Paper ID: 89005
oral
student

IAF MICROGRAVITY SCIENCES AND PROCESSES SYMPOSIUM (A2)
Microgravity Experiments from Sub-Orbital to Orbital Platforms (3)

Author: Mr. Philip Arm
ETHZ, Switzerland

Mr. Andrea Del Buono
ETHZ, Switzerland
Mr. Moriz Berclaz
ETHZ, Switzerland
Mr. Valerio Schelbert
ETHZ, Switzerland
Mr. Jorit Geurts
ETHZ, Switzerland
Mr. Fabio Bühler
ETHZ, Switzerland
Mr. Alexander Spiridonov
ETHZ, Switzerland
Mr. Fabian Tischhauser
ETHZ, Switzerland
Dr. Hendrik Kolvenbach
ETHZ, Switzerland
Prof. Marco Hutter
ETHZ, Switzerland

IMPULSE-FREE RELEASE MECHANISM AND TEST SETUP FOR ROBOTIC FREE-FLOATING EXPERIMENTS ON PARABOLIC FLIGHTS

Abstract

We present the experiment setup we used to test SpaceHopper - a limbed hopping robot for small-body exploration - on the 83rd ESA Parabolic Flight Campaign. SpaceHopper is a three-legged robot with a mass of 5kg. The robot is designed to hop and control its attitude using only its limbs. It serves as a platform to conduct low-gravity locomotion research and raise the Technology Readiness Level (TRL) of limbed robots for space exploration. To test SpaceHopper in a relevant environment, we deployed it on a parabolic flight and conducted two experiments: Firstly, we deployed the robot in a free-floating space onboard the plane and tested the attitude control capability in microgravity. Secondly, we deployed the robot on the ground and tested a combined jump-off and attitude control behavior.

To enable these experiments on a parabolic flight, we needed to maximize the time before the robot hit the boundaries of the free-floating space. To this end, we designed, built, and tested a manually operated release mechanism to deploy the robot in the free-floating space without inducing an impulse on the robot. Our experiment setup furthermore contains an operator rack, which allows two operators to operate the full experiment, and a motion capture system for ground-truth position and attitude feedback.

We present the system design of the release mechanism and an analysis of the impulse the mechanism exerted onto the robot based on the flight IMU data and our motion capture system. We show, which test results we could achieve with SpaceHoppper thanks to the custom free-floating experiment setup. Furthermore, we provide in-depth learnings from our experiment on the parabolic flight both regarding

the experiment design and operations. We hope that this paper can inform the design of future robotic free-floating experiments in microgravity.