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# A FEASIBILITY STUDY OF AN ARTIFICIAL GRAVITY SYSTEM CONCEPT

**Abstract**

Future crewed (manned) space exploration targets ambitious and distant destinations, requiring long-duration missions. The astronauts will be facing demanding endeavours that will largely affect their health condition. To limit these effects, on ground training and in-space exercise will not be sufficient. Therefore, spacecraft for these kind of missions will require additional solutions for the support of human safety, health and quality of life. Among those, the adoption of artificial gravity might introduce a disruptive development to allow manned space exploration to achieve broader frontiers: indeed, artificial gravity would be very beneficial to reduce and contain the side effects associated with bone and muscle deterioration, motion sickness, and fluid redistribution. A number of diverse futuristic concepts have been proposed, developed and studied. Those include the von Braun's toroidal space station concept, proposed in early 50s of the past century, and the Multi-Mission Space Exploration Vehicle (MMSEV), proposed by NASA in 2011 as a space transport vehicle for long-duration crewed mission. However, several technological limitation grounded these concepts to the vision stage. Most of the artificial gravity concepts proposed in literature rely on the use of the centrifugal force as a surrogate for gravity acceleration. The centrifugal force depends on the size of the rotating structure and its rotational speed. To obtain a given force magnitude, higher rotational speeds allow for smaller rotating structures, with associated mass savings, but would introduce controllability issues. On the other hand, slower rotational speeds ease controllability, but at the price of larger and heavier structures that would, in turn, limit launching and maintenance capabilities. This work proposes the preliminary design of a rotating gravity system developed to support long-duration manned missions with a healthy living environment for human comfort. The design problem considers different aspects of the possible missions: it includes the identification of key design drivers and mission requirements, along with the exploration and assessment of possible system architectures accounting for deployment and operation constraints. The design process relies on the use of Multidisciplinary Design Optimization (MDO) methodologies to account for the interaction of multiple disciplines at the conceptual stage, and to benefit from this knowledge for the identification of the best design solutions for the rotating gravity system.