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

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# ANALYSIS OF SCALED ROBOTIC ARM MANIPULATORS UNDER MICROGRAVITY CONDITIONS

## Abstract

Robotic systems are crucial for future space exploration missions. An important component that will be part of these missions are articulated manipulators or robotic arms. Currently, not much data or research on the response of these components to artificial gravity systems can be found, and this might be attributed to the difficulties of creating such kind of test conditions. Therefore, it is important to conduct experiments with electromechanical systems under microgravity conditions to develop a better understanding on how gravitational forces influence their dynamic behavior and to define strategies to guide the design process for such scenarios.

Microgravity conditions on Earth can be achieved either by parabolic flights or by free-fall drops from towers (drop towers). Experiments with electromechanical systems in drop towers are not so commonly reported in the literature, probably due to the short period where microgravity conditions can be sustained (below 10 seconds). Nevertheless, this limitation can be waived with a careful planning of the experiments. This work presents the results of a drop tower experiment series with a reduced-scaled robotic arm manipulators, performed under Human Space Technology Initiative (HSTI) of the United Nations Office for Outer Space Affairs (UNOOSA), Drop Tower Experiment Series (DropTES), at the Center of Applied Space Technology and Microgravity (ZARM), in Bremen, Germany in 2016.

The effect of forces on reduced-scale robotic arms is studied within a non-inertial, rotating frame of reference, as would be the case for a rotating space station or rotating spacecraft. The tested prototype consists of two articulated arm manipulators with three degrees of freedom (DoF), about 30 cm long, installed on a rotating plate in the drop capsule. The forces on the structure, with a predefined movement sequence, were monitored during the fall through four load cell sensors per arm, located on the base; an inertial measurement unit (IMU) sensor on the end effector of one arm was also used to measure acceleration. The results are compared to the case of Earth's gravity conditions and correlated with theoretical models.