BIRDS Satellite Project as a Model for Capacity Building Towards Sustainable Space Program in Africa

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Outline

- Space Engineering at Kyutech
- Reinventing Space _Let's do more with little_
- BIRDS Satellite Project
- BIRDS Network
- Conclusion
Scholarship announcement!

- 6 graduate students each year –
  - 3 Doctoral degree
  - 3 Master degree.

If you are interested, please see UNOOSA BSTI website

Deadline is January 2018!

International Lean Satellite Workshop- 2018

January 22 - January 24, 2018
Venue: Kitakyushu International Conference Centre

If you are interested, please see me after my talk.

http://cent.ele.kyutech.ac.jp/2018_nets-regist/
Kyushu Institute of Technology

- A national university founded in 1909
  - 4,200 Undergraduate students.
  - 1,300 Graduate students.
  - 360 Faculty members.
  - Engineering, Computer science, Life-science.
- Located in the Kitakyushu region
  - Population of more than 1 million.

http://www.kyutech.ac.jp/english/
Space Engineering International Course (SEIC)

- Started in April 2013 at Graduate School of Engineering, Kyutech to support PNST.

1. Research toward a Master or Doctoral degree.
2. On-the-job training such as space environment testing workshop.
3. Project Based Learning (PBL) through a space project.
4. Space-related lectures in English.
   - Not only engineering, but also space policy and others.
Where are we from?

We are highly diverse and interdisciplinary mid-career Space Engineers from across the Globe.
Why Space Technology?

• Every nation need **skilled workforce to compete** effectively in today’s global market.

• **Space technology** has been identified as one of the available tools for **achieving sustainable goals**.

• **Applications** are evident in several areas of human endeavours such as **earth observation, communication, navigation and science**.

• How can we **create a sustainable, prosperous and peaceful future here on Earth**?
  – Growing population.
  – Planetary boundaries.
Small satellite activities are expanding worldwide

- 2012 (~21 countries)
- 2013 ~ 2015 (+18 countries)
Global participation in space activity is growing as satellite technology matures and spread due to proliferation of Lean Satellites (1kg -50kg)

2017 Nano/Microsatellite Launch History and Forecast (1 - 50 kg)

Projections based on announced and future plans of developers and programs indicate nearly 2,400 nano/microsatellites will require a launch from 2017 through 2023.

Trend of small satellite launch
....Lets go Lean

Space missions *cost too much* and *take too long* to achieve the mission objective.

Reinventing space using modern technology and *willingness to accept risk* to *do much more, much faster with fewer resources.*

Lean satellite project

- Reduction in space mission cost and delivery time.
- Acceptance of higher mission risk and fragility.
- More responsive to world events and end user needs.
- More economical sustainable business model for space industry.
  - Developing countries can adopt this model.
Successfully building and operating the first national satellite and making the foremost step toward indigenous space program at each nation.
Project features

- 7 Participating countries
- 5 Units of 1U CubeSats
- Team of 15 graduate students
- 2 years to achieve satellite Missions
- 6 Missions
- 4 Faculty members
- Operation from 7 ground stations

http://birds.ele.kyutech.ac.jp/
Essential Values

- Human network to achieve innovative System Engineering.
  - Demonstrate that a 1U CubeSat can be built and operated successfully in a **time frame shorter than 2 years** even for countries with limited (or zero) satellite experience with proper design and planning.
  - Starting a **sustainable and robust space program** with minimum budget at universities in emerging or developing countries.
  - **Competition and collaboration** among student members accelerate satellite development process and enhance the satellite quality.

- International Ground station network for CubeSat.
  - Obtain **key experiences regarding operation of satellite** constellation.
  - **Synergetic mission value and capability** via international operation.
Development Philosophy

- Minimize waste of “waiting” and “moving”
  - All development, AIT done at Kyutech

Office & work room (3F)  
Clean room (3F)  
Ground Station (8F)  
UHF/VHF  
Test facility (1F)
System Configuration

- Modularized and Less harness design.
- Share same frequency for TM & TC (UHF/VHF).
- Using Backplane style used in UWE-3.
- Miniaturized single board for OBC, COM and EPS.

Main board and Backplane Designed by Sagami Tsushin Co., Ltd
System Configuration

- Front Access Board
- OBC/EPS/COM Board
- Battery box
- 1200bps/9600bps TX
- Mission Board
- Antenna Board

Top View
### Missions: On-board Missions

<table>
<thead>
<tr>
<th>Mission</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Take photograph of homeland via onboard cameras (CAM)</td>
<td>Using 2 Cameras (SCAMP at 0.3MP, OV5642 at 5MP).</td>
</tr>
<tr>
<td>Digi-singer Mission (SNG)</td>
<td>Exchange of voice data from satellites to Ham Radio receivers (UHF band)</td>
</tr>
<tr>
<td>Measure Single Event Latch-up in orbit (SEL)</td>
<td>By taking log of microcontroller reset events over period of time.</td>
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UN/SA Symposium, Capetown. South Africa December 11th-15th, 2017
Missions; Ground based Missions

- Determination of Satellite Precise Location (POS) without GPS
  Using analysis of TOA from time lag among multiple ground stations

- Atmospheric Density Measurement (ATM)
  Using Orbital analysis from precise satellite tracking information (POS).

- Demonstrate Ground Station Network for CubeSat Constellation (NET)
5 units of 1U CubeSats operated from 7 UHF/VHF ground stations

First time in the World!
Strategy for sustainability

• BIRDS program aims at fostering university space programs in non-space faring countries.
• Often a national space program suffers disruption because of political and economical disturbance.
• University space program is immune to the external disturbances.
• To start with the minimum budget, a university is an ideal place.
  – CubeSat chosen as a training platform for affordability enough at university budget level.
• The university space program cannot grow forever.
  – Need to hand over the national space program to the government or companies.
  – University continue to support the program and provide human resources.
BIRDS Network

• Human network
  – Formed during intensive two years project by “living under the same roof”
  – Assist the infant space programs survive the hard time

• Ground station network
  – The backbone of the inter-university network
  – Enable constellation operation in future.

• Space research using a small satellite constellation generating scientific outputs
Multi-spacecraft manufacturing using lean concept to reduce waste and focus on activities that add values to the manufacturing process.
Project schedule

Project timeline fit into 2 years which is appropriate for a graduate student Master degree

- Bread Board Model
- Engineering Model Development
- Flight Model Development
- Satellite Testing + Delivery to JAXA
- Satellite Launch + Operation

Oct 2015
- 11/25/2015 Mission Definition Review
- 2/29/2016 Preliminary Design Review
- 6/28/2016 Critical Design Review

Jan 2016
- 11/25/2015 Mission Definition Review
- 2/29/2016 Preliminary Design Review

Apr
- 2/29/2016 Preliminary Design Review

Jul
- 6/28/2016 Critical Design Review

Oct
- 6/28/2016 Critical Design Review

Jan 2017
- 11/25/2015 Mission Definition Review
- 2/29/2016 Preliminary Design Review

March
- 11/25/2015 Mission Definition Review
- 2/29/2016 Preliminary Design Review
- 6/28/2016 Critical Design Review

June
- 11/25/2015 Mission Definition Review
- 2/29/2016 Preliminary Design Review
- 6/28/2016 Critical Design Review
- January Safety Review Phase 0123

- All stages of Safety Review is better to be separated

UN/SA Symposium, Capetown, South Africa December 11th-15th, 2017
Outreach Activities
Environment Testing

Thermal Vacuum Chamber

Vibration Test
GEDC-Airbus Diversity Award

BIRDS Satellite Project won the 2017 Global Engineering Dean Council, Airbus Diversity Award for Engineering Education.
BIRDS-1 Satellite Project is undertaken by 15 students from 6 countries (Japan, Ghana, Mongolia, Nigeria, Bangladesh and Thailand).

Lean Satellite project concept is used in the development of the CubeSats.

The 5 CubeSats were launched into the ISS on June 4th (JST) and deployment to space on July 7th, 2017.

Participating students from developing countries shall return home and start a sustainable space program.

BIRDS-2 kicked off in October 2016 with Philippines, Bhutan, and Malaysia. BIRDS-3 started in October 2017 with Nepal & Sri-Lanka.
Thank you for your attention

http://birds.ele.kyutech.ac.jp/