulator are implemented for control model of the system. And the Floquet Theory is used to check the stability of the controls, and an optimization method further optimizes the results.

Model was constructed by simulink program that was packaged with mathematical software called “Matlab”.

3D model of the satellite was drawn in SolidWorks for the purpose of visual interaction and behavior.

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Table of Contents

Chapter:

LIST OF TABLES, FIGURES AND GRAPHS

LIST OF SYMBOLS

H - Magnetic field of a bar magnet

r **-** Distance between the magnetic field source and the measurement point

$\widehat{a_r}$ **-** Unit vector from the center of the magnet to the measurement point

M **-** Magnetic dipole moment of the bar magnet

$\mathcal{M}$ - Magnitization

B - Flux density

μ_0 - Magnetization and the permeability of free space

$R_{\oplus}$ - Radius of the Earth

F - Force

q_1, q_2 **-** Electrical charges

v_1, v_2 **-** Drift velocity of the positive charge

n_i **-** Number of positive charges

A_w **-** Cross-sectional area of the wire

l_w **-** Length of the wire

J - Current density

I - Current

B_k **-** Component of the field which is parallel to the wire

N **-** Number of turns of wire

μ - Permeability of the core material

$\hat{n}$ **-** Unit vector normal to plane of the coil

Δg_m **-** Undesired magnetic torque

$\widehat{B}$ **-** Unit vector in the direction of the magnetic fiel

m - Mass of the object

∑F - vector sum of the forces acting on mass of the object

$\ddot{\boldsymbol{r}}$ **-** Vector acceleration of **m**

G - Universal gravitational constant with a value of **6.670 × 10−11$_m$3/(kg·s^2)**

μ - Gravitational parameter

h - Angular momentum

ϕ_f - Fight path angle

p - Semilatus parameter

e - Eccentricity

a **-** Semi-major axis

I - Inclination (chapter 2)

Ω - Right ascension of the ascending node

ω - Argument of periapsis

T - Time of periapsis passage

Π - Longitude of periapsis

ν_0 - True anomaly at epoch

t_0 - Particular epoch

u_0 - Latitude at epoch

l_0 **-** The true longitude at epochs