Flight Control of Flying Test Bed for Future Planetary Landing

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Flying Test Bed (FTB) for future planetary landing aims to test the guidance and control law for future planetary landing. Recently, the planetary landing has been popular throughout the world targeting to moon, the Mars and beyond. Japan is now planning some planetary landing missions starting from the SLIM project in FY2019[1]. Although there are some projects and researches that are proceeding, Japan does not have a FTB that could be used to check the guidance and control system for the landing, whereas USA has developed various flying test beds such as Morpheus[2] and Xombie.

JAXA has begun the development of the planetary landing FTB to experiment future planetary landing[3]. Figure 1 is the photo of the FTB in the testing sight. The FTB has eight 200N class main thrusters and four 2N class yaw thrusters for altitude and attitude control. One of the difficulties for the control system for the FTB is the time delay that appears for activating and terminating the main thrusters. From the ground test, 40ms of activation delay and 80ms of termination delay has been measured. The time delay does appear in various control systems but the problem is critical for this FTB system where the gravity force is basically larger than the target planets, the main thrusters have to control the roll/pitch attitude and the altitude at the same time, the center of gravity of the system is high and the thrusters are placed in the bottom of the vehicle, the thrusters only allows on/off commands, and the duration of the flight can only last up to about 10 seconds in descending test.

To achieve the control for the FTB, the PID controller combined with discrete time interval has been designed. Figure 2 shows one of the examples of the simulation result with the error in the installation angle on the main thruster. Although there is strong delay and error in the installation, the control law keeps the roll and pitch angles with-in 3 degrees. Also, we can see that the yaw angle diverges because of the small yaw thrusters compared to the main thrusters. More results will be shown in the proceedings/presentation and we are expecting the results of the flying test in the end of FY2016 can be compared with the simulation results.

Fig. 1. Flying Test Bed.

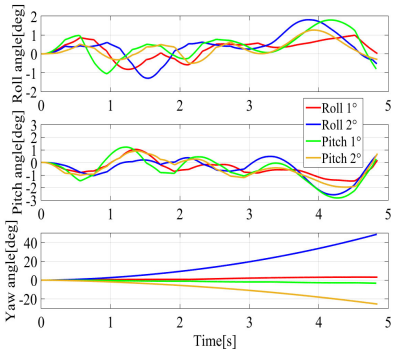

Fig. 2. Simulation results with displacement errors.

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