IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

Author: Mr. Chaitanya Goruputi
U R RAO SATELLITE CENTRE (URSC), India, chaitanyagoruputi@gmail.com

NGC DESIGN FRAMEWORK FOR THE DUAL SWASHPLATE CO-AXIAL HELICOPTER FOR MARTIAN TERRAIN

Abstract

NGC Design framework for the Dual Swashplate Co-Axial Helicopter for Martian Terrain

G.Chaitanya*,Vaibhavraj.P**,Aditya.R*
UR Rao Satellite Centre,KA,Manipal Institute of Technology,KA*

Co-Axial Helicopter can travel to places where a terrain rover can't travel due to craters, harsh land conditions. The Co-Axial helicopter is small in structure and can be stabilized easily in yaw direction by spinning the rotor blades in opposite directions. The typical coaxial helicopter is configured with one servo motor to control the lower swash plate and the inertial bar to control the upper swash plate. Proposed co-axial helicopter consist of two independent servos controlling two swash plates i.e. upper and lower swash plate. This configuration provides better control as well as removes requirement of passive stabilizer bar. Overall NGC architecture to perform a given task like to heave, hover, head forward, head back, and touch down the coaxial helicopter in a Martian environment is the focus of the paper presented. High fidelity six degree of freedom dynamics is developed along with high speed rotors dynamics (mainly flapping and twisting moments) to simulate the co-axial helicopter behavior. Navigation framework then derives the vehicle states namely position, velocity, attitude and angular velocity using EKF with respect to local fixed surface relative reference frame. PV Guidance derives the thrust and tip plane angle required to meet the given target. Control objective here is to achieve the required thrust and tip plane angle. Required thrust is then mapped into collective pitch based on actual blade parameters (derived using wind tunnel tests and CFD analysis) and tip plane angle is converted into servo commands based on inverse kinematics and geometry of co-axial helicopter to set the cyclic pitch of the lower and upper rotor.

ISRO has developed coaxial helicopter which is planned to be flown in Martian atmosphere in near future. Algorithm developed will be then implemented in actual hardware to evaluate overall performance of NGC. In this research, mainly focused on dynamic formulation and NGC design to deriving the blades parameters to be used for converting required thrust and tip plane angle to servo commands. Simulations are performed with parameter variation to validate NGC design.

Key words: Co-axial helicopter, Martian terrain, Navigation, Guidance and control