C U A V A

ARC TRAINING CENTRE FOR CUBESATS, UAVs, AND THEIR APPLICATIONS

Australian Government
Australian Research Council

PhD Research Project List

PROJECT 1.1 PLASMA THRUSTERS

Description:

The objective of this project is to extend the initial working model of the Miniaturized Charge eXchange Thruster (MCXT; provisional Australian patent), into a space-qualified, fully tested, and commercial thruster with a modular construction that can be easily added externally to CubeSats. This project will refine the design by elucidating the plasma physics via theoretical modelling and spectroscopic experiments.

Project Chief / Partner Investigators:

Iver Cairns (Sydney - CI); Joe Khachan (Sydney - CI); Xiaofeng Wu (Sydney - CI)
Weitang Li (DSTG - PI); Gregory Chamitoff (Texas A&M - PI)

PROJECT 1.2 GIGABIT/S COMMUNICATIONS

Description:

The objective of this project is to build, test, and refine the design of Air@Wave Communications communication system for CubeSats and UAVs, converting it into a fully space-tested, widely-used, and profitable CubeSat and UAV communications system.

Project Chief / Partner Investigators:

Iver Cairns (Sydney - CI); K C Wong (Sydney - CI); Andrew Dempster (UNSW - CI)
Paris Michaels (Air@Wave - PI)

PROJECT 1.3 SNAP-TOGETHER, PLUG-AND-PLAY, ASSEMBLED CUBESATS

Description:

The objective of this project is to explore and develop plug-and-play CubeSats and their systems, some of which will have applications to UAVs.; analyse existing Commercial Off-The-Shelf (COTS) CubeSat parts, especially their electrical and mechanical connectivity; refine these connections and products, UNSWs 3D-printed CubeSat structure, and USydney's CubeSat boards; implement plug-and-playsoftware; develop and test initial snap-together plug-and-play CubeSat kits, using external and new components as desired; and commercialise the systems, refining as needed.

Project Chief / Partner Investigators:

Iver Cairns (Sydney - CI); Xiaofeng Wu (Sydney - CI); Andrew Dempster (UNSW - CI); Elias Aboutanios (UNSW - CI); Ediz Cetin (MQ - CI); Andreas Antoniades (Saber Astronautics - PI); Gregory Chamitoff (Texas A&M - PI)

THE UNIVERSITY OF SYDNEY · UNSW SYDNEY · AIR@WAVE · ArborCarbon · Australian Government Bureau of Meteorology · Australian Government Department of Defence Defence Science and Technology Group · HyVista Corporation · R·I·T · SABER ASTRONAUTICS · TEXAS A&M UNIVERSITY

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PROJECT 2.1 COMPACT IMAGERS

Description:
This project will focus on broadband optical imaging applications, aiming to develop, build, and test a novel, very high fidelity (narrow point-spread function), 10-cm long system without mirrors for a 1U CubeSat and UAVs.

Project Chief / Partner Investigators:
Sergio Leon-Saval (Sydney - CI); Jon Lawrence (MQ - CI); Iver Cairns (Sydney - CI)

PROJECT 2.2 PHOTONIC SPECTROMETERS AND HYPERSPECTRAL IMAGERS

Description:
The focus of this project is on developing, building, and testing the first fully photonic CubeSat-sized spectrographs and hyperspectral imagers for CubeSats and UAVs, analyse them theoretically and experimentally, with the intention of revolutionising spectroscopic imaging in space.

Project Chief / Partner Investigators:
Sergio Leon-Saval (Sydney - CI); Jon Lawrence (MQ - CI); Iver Cairns (Sydney - CI);
Roy Hughes (Sydney - CI); Stephen Carr (DSTG - PI); Daniel Bongiorno (DSTG - PI); Terry Cocks (HyVista - PI); Paul Barber (ArborCarbon - PI)

PROJECT 2.3 CALIBRATION AND VALIDATION

Description:
The focus of this project is to evaluate the capabilities, limitations, and space-readiness of Project 2.1 and 2.2's new instruments using UAV, ground-based, and CubeSat and other satellite data.

Project Chief / Partner Investigators:
Eleanor Bruce (Sydney - CI); K C Wong (Sydney - CI); Roy Hughes (Sydney - CI); Bradley Evans (Sydney - CI); Jon Lawrence (MQ - CI); Iver Cairns (Sydney - CI); Stephen Carr (DSTG - PI); Daniel Bongiorno (DSTG - PI); Gregory Chamitoff (Texas A&M - PI); Chip Bachmann (R.I.T - PI); Terry Cocks (HyVista - PI); Paul Barber (ArborCarbon - PI)

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PROJECT 2.4 RETRACTABLE TETHER

Description:

The objective of this project is to design, build, and test a Retractable Tether Instrument, based on space-qualified Tether (for de-orbiting spaceraft), that will partially retract and deploy multiple times on command to change the spacecraft drag. This will allow us to measure spatio-temporal variations of the extent and density of the plasma and so predict changes in spacecraft drag and orbits. The longterm goal is a commercialisable device that not only de-orbits spacecraft but also provides data to the proposed global ionospheric density network proposed in Projects 3.4 & 3.5

Project Chief / Partner Investigators:

Iver Cairns (Sydney - CI); Andrew Dempster (UNSW - CI); Joe Khachan (Sydney - CI); Jason Held (Saber Astronautics - PI); Andreas Antoniades (Saber Astronautics - PI)

PROJECT 3.1 REMOTE SENSING: COASTAL / MARINE

Description:

The aim of this project is to (a) Perform high resolution mapping with isolation of spectral signatures for inter-tidal and nearshore environments (including reefs) to classify nearshore vegetation and geomorphic features and to monitor spatio-temporal changes in environmental, natural resource, and sea-level conditions, all with multiple public good, scientific, and commercial applications. (b) Exploit Project 2.2's hyperspectral data to develop narrowband spectral indices for retrieval of biophysical coastal parameters, for instance allowing improved estimates of vegetation biomass and sediment properties, relevant to the Great Barrier Reef's health. (c) Identify and perform other projects using similar data and techniques for coastal and marine applications considered important by the team.

Project Chief / Partner Investigators:

Eleanor Bruce (Sydney - CI); Bradley Evans (Sydney - CI); K C Wong (Sydney - CI); Roy Hughes (Sydney - CI); Richard Murphy (Sydney - CI); Iver Cairns (Sydney - CI); Stephen Carr (DSTG - PI); Daniel Bongiorno (DSTG - PI); Chip Bachmann (R.I.T. - PI); Terry Cocks (HyVista - PI); Paul Barber (ArborCarbon - PI)

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PROJECT 3.2 REMOTE SENSING: LAND / AGRICULTURE/ FORESTRY / MINERALS

Description:

The intention of this project is to (a) Extend the team's spatial and spectral feature recognition algorithims, developed for vegetation, and use machine-learning algorithims and eData techniques to differentiate crops, classify native grasses and trees (of particular species), and identify the surface mineralogy. A major focus will be analysis of truly hyper-spectral data (e.g., Projects 2.2 & 3.1), with resolution of 1 nm or less, rather than the broader bandwidth data currently used (e.g. 5nm for NASA's AVIRIS). (b) Use Project 2.1's imaging data in several optical bands, selected for complementarity with existing commercial remote sensing products, to assess CubeSat potential for both validating and better estimating broadscale land cover estimates from moderate resolution sensors. The results will improve and extend the partner's commercial services for vegetation. (c) Identify and perform other projects using similar data and techniques for land-based applications considered important by the team.

Project Chief / Partner Investigators:

Eleanor Bruce (Sydney - CI); Bradley Evans (Sydney - CI); K C Wong (Sydney - CI); Roy Hughes (Sydney - CI); Richard Murphy (Sydney - CI); Iver Cairns (Sydney - CI); Stephen Carr (DSTG - PI); Daniel Bongiorno (DSTG - PI); Chip Bachmann (R.I.T. - PI); Terry Cocks (HyVista - PI); Paul Barber (ArborCarbon - PI)

PROJECT 3.3 GPS SEA-STATE REFLECTOMETRY

Description:

This technique involves the reflection of GPS signals off the sea and their subsequent detection by a GPS receiver on another satellite. Inversion of the delays allows the time-varying location of the reflecting surface to be determined, and so the height and propagation velocity of water waves and the local wind velocity. Crucially, these data can be obtained remotely and over very large spatial regions in the open ocean, major advantages compared with using buoys and ships. This project will make use of UNSW's GPS instruments on the UNSW ECO and INSPIRE-2 CubeSats, as well as on UAVs & new CubeSats, to detect and analyse the reflected signals, develop associated algorithms for extracting the sea state, and then test and validate the results against BoM data. The goal is to make GPS sea-state reflectometry and sea-state predictions widely-used commercial CubeSat data products.

Project Chief / Partner Investigators:

Andrew Dempster (UNSW - CI); Roy Hughes (Sydney - CI); Iver Cairns (Sydney - CI); Stephen Carr (DSTG - PI)

PhD Research Project List

PROJECT 3.4 GPS RADIO OCCULTATION AND SPACE WEATHER

Description:

Reliable detection and tomographic inversion of path-integrated electron density data encoded in GPS signal propagation and phases for satellites undergoing radio occultation is vital for multiple reasons. (a) Observations: we will extend an existing capability for inverting COSMIC-1 radio occultation data to the UNSW GPS instruments on UNSW ECO, INSPIRE-2, and future Centre CubeSats and to COSMIC-2. These and other satellite data will be used by the Bureau of Meteorology in their numerical / computer modelling if provided quickly enough in a suitably calibrated form. (b) Modelling: We will develop a time and spatially varying 3D model for the ionospheric electron density. It will assimilate ionosonde observations with GPS tomographic data from (a), Project 2.4, and possibly INSPIRE-2. Outputs will be compared with independant ground and space data, refining the simulation and assimilation as needed. The project will result in novel Australian capabilities for using these GPS data and for measuring and simulating space weather effects, and will be of use for GNSS Position Navigation and Timing (PNT) and HF radio systems such as OTHR and communications.

Project Chief / Partner Investigators:

Andrew Dempster (UNSW - CI); Iver Cairns (Sydney - CI); David Neudegg (BoM - PI)

PROJECT 3.5 SPACE WEATHER CONTROL SYSTEMS

Description:

Saber Astronautics sells the Predictive Interactive Groundstation Interface (PIGI), mission control software that combines spacecraft datastreams with world-class data mining to give operational intelligence. The primary drivers of space weather events at Earth are the direction and magnitude of the magnetic field and the ram pressure (density times speed squared) of the solar wind. We will apply Saber's data-mining techniques to these drivers for known space weather events in order to extract time-lags and changes in the plasma, magnetic field, and energetic particles suitable for operational prediction of space weather effects on satellites. The envisaged result is one or more sellable plug-in modules for PIGI, thereby both addressing the predictability of space weather and producing commercial outputs for Saber. This research links with projects 2.4 and 3.4 as well.

Project Chief / Partner Investigators:

Iver Cairns (Sydney - CI); Jason Held (Saber Astronautics - PI)