Ke Ao: A Low-Cost 1U CubeSat for Aerospace Education and Research in Hawai'i

I. Problem & Background

Ke Ao is a low-cost 1U CubeSat designed and developed by an undergraduate team of engineering students at the University of Hawai'i at Mānoa. The primary goal of the mission is to take one or more pictures of the Hawaiian Islands from space and automatically identify the Hawaiian Islands using undergraduate team of engineering students at the University of Hawai'i.

II. Project Scope

Spring - Fall 2020
Preliminary and Critical Design reviews. Validate requirements from CubeSat Spec, CSUI, Nanoracks, and stakeholder (HSFL). Board design and assembly.

Future Work for 2021-22
Integration and testing towards space readiness includes manufacturing, functional testing, environmental/system-level testing, and seeking a launch service provider.

III. Systems Engineering

Concept of Operations (CONOPS)

Initial Phase
1. LEO Launch (ISS)
2. Orbit (~90 min)
3. Sun Charging
4. Data Collection
5. Data Processing
6. Data Download (Satnogs and HSFL station)

Performance Budgets

Mass & Volume

For one orbit
- Generated: ~1.5 W av.
- Consumed: 0.5 W av.

Power

Radio Model: RFM95W-433S2
- S/M: @100 mW, 433MHz

Link

Current Estimated mass
- 0.9 kg

IV. CAD Model & Final Unit Cost | Ke Ao’s cost shall be no more than $10,000 with built hardware.

Assembly & Exploded Views

1. Antenna board
2. PLD board
3. PDU board
4. OBC board
5. Pyedboard
6. Pyed battery board
7. Solar Panels (on five faces)

V. Results: Mission | Ke Ao shall take one or more pictures of the Hawaiian Islands from space.

VI. Results: Survival | Ke Ao shall be launch-ready via the NASA CSLI application and requirements.

Thermal Control System (TCS)

TCS maintains operational temperature ranges for all components.

- Key limitation: the batteries: 0 to 45°C
- Current simulation estimates: ~12 to 28°C
- Temperature measurements by sensors on all boards, modeled as 11 surfaces and 275 nodes in simulations

On-Board Computer (OBC) Flight Software (FSW)

EPS generates, stores, and distributes power.

- 5 Solar Panels: total of 9 EMCORE cells
- ~2W per solar panel
- Battery Pack 2SP: Cells Samsung IRR
- 18650-35E, Total capacity: 24 Whr

Electric Power System (EPS)

Communications System (COMMS)

The radio sounds and received commands with Satnogs and HSFL ground station at KCC.

- TR: HSFL ground station at the Kurai’s Community College has HSFL VHF and S-band
- RX: Satongs network

VII. Results: Operations | Ke Ao shall be operated with the HSFL COSMOS software.

Ke Ao is one of three 1U CubeSats currently co-developed at the University of Hawai’i (UH) alongside with Huiapo and the Artemis CubeSat Kit. Mutually beneficial results during development during the COVID-19 pandemic include:

- Provisional low-cost, baseline design by undergraduates engineering students
- More reliance on open-source and commercial-off-the-shelf (COTS) parts
- Documentation of process, user-friendly for other students
- Inception of a satellite-focused, undergrad Vertical Integrated Project (VIP) at UH, mentored by HSFL engineers

VIII. Future Work

- Train machine learning algorithms to detect Hawaiian Island Chain from space (and other ground targets).
- Integrate the Intel Neural Compute Stick 2 (NCS2) with the payload board and integrate software with the HSFL OBC

IX. Conclusion

Ke Ao is one of three 1U CubeSats currently co-developed at the University of Hawai’i (UH) alongside with Huiapo and the Artemis CubeSat Kit. Mutually beneficial results during development during the COVID-19 pandemic include:

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- Inception of a satellite-focused, undergrad Vertical Integrated Project (VIP) at UH, mentored by HSFL engineers
- Synoptic work with:
  - (1) the Huiapo project - delivered in late 2020 in collaboration with K-12 students, and
  - (2) the NASA Artemis CubeSat Kit project - initialized in mid-2020 for increasing accessibility to aerospace education in the public domain.

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