CanSat Leader Training Program (CLTP) - 8th Cycle

Final Presentation

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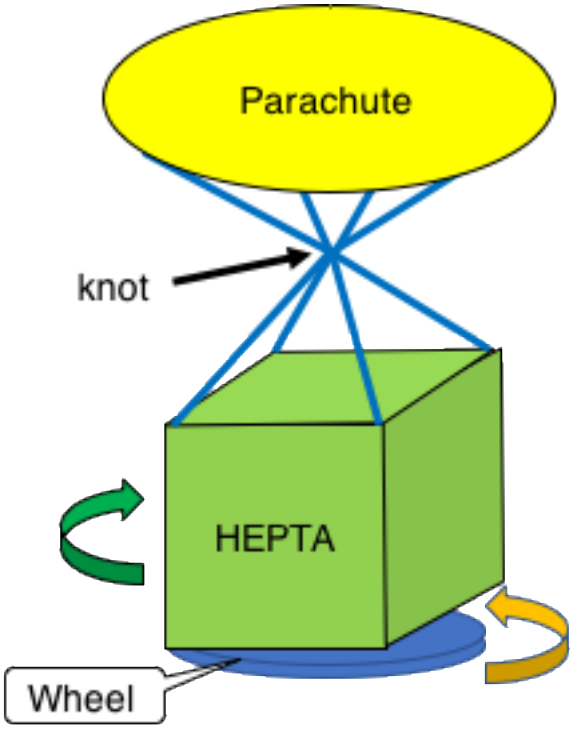
Mission Statement

Attitude control system with reaction wheel

Using camera in CanSat is popular in Japan

A lot of CanSats doesn't control its attitude in the air

It is difficult that turn the camera on intended direction



The range of camera mission will expand

Mission Statement

Minimum Success 50 % success	Fundamental functions & Survival • To open parachute and soft landing • To get data from sensors
Full Success 100 % success	Reaction wheel • To rotate the wheel • To get angular velocity data which shows that attitude is affected by the reaction wheel
Advanced Success 120 % success	Feedback control • Feedback controlling the wheel's rotating speed by sensor data • Stop the rotation of main structure

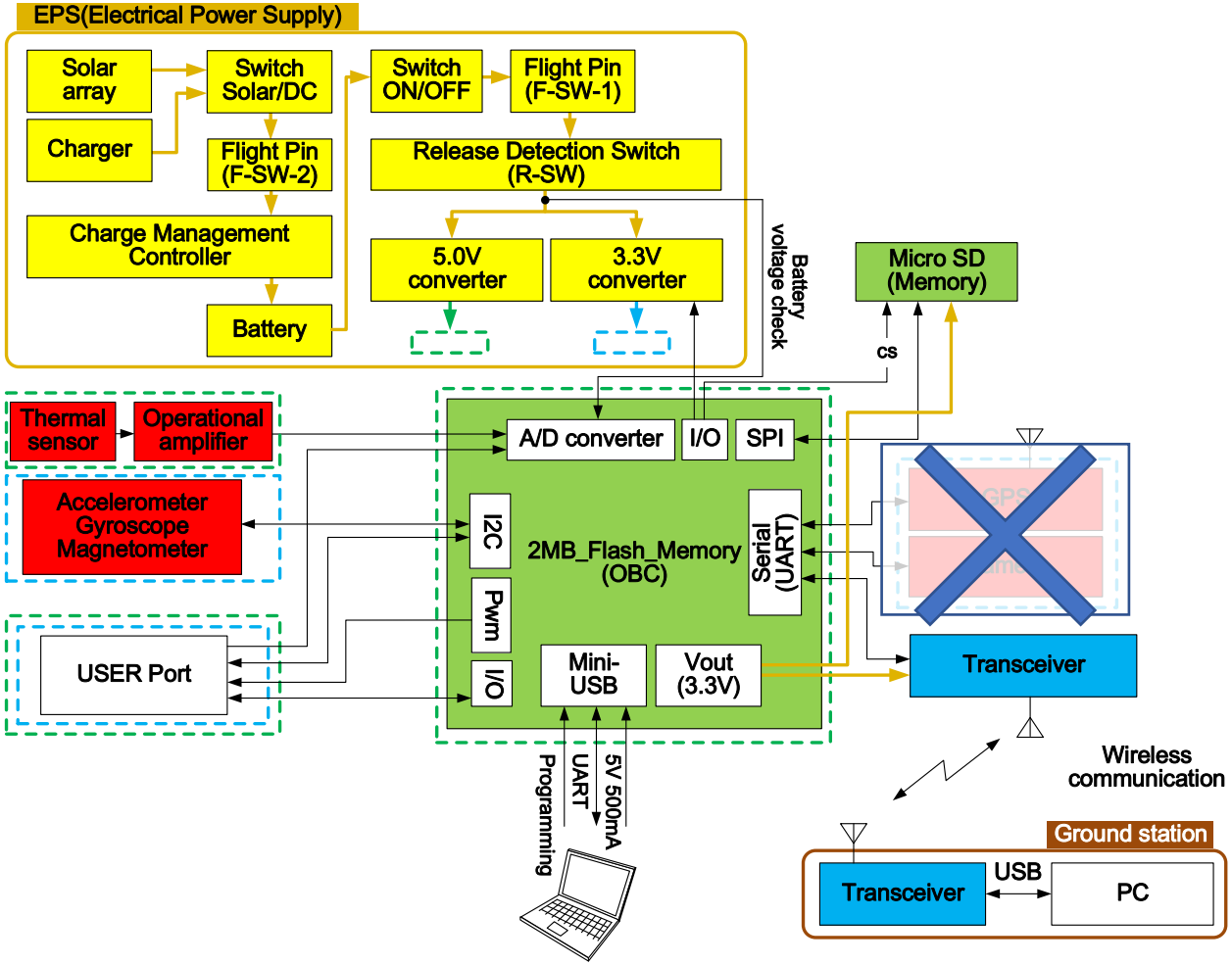
Mission Requirements

No.	Event	Requirement
R-1	Preparation phase (Test phase)	Not to work unintentionally
R-2		Reprogram the OBC
R-3		Power supply from external source
R-4		To check internal data in HEPTA
R-5	Standby time phase	Battery voltage is 4.0V or more
R-6		Connection between HEPTA and GS
R-7		To start rotation of the wheel
R-8		To stop rotation of the wheel

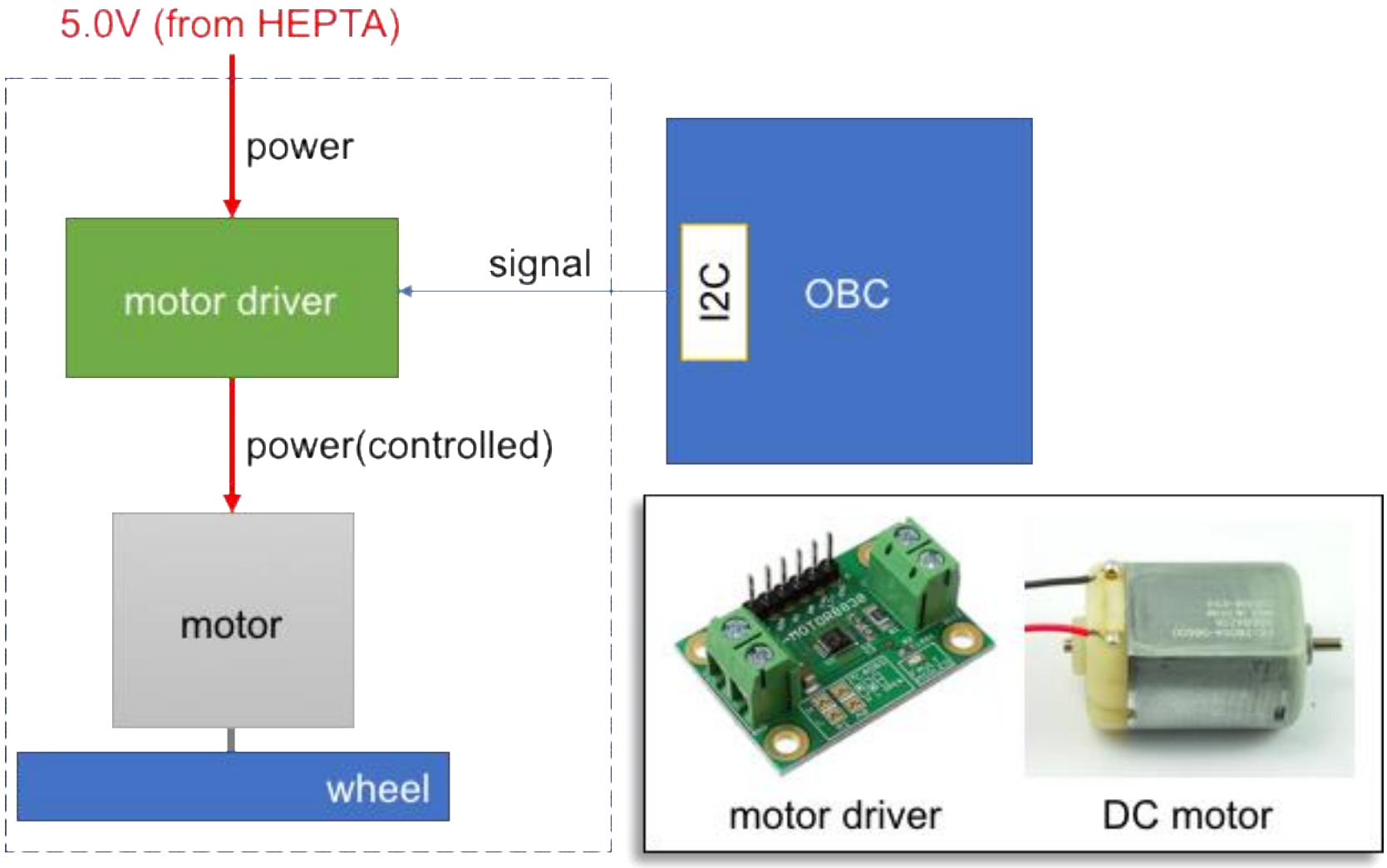
Mission Requirements

No.	Event	Requirement
R-9	Launch phase	Not to rotate wheel unintentionally
R-10		Connection between HEPTA and GS
R-11	Mission phase	To start rotation of the wheel after release
R-12		Rotation of the wheel affects HEPTA's angular velocity
R-13		To get angular velocity and motor status
R-14		To get log of software process
R-15	Analysis phase	To get correlation between angular velocity and rotation of wheel
R-16		To get log of software

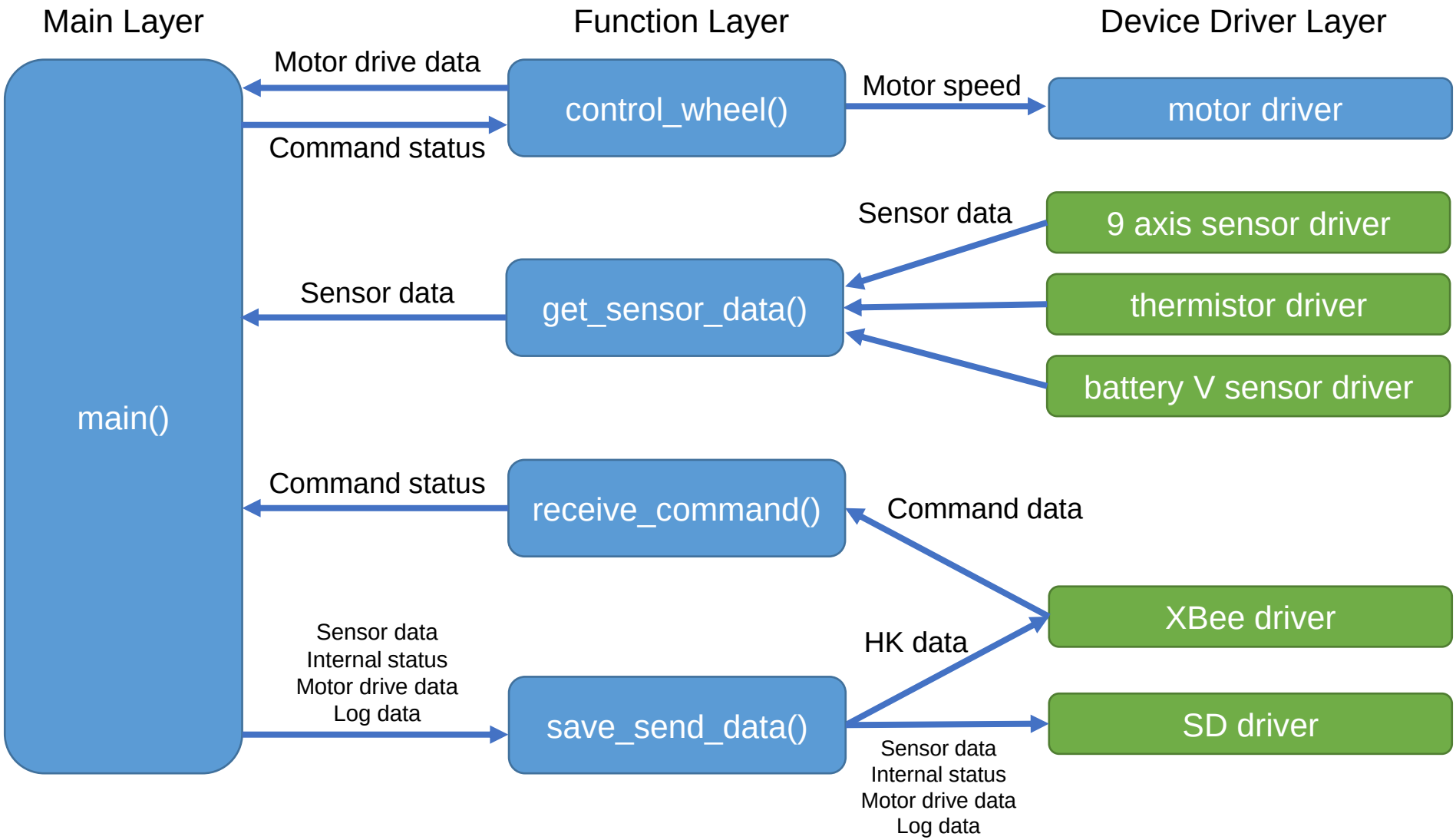
Bus System Architecture



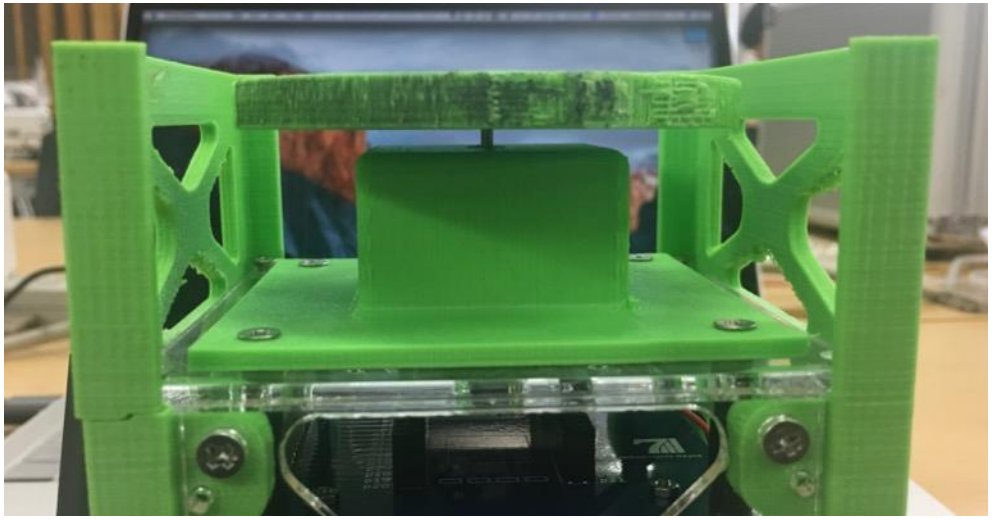
Payload Subsystem Architecture (hardware)

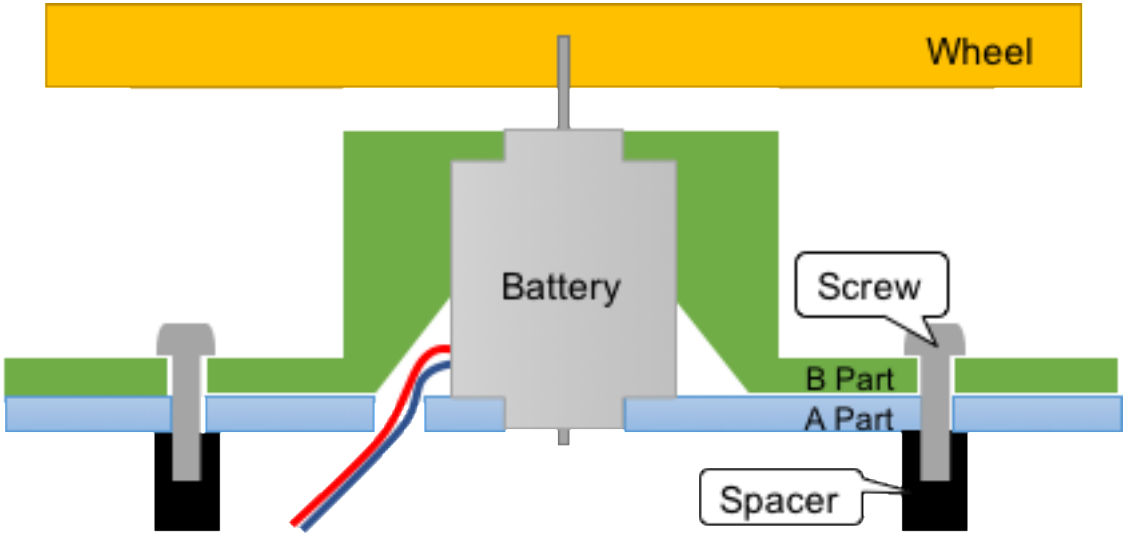


Payload Subsystem Architecture (software)



Payload Subsystem (structure)





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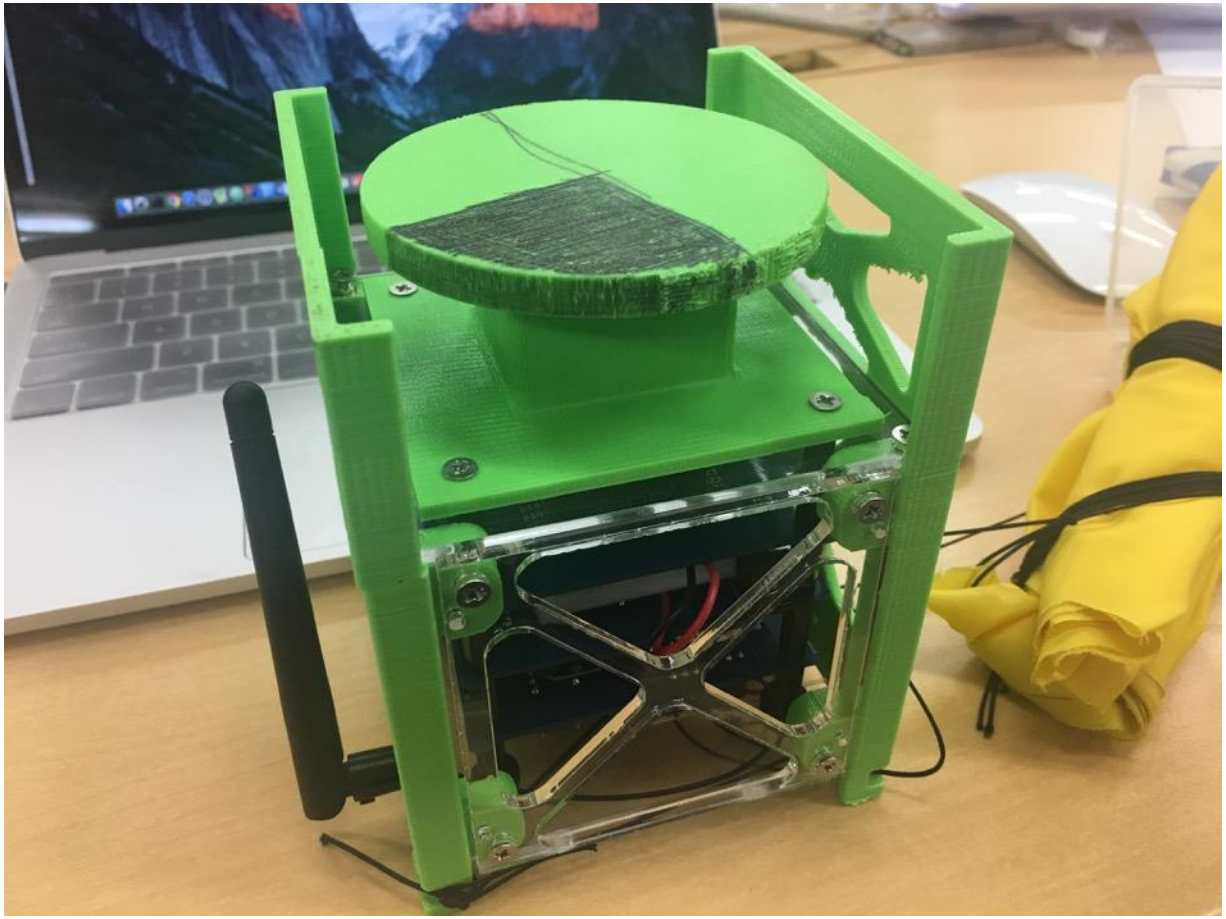
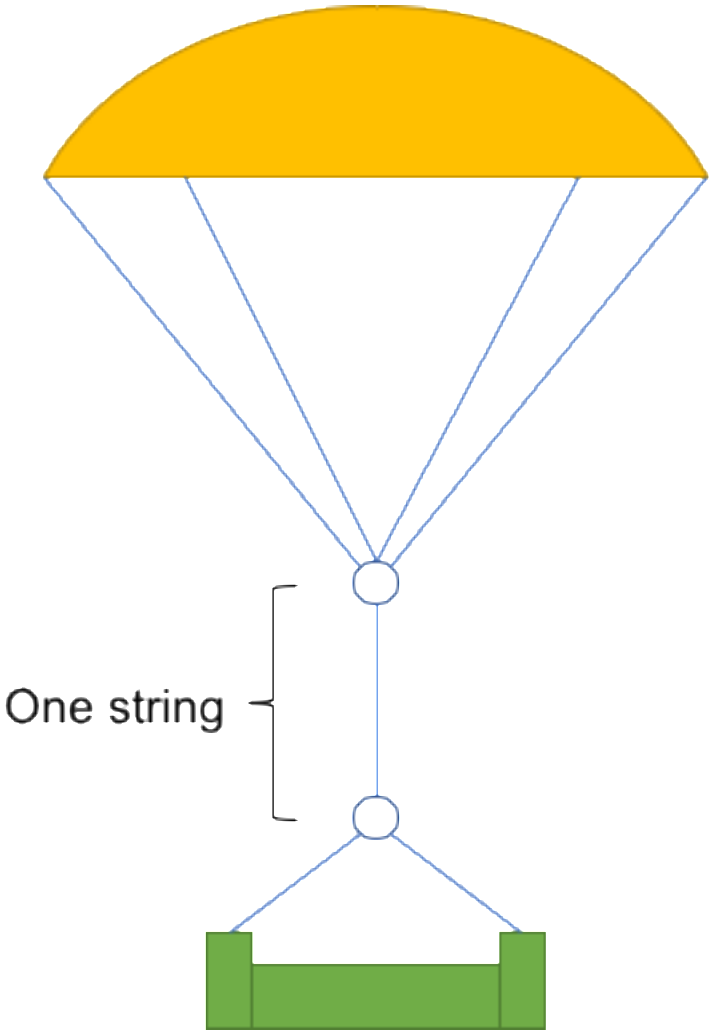


Parachute



Validation and Verification Plan/Testing

No.	Event	Requirement	Required Function	Verification Way
R-1	Preparation phase (Test phase)	Not to work unintentionally	- ON / OFF switch - Inhibits	Confirm LED is switched OFF
R-2		Reprogram the OBC	Reprogram and restart OBC	Confirm loop count in telemetry data is restarted
R-3		To check HEPTA is working	- Power supply from external source - Output internal information	- Confilm battery is charged - Confilm: - LED brink - telemetry to Xbee - selial data to PC
R-4		To check internal data in HEPTA	Insert and eject the SD card	Insert and eject the SD card
R-5	Standby time phase	Battery voltage is 4.0V or more	Charge from external source	Confilm battery is charged
R-6		Connection between HEPTA and GS	- Send telemetry from HEPTA to GS - Send command from GS to HEPTA	- Confilm telemetry data is collect - Confilm data telemetry is change by command
R-7		To start rotation of the wheel	Start rotation of the wheel	Check visually
R-8		To stop rotation of the wheel	Stop rotation of the wheel	Check visually

Validation and Verification Plan/Testing

No.	Event	Requirement	Required Function	Verification Way
R-9	Launch phase	Not to rotate wheel unintentionally	Receive command and start rotation	Confirm start rotate wheel when receive command
R-10		Connection between HEPTA and GS	- Send telemetry from HEPTA to GS - Send command from GS to HEPTA	- Confirm telemetry data is correct - Confirm data telemetry is change by command
R-11	Mission phase	To start rotation of the wheel after release	Receive command and start rotation of the wheel	Confirm start rotate wheel when receive command by log data
R-12		Rotation of the wheel affects HEPTA's angular velocity	Spin the wheel Special Parachute	Running actually
R-13		To get angular velocity and motor status	Save angular velocity, status of motor to the SD card	Confirm data in SD card is correct
R-14		To get log of software process	Save log to the SD card	Confirm data in SD card is correct
R-15	Analysis phase	To get correlation between angular velocity and rotation of wheel	Save angular velocity, status of motor to the SD card	Confirm data in SD card is correct
R-16		To get log of software	Save log to the SD card with loop count	Confirm data in SD card is correct

Validation and Verification Plan/Testing

End to end test

☑ Rehearsal of mission sequence
- All of functions were verified
- No bug

☑ 5 minutes long run
- Battery capacity is enough for mission
- No bug

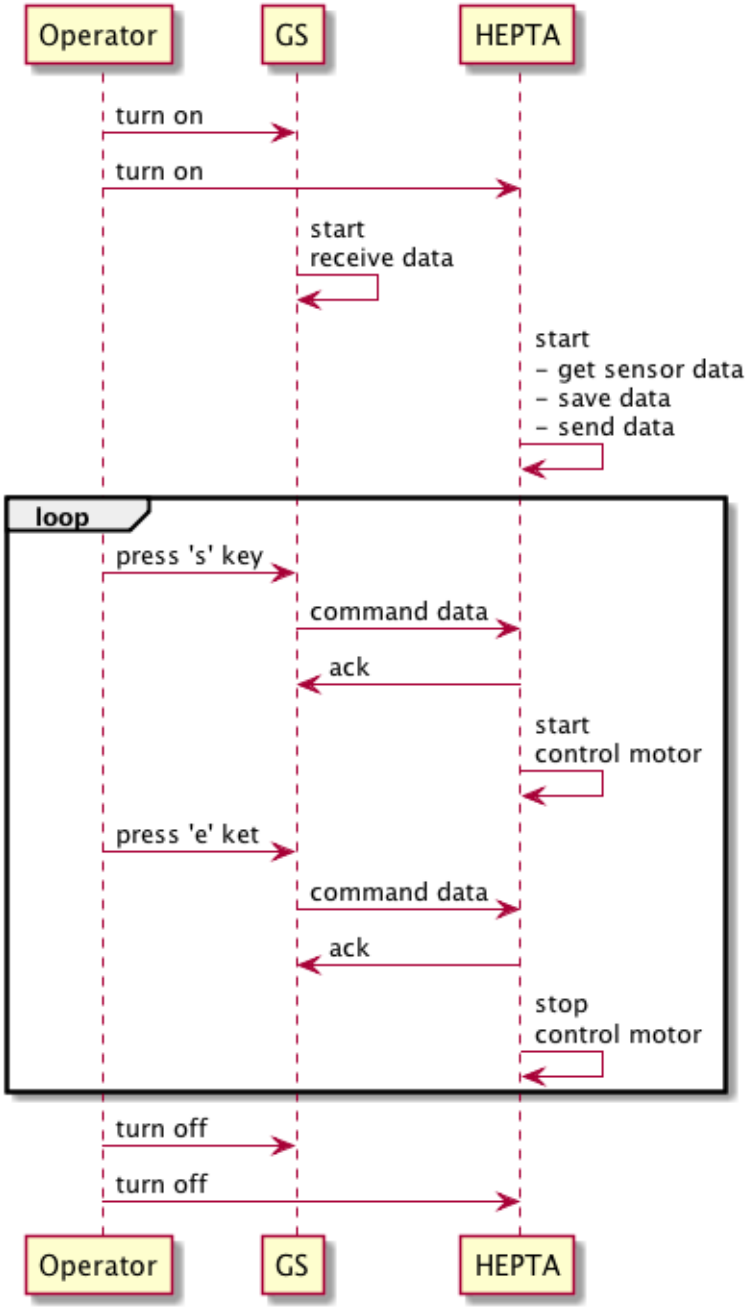
Parachute test

☑ Shock
- The string did not get cut or come untied

☐ Deployment

Mission Sequence

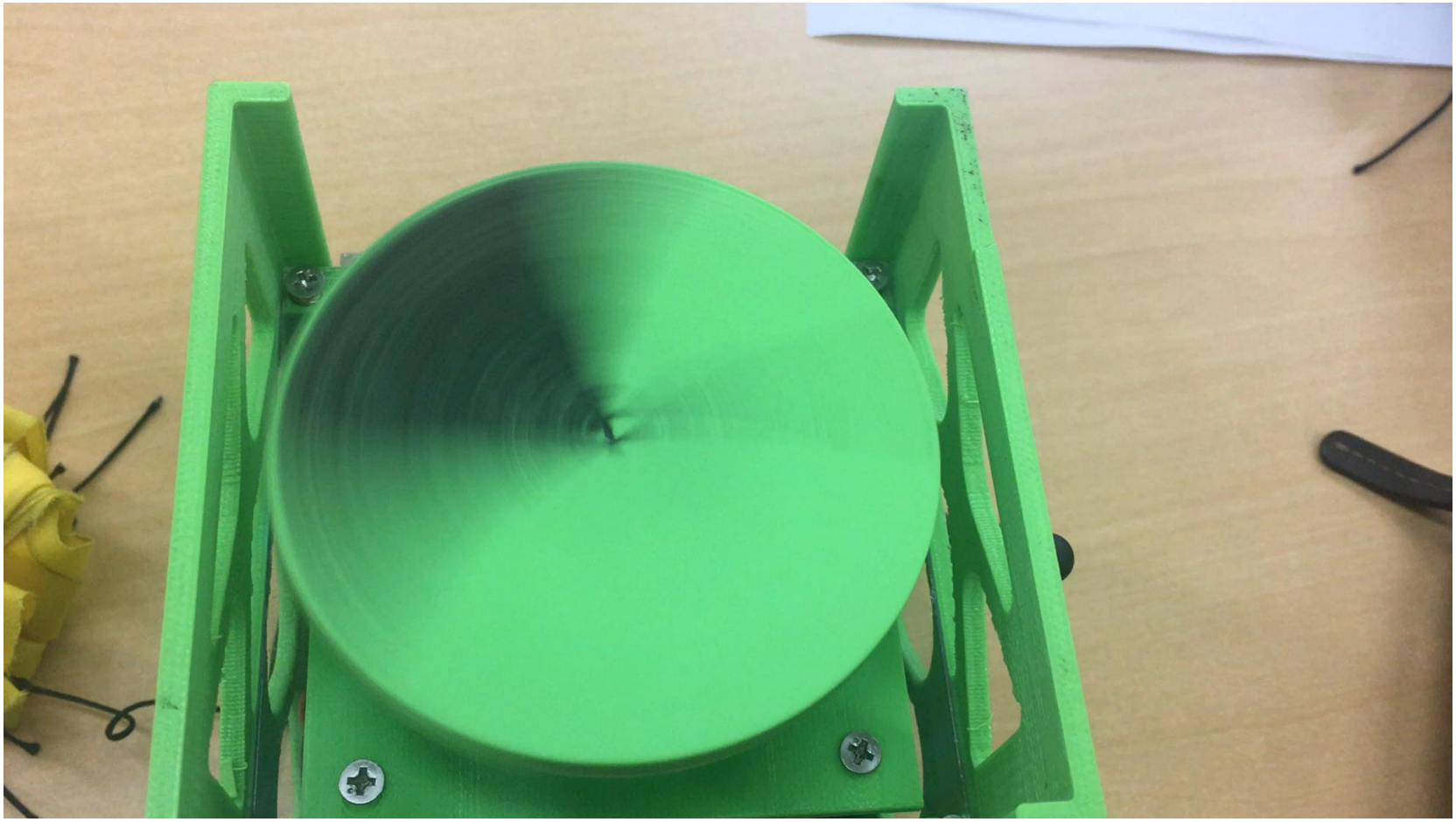
1. Preparation
   i. Program finally
   ii. Inserted SD card
2. Standby
   i. Turned on
   ii. Start send HK data (GS: Start receive HK data)
   iii. Receive command and start motor control (GS: Send command)
   iv. Receive command and stop motor control
   v. Charged battery
3. Launch
   i. Installed to POD
   ii. Launched
4. Mission
   i. Released from POD
   ii. Deploy a parachute
   iii. Receive command and stop motor control
   iv. Landing
   v. Receive command and stop motor control
5. Analysis
   i. Turned off
   ii. Eject SD card



Flight Result: First Attempt

Algorithm:

The wheel repeats forward and reverse rotation



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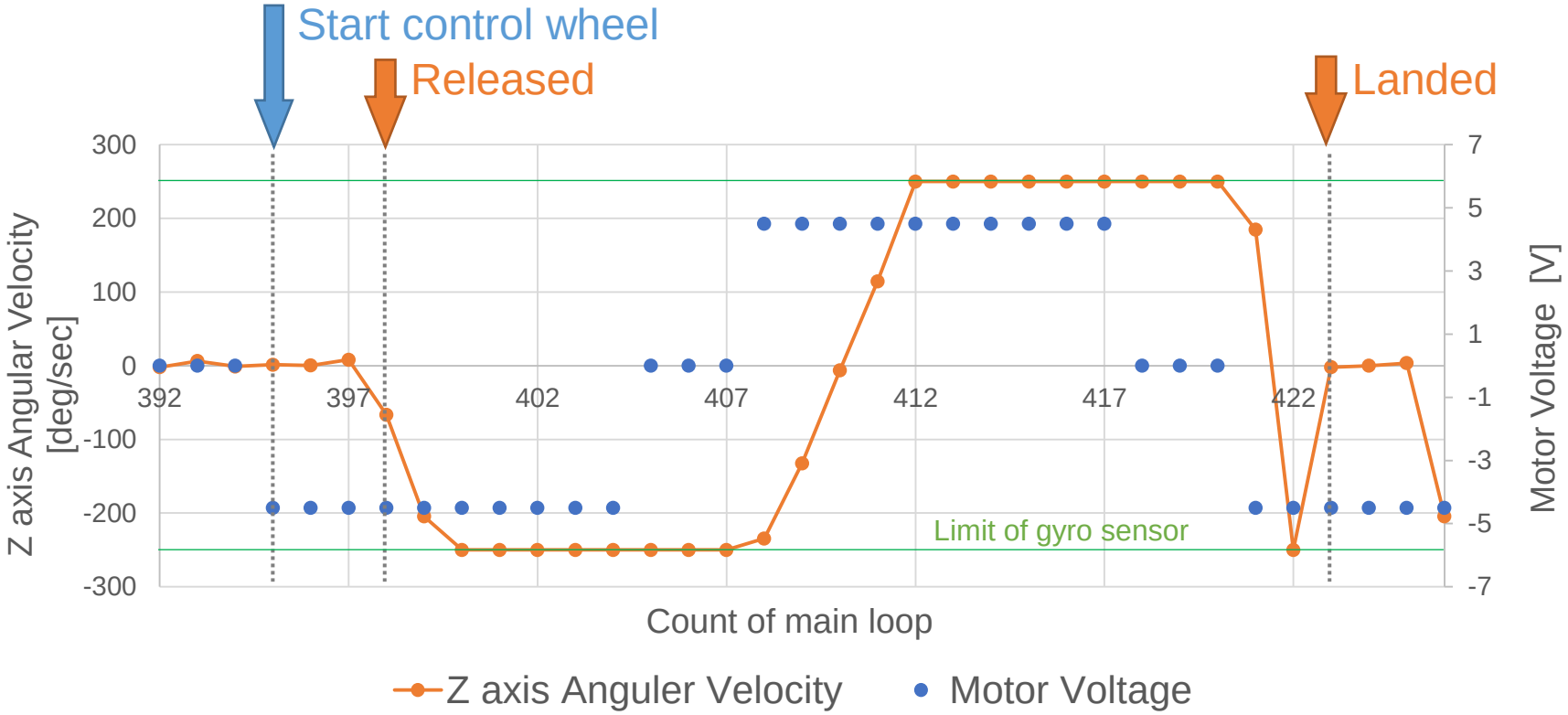


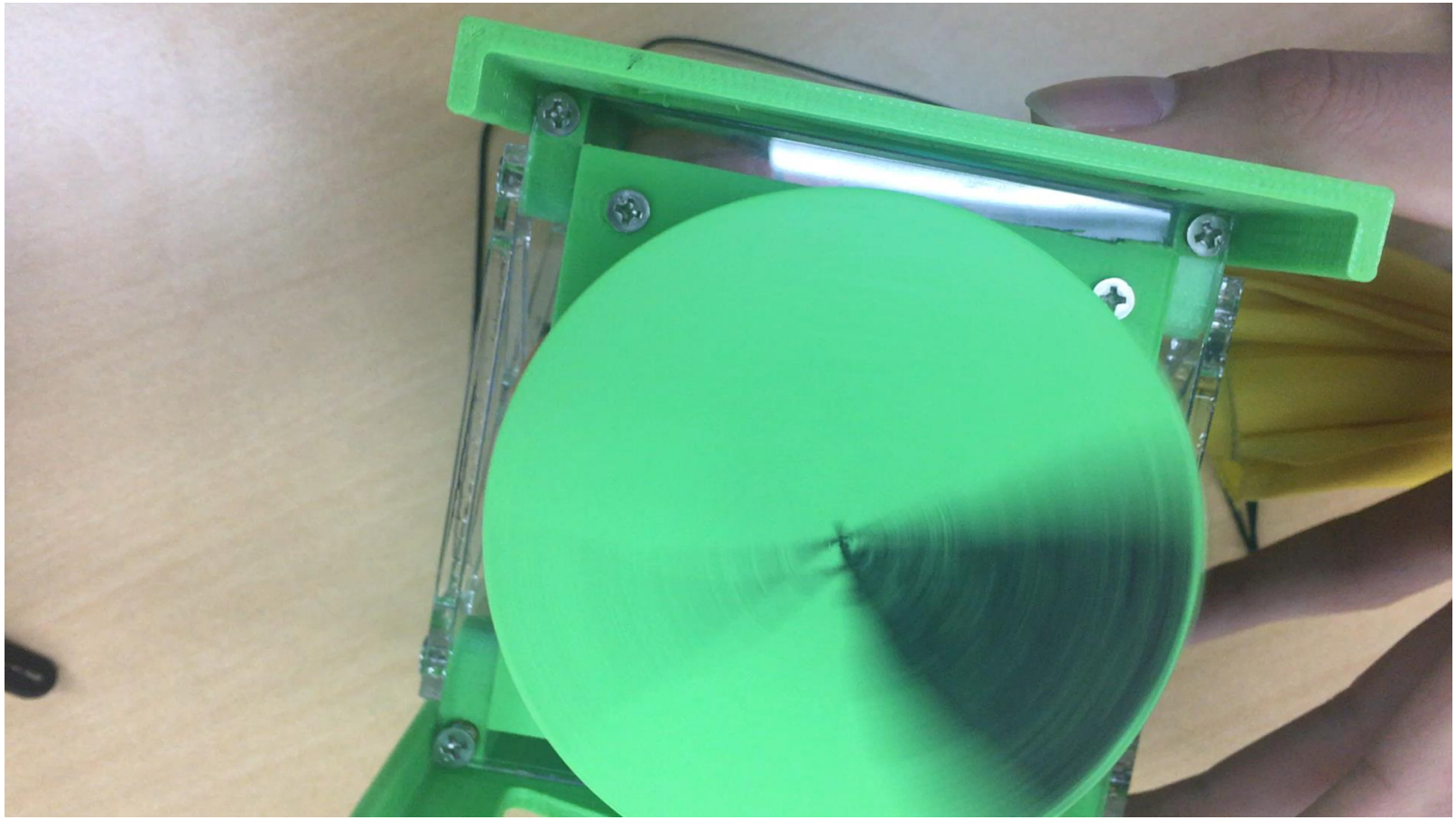
Angular velocity data shows that
attitude was affected by the reaction wheel.

Flight Result: First Attempt

Minimum Success 50 % success	Fundamental functions & Survival • To open parachute and soft landing • To get data from sensors
Full Success 100 % success	Reaction wheel • To rotate the wheel • To get angular velocity data which shows that attitude is affected by the reaction wheel
Advanced Success 120 % success	Feedback control • Feedback controlling the wheel's rotating speed by sensor data • Stop the rotation of main structure

Flight Result: Second Attempt

Algorithm:
The wheel counteracts the angular velocity of main structure



Flight Result: Second Attempt

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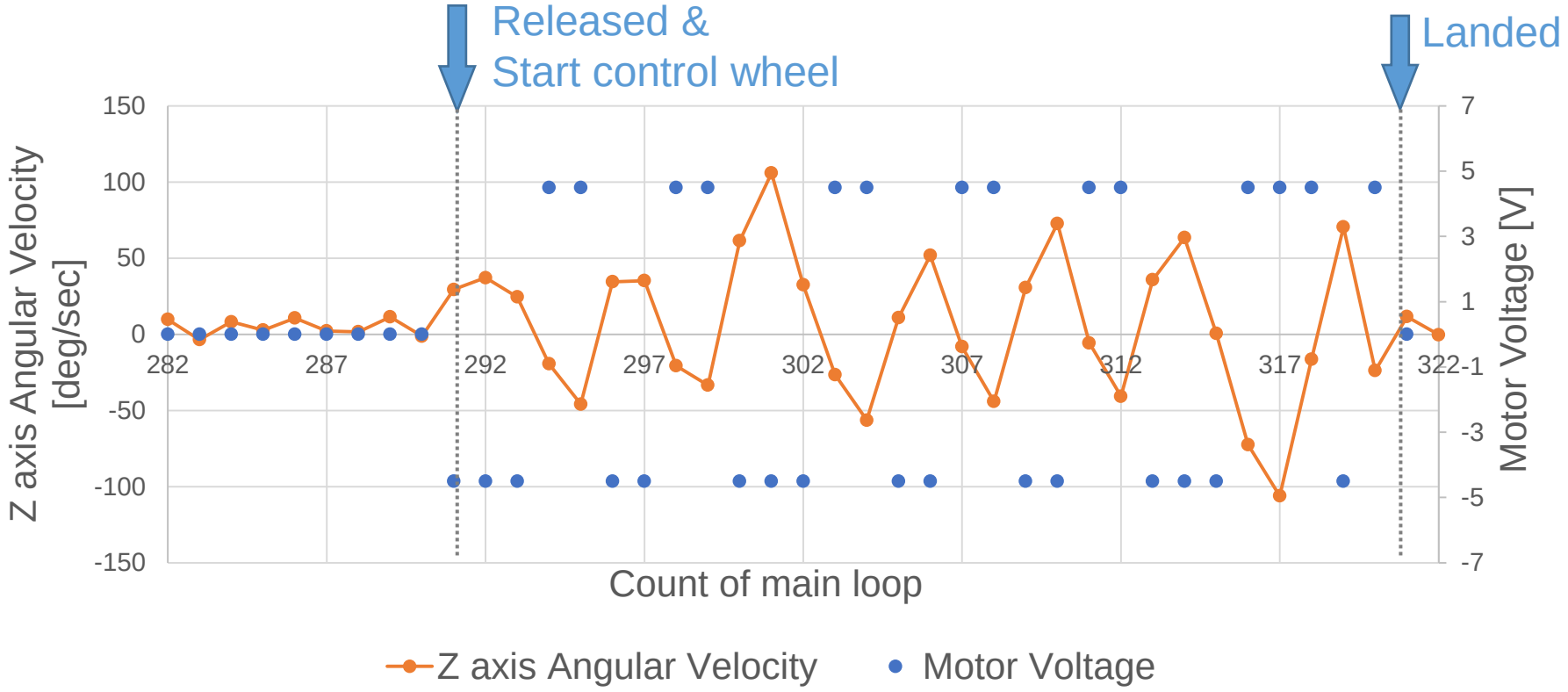

- The control algorithm went well
- The angular velocity was affected by the reaction wheel
- The vibration of angular velocity did not converge

Flight Result: First Attempt

Minimum Success 50 % success	Fundamental functions & Survival • To open parachute and soft landing • To get data from sensors
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Advanced Success 120 % success	Feedback control • Feedback controlling the wheel's rotating speed by sensor data • Stop the rotation of main structure

✔

✔

50%

110% achieved!

Schedule

My project went on as scheduled

	11			12			13			14
	9:00~12:00	13:00~15:30	15:30~18:00	9:00~12:01	13:00~15:31	15:30~18:01	9:00~12:02	13:00~15:32	15:30~18:02	
Create Schedule	MDR									
System design										
Development of motor drive system										
Software and circuit Integration										
Structure design										
Structure production										
System integration										
Test & debug							Thermal Test		CDR	
Margin										
Experiment										

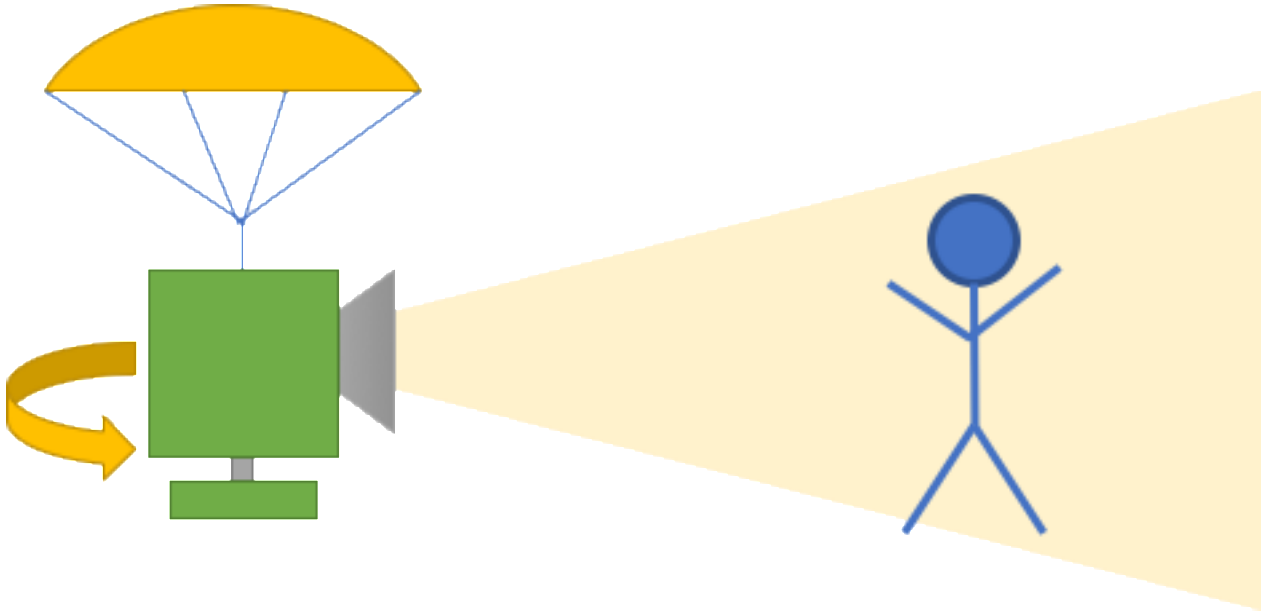
Plan	
Actually	
Milestone	

Conclusions

- My mission was to develop the attitude control system with reaction wheel for CanSat.
- I got angular velocity data which shows that attitude was affected by the reaction wheel.
- I implemented first step of feedback control algorithm and it worked well, but it was not perfect.
- 110% of mission success criteria was completed.

Recommendation and Future Work (Mission)

1. To develop reaction wheel
2. To implement perfect attitude control algorithm
3. To turn the camera on intended direction



Feedback and Recommendation (CLTP)

😀I learned about each sub-systems of satellite by reading lecture note and assembling HEPTA.

😀Through user board integration, I had experience everything in actual project in short time.

😊Too short to define mission.

😊Not enough for acquire software design and time management. It is necessary when we develop satellite with our team members.

Cansat Leader
CLTP
Training Program

Opu & OPUSAT-KID

@_OPU_