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Microgravity Sciences Onboard the International Space Station and Beyond - Part 2 (7)

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# DEVELOPMENT OF THE DEXTEROUS MANIPULATION EXPERIMENT FOR THE ISS

**Abstract**

The International Space Station provides a major platform for long-term experiments in Human Physiology under microgravity conditions. These conditions provide a unique environment to study dexterous manipulations of the human hand. Changes in gravity levels can be considered as perturbations to the performance of these tasks, which must somehow be compensated through adaptive control. Measurements of finger grip force on an object, in relationship to the acceleration applied to this object by the human subject, will help to better understand fundamental and applied scientific questions.

It has been shown that during exposure to microgravity in parabolic flights the control of interaction forces adapts partially to the lack of gravity, yet evidence indicates that anticipation of gravity's effects persists in the short term. The motivation for these experiments to be performed in long duration space flight is to understand how the central nervous system adapts to an environment without gravity and what will be the consequences of long term adaptation when an individual returns to a normal (Earth) or partial (Moon or Mars) gravitational field. These studies could also contribute to the design and control of intelligent haptic interfaces to be used in challenging environments such as space.

The subject will perform a variety of movements (oscillations, targeted point-to-point movements and controlled collisions) while holding an instrumented manipulandum in a precision grip between the thumb and index finger. Thereby the forces acting between the hand and the manipulandum are measured, i.e. the load force which moves the object and the grip force which prevents the object from slipping in the hand.

The overall experiment setup, which has been prototyped during several ESA parabolic flights, will allow to measure

" grip force and load force between hand and manipulandum
" finger humidity
" manipulandum acceleration and rotational velocity
" manipulandum 3D motion tracking
" which additional mass has been attached to the manipulandum

The experiment will be performed in a restraint-system including seating and lying accommodation. A control computer will be used for data storage and to provide instructions to the subject via a touch screen. An Eye-Tracking Device is taken into account in the design as a possible future extension.

QinetiQ Space, under ESA contract, is developing an Engineering Model, a Training Model and a Flight Model in the framework of the Dexterous Payload program. The Flight Model is foreseen to be launched in the first half of 2014.