Paper ID: 17327
oral
student

20th SYMPOSIUM ON SMALL SATELLITE MISSIONS (B4)
Small Distributed Space Missions (7B)

Author: Ms. Sreeja Nag
Massachusetts Institute of Technology (MIT), United States

DESIGN AND ANALYSIS OF DISTRIBUTED NANO-SATELLITE SYSTEMS FOR MULTI-ANGULAR, MULTI-SPECTRAL EARTH OBSERVATION

Abstract

Multi-angle, multi-spectral remote sensing furnishes measurements of a very important target property called Bidirectional reflectance-distribution function (BRDF). BRDF of an optically thick body is a property of the surface material and its roughness, and depends on 3D geometry of incident and reflected elementary beams. It is used in many earth science remote sensing applications, e.g. derivation of surface albedo, calculation of radiative forcing, land cover classification and aerosol optical properties. Thus, a dedicated BRDF space mission requires radiance measurements across a large 3D angular spread of solar illumination and detector directions, fine spatial resolution, frequent repeat of the ground track for a high temporal resolution and large spectral range in the visible and near infrared (VNIR) solar spectrum.

Current spaceborne instruments provide sparse sampling of the BRDF function. These instruments estimate BRDF by making multi-angular measurements owing to their large cross track swath (e.g. MODIS), multiple forward and aft sensors (e.g. MISR), or autonomous maneuverability to point at specific ground targets that they have been commanded to observe (e.g. CHRIS). But all the instruments fall short in at least one major BRDF science metric mentioned and trade-offs between variables depend on geo-science applications.

Our overall goal is to show that nanosatellite clusters can be used to estimate BRDF globally, better, cheaper and faster than current sensors and will complement existing BRDF data products. The cluster will 'formation' fly on an orbit selected for appropriate solar illumination angles, each satellite with a VNIR imaging spectrometer. They will make multi-spectral measurements of a ground spot at multiple 3D angles at the same time as they pass over. Our proposed approach leverages and builds on the technologies of the 6U cubesat standard (a standard satellite bus ideal for university programs and the largest satellites for launch on the Poly-PicoSatellite Orbital Deployer) and the GENSO (Global Educational Network for Satellite Operations) ground station network.

Specific research goals are evaluating the technical feasibility of such clusters to sample the BRDF function, selecting the Pareto optimal clusters and comparing monolithic counterparts. To achieve our research objectives, we have built a system engineering (SE) model integrated with BRDF estimation science models for tradespace exploration. The model will allow optimization within the individual SE modules (cluster geometry, attitude control systems, payload and complexity evaluation) to maximize metric values of performance and resources.