Flight & Mission Report
Ibis Works

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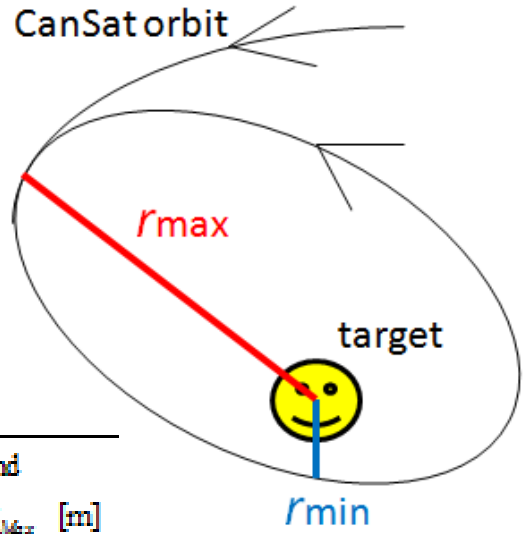
Tales of Ibis Works

- A student in my lab., TOKI, Shuhei,
  - constructed an innovative control law for fly-back type CanSat,
  - confirmed effectiveness of the control law with simulation,
  - and tried to demonstrate the control law in the last ARLISS,
  - but failed it because of a slight mistake in the program.
- The innovative control law guides a CanSat to the target STABLY, which depends on EITHER a distance OR azimuth to the target.
- So that after his graduation,
  - I, as his supervisor, had to retry the demonstration in ARLISS2011,
  - and would confirm effectiveness of the law with DISTANCE.

An Innovative Control Law with DISTANCE

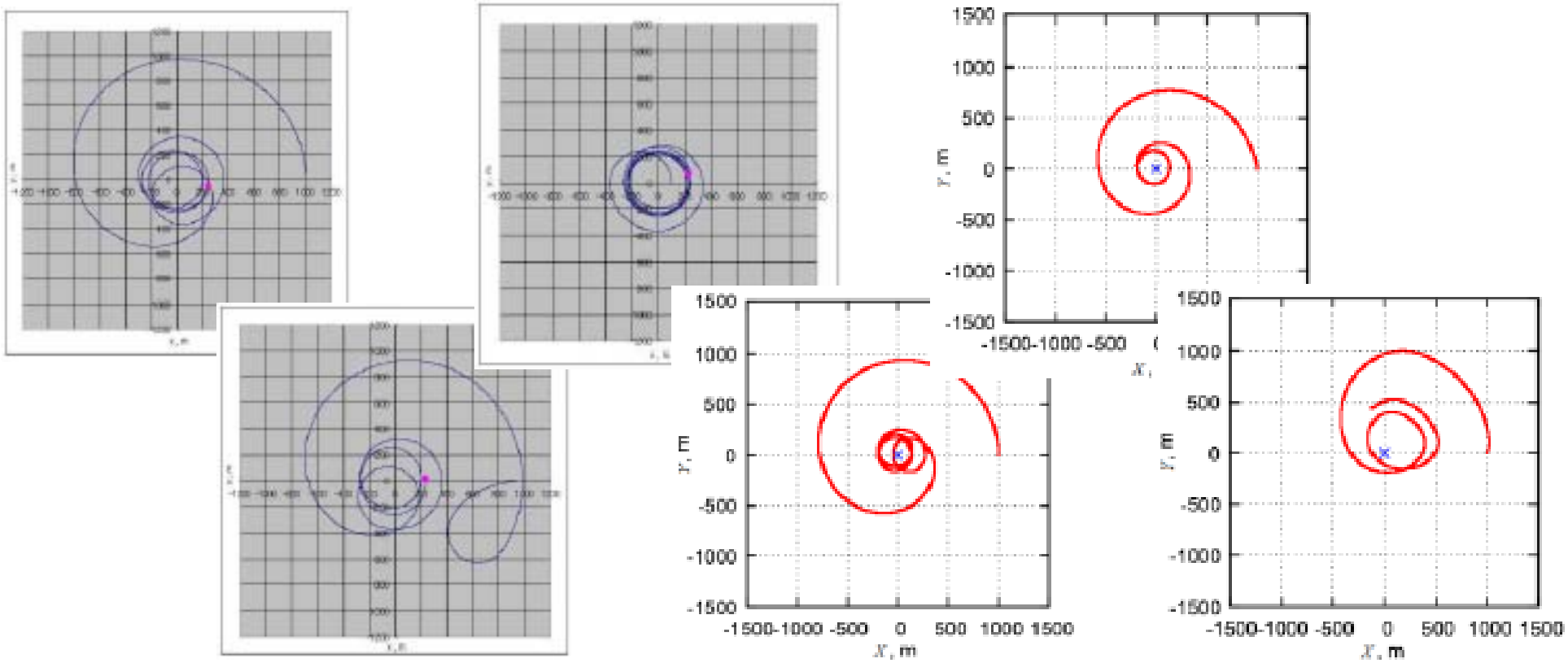
- CanSat
  - calculates rotation angle of servomotors with the control law,
  - and attains CanSat to reach an stable orbit around the target under a level of wind speed.
- We estimated
  - radii of the orbit on ahead as the table,
  - And landing point in a region inside of the orbit.



	Beaufort number	Steady wind r_{min} [m]	Steady wind r_{Max} [m]	Unsteady wind r_{min} [m]	Unsteady wind r_{Max} [m]
Law C	B_0	136.0	221.4	136.2	221.4
	B_1	131.6	269.7	132.2	269.7
	B_2	117.2	414.2	117.2	414.2
	B_3	92.6	546.7	93.0	543.0
	B_4	72.2	746.4	72.3	739.3
	B_5	1000.0	5916.6	1000.0	5766.6

Simulation Results

- We conducted simulations under many conditions of wind speed, velocity and azimuth at separation, and so on,
- tabulated them in the table, and adjusted control parameters in CanSat.



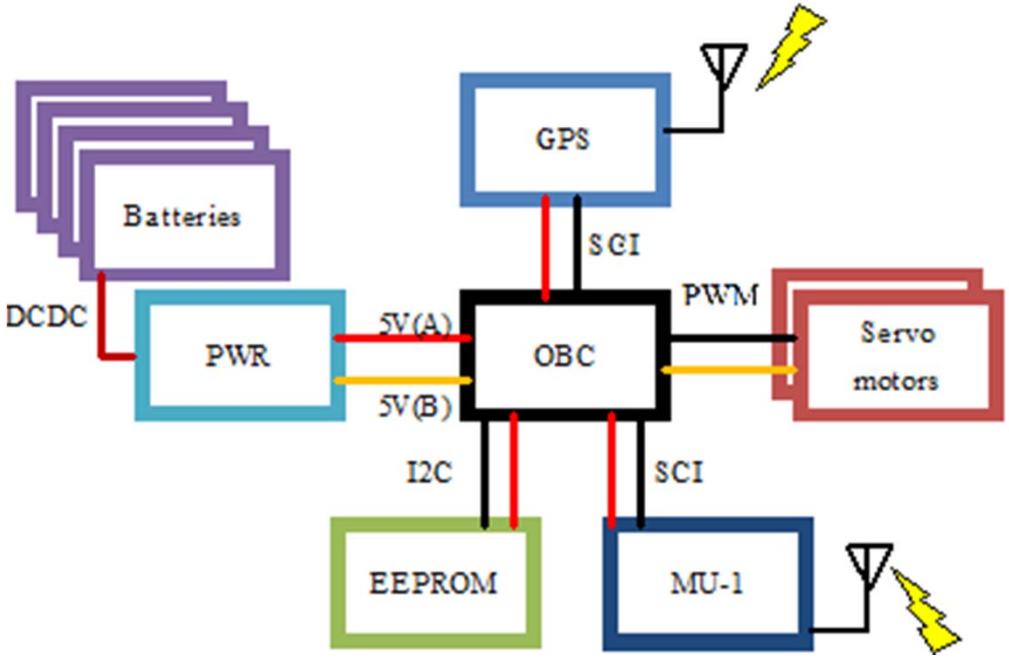
Mission Items

- Definition of Full Success
  - Our CanSat approaches the region from *r*min to *r*max around the target stably according the law, and lands within the region.

- Definition of Minimum Success
  - Our CanSat calculates the control parameter for servomotors installed by using a distance to the target, and tries to approach the region from *r*min to *r*max around the target stably, according to the law.

System Block Diagram

- Our CanSat has
  - a main on-board computer (OBC) centered in the whole system,
  - and components of Batteries, Power Supply, GPS, Servomoters, EEPROM, and Transceiver, are connected to OBC, respectively.
- OBC is driven by 20MHz quartz to avoid interference against GPS data acquisition.

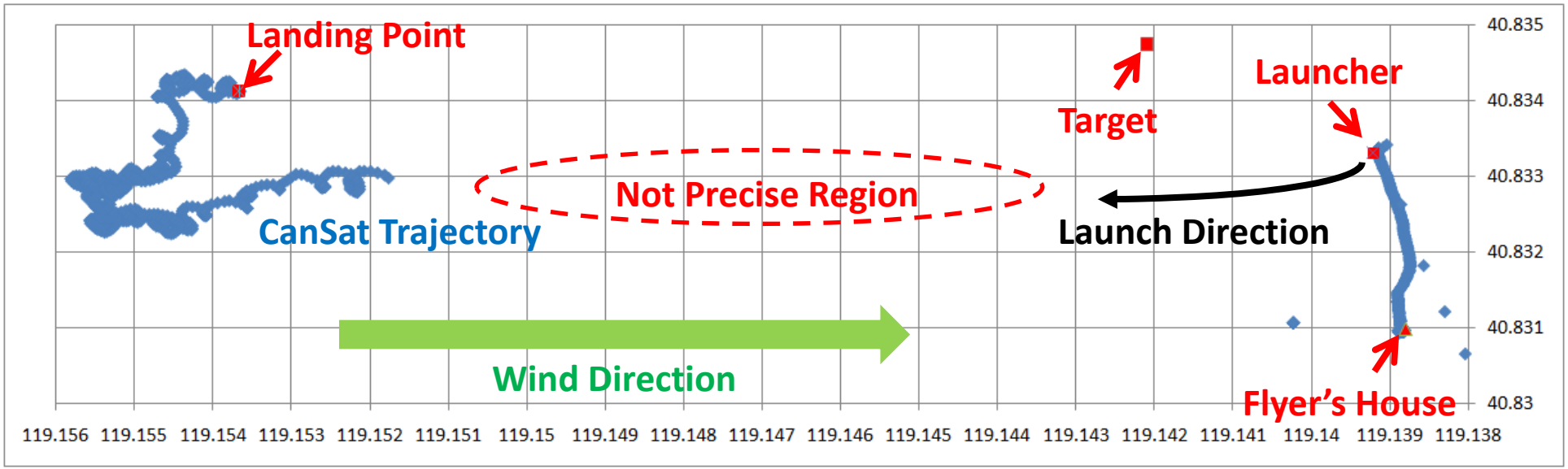


Result of 1st Flight

- The result is not of success.
- We found three facts from the recorded data as follows:
  - Whole system was operated with no problem UNTIL separation.
  - GPS sensor was transmitting a set of data to OBC, but could not acquire the GPS satellites.
  - Aspect of GPS had no trouble.
- Analysis resulted in a process to the failure that…
  - structure of CanSat was broken due to shock at the separation,
  - a shelf in the CanSat installing the GPS sensor was stirred after separation,
  - which broke the GPS sensor electrically, or circuit around antenna.
- It was caused by only one screw of aluminum.

Result of 2nd Flight

- CanSat
  - operated with no problem, and landed at the point of 978m from the target,
  - was separated from the rocket at 3,185m, and thrown to 4,738m after the separation, which indicated velocity of CanSat at the separation was 174m/s.
- With not-so-high precision,
  - the maximum speed of rocket was 267m/s at 3 sec after lift-off,
  - the max./min. acceleration of CanSat was +18G at 3 sec and –11.6G at 4 sec after the lift-off, respectively.



Evaluation of Flight

- The repeated circular motion with 10m in radius, is caused by roll offset of parafoil.
- Our CanSat was approaching to the target according to the law, compared to the simulation with a similar condition.
- Suppose that about 10m/s-wind blew in the sky, our CanSat landed within the region we had estimated.

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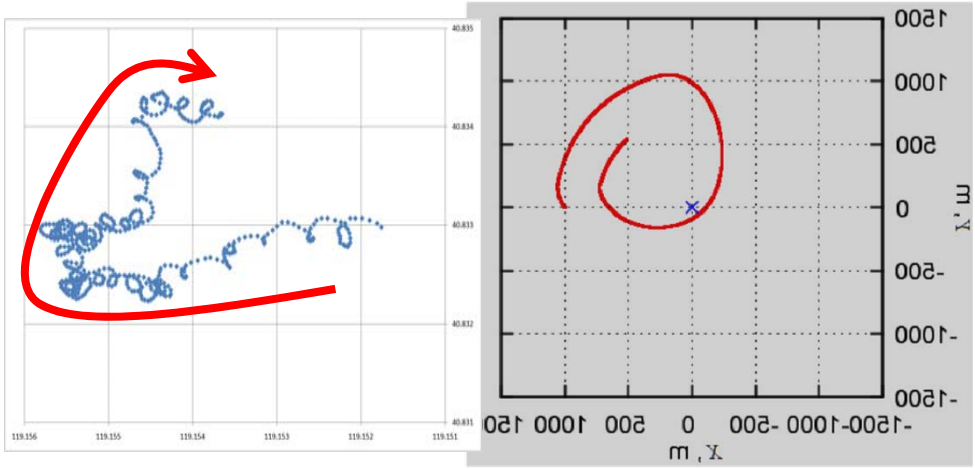

Summary

- We conducted two flights with an innovative control law for fly-back type CanSat, and a flight confirmed it effective under a windy condition.
- Our CanSat approached to the target, and landed within the region we had estimated, which indicates that we attained Full Success of our mission.
- In ARLISS2012,
  we would like to confirm the law with AZIMUTH.

Acknowledgment

We gratefully thank the flyers of our flight,
and all the members of AeroPac and ARLISS2011!