Title: Reduced-order modeling for rapid mission planning of the Mars 2020 Helicopter

Author: Derek Hengeveld, PhD, PE - LoadPath

Jacob Moulton - LoadPath

Stefano Cappucci – Jet Propulsion Laboratory, California Institute of Technology.

Institution: LoadPath

2309 Renard Place SE, Ste 101

Albuquerque, NM 87106

605.690.1612

dhengeveld@loadpath.com

Topic Area: Interdisciplinary

Abstract:

The Mars Helicopter is a technology demonstration to be conducted during the Mars 2020 mission. The primary mission objective is to achieve several 90-second flights and capture visible light images via forward and nadir mounted cameras. In addition, these flights could possibly provide reconnaissance data for sampling site selection for other Mars surface missions. The helicopter is powered by a solar array, which stores energy in secondary batteries for flight operations, imaging, communications, and survival heating. The helicopter thermal design is driven by minimizing survival heater energy while maintaining compliance with allowable flight temperatures in a variable thermal environment (i.e.. wide range of sky/ground/air temperatures, solar irradiance, and wind speed).

A Thermal Desktop® model was developed to help with mission planning for the next Sol (solar day on Mars). The model predicts eight component temperatures (e.g. battery, camera, etc.) and available battery energy as a function of environmental/convection conditions and a battery set-point profile. Given the broad range of input/output factors and limited time in which to perform simulations and evaluate the results, a reduced-order model (ROM) was developed. The ROM, created with the Veritrek software, was used to quickly find a battery set-point profile which optimized battery energy for rapidly changing environmental conditions. As a result, the ROM will be used during mission operations to provide engineers with the proper battery set-point profile to use for the next Sol’s helicopter flight, based on measured telemetry data from the previous Sol.

This paper describes the Mars Helicopter mission, Thermal Desktop® model, and development of the ROM. A description of how the ROM will be used in mission planning for this upcoming mission will be provided.