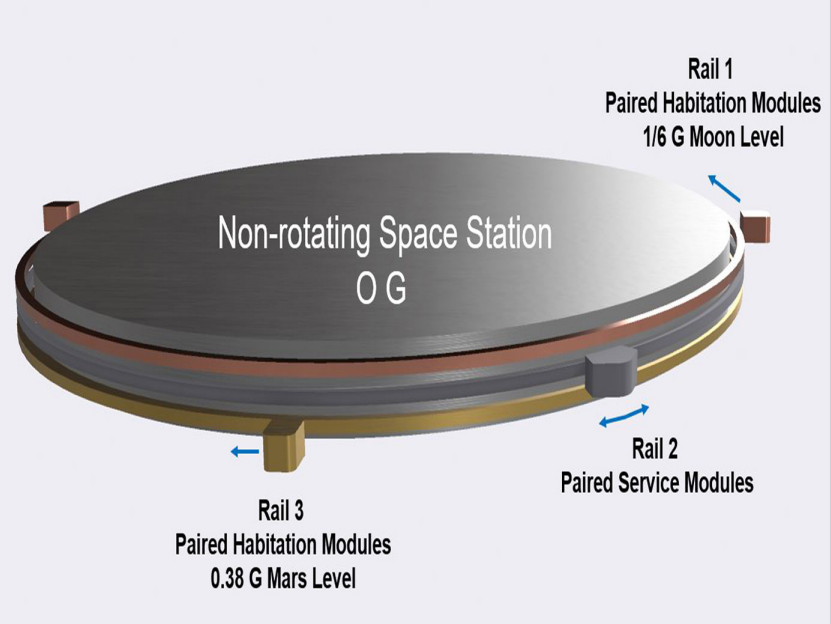


National Aeronautics and Space Administration

NASA

TECHNOLOGY SOLUTION

Aerospace

Spacecraft with Artificial Gravity Modules

Spacecraft capable of generating artificial gravity environments

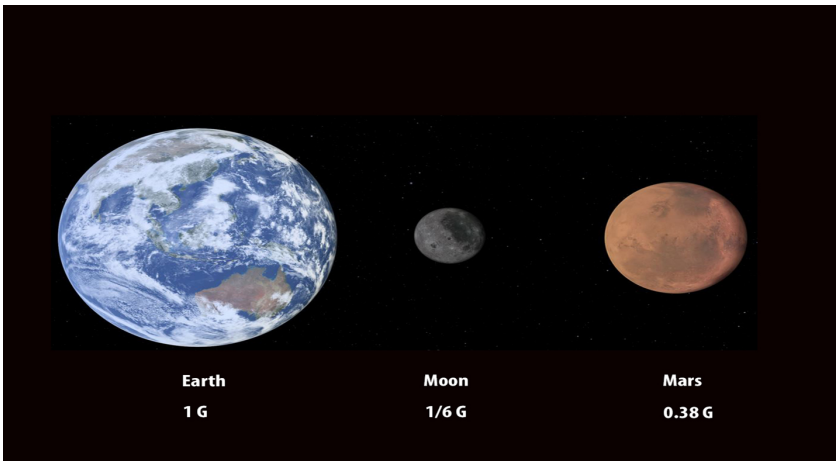
Space travel is becoming increasingly accessible in recent years with the advancement of private space programs as well as NASA space programs such as the Mars Exploration Program. For both space tourism and space exploration, there is an interest in generating artificial gravity in space for entertainment, recreational, and scientific purposes, as well as to counter the health concerns of extended exposure to a microgravity environment. Conventional systems for generating artificial gravity in space involve large rotating space stations that create an inertial force that mimics the effects of a gravitational force. In such examples, the entire space station rotates to generate the artificial gravity that creates several critical engineering and safety issues. NASA Ames Research Center has developed a novel technology that can help provide solutions to these and other problems by a system and approach for creating artificial gravity using a non-rotating spacecraft with connected moving modules, which can be used for habitation and other purposes.

BENEFITS

- Practical and cost-effective approach: basic configuration can be easily expanded over time to accommodate more space station inhabitants and more capabilities without perturbing the ongoing artificial gravity
- Mass balancing task is much simpler when compared to mass balancing a rotating vehicle
- The paired module configuration minimizes any mass imbalance that would perturb the 0G environment of the vehicle
- The active interrogation capability determines the levels of mass imbalance that are acceptable, to establish operational constraints such as space inhabitants movement and congregation
- The resources required for motion control of each module (e.g., propellant, sensors, software) are much fewer and simpler than for motion control of a large rotating spacecraft
- The invention simplifies the implementation of important systems, such as articulated solar power systems, heat rejection systems, guidance, navigation and control systems

THE TECHNOLOGY

Conventionally, the approaches of creating artificial gravity in space was envisioned as a large rotating space station that creates an inertial force that mimics the effects of a gravitational force. However, generating artificial gravity with large rotating structures poses problems, including (1) the need to mass balance the entire rotating spacecraft in order to eliminate or minimize rotational imbalance causing gyroscopic precession/nutation motions and other oscillations of the rotating spacecraft; (2) the potentially prohibitive cost, time and schedule to build such a large rotating system; (3) the need to mass balance the spacecraft in real-time so as to minimize passenger discomfort and structural stress on the spacecraft; (4) the difficulty in docking other spacecraft to the rotating spacecraft; (5) the absence or minimal presence of non-rotating structure for 0G research and industrial use; and (6) the generation of extraneous Coriolis effect on spacecraft inhabitants. The novel technology can help solve the problems referenced above and other problems by (1) providing a non-rotating space station or structure, and connecting modules that generate artificial gravity by traveling along a circular path around the non-rotating space station; (2) providing modules that are more easily built and balanced; (3) providing a stationary structure that can provide a platform for other components that do not need gravity to function; (4) providing capability to actively interrogate what levels of mass imbalance are acceptable, for use in determining operational constraints; and (5) reducing or eliminating Coriolis effect on occupants in habitation modules. The concepts of the invention are very cost-effective and allow for building a minimal initial system to produce artificial gravity at the first phases of construction, before the full structure is built. An additional benefit is that construction and assembly of new capabilities can be performed without disrupting the ongoing artificial gravity environment of the existing structure.



Creating artificial gravity in Space

APPLICATIONS

The technology has several potential applications:

- Space industry
- Spacecraft manufacturing companies
- Artificial gravity spaceport developers to serve as a gateway for space exploration to other planets
- 0G environment for research and industrial use
- Platform for spacecraft refueling/resupply, housing a fleet of spacecrafts, and space telescope observatory; platform for waste management system, supply and equipment storage, etc.
- Platform for waste management system, supply and equipment storage
- Space construction industry
- Artificial gravity space station

PUBLICATIONS

Patent No: 11,884,425

Wilson, E., Mah, R.W., Automatic Balancing and Intelligent Fault Tolerance for a Space-Based Centrifuge, AIAA Guidance, Navigation, and Control Conference, San Francisco, August 2005. https://www.researchgate.netpublication268554961_Automatic_Balancing_and_Intelligent_Fault_Tolerance_for_a_Space-Based_Centrifuge

Mah, R.W., et. al., Development of Telescope Balancing Methodologies for SOFIA, Astronomical Telescopes and Instrumentation, Kona, Hawaii, March 1998. Also published in Society of Photo-optical Instrumentation Engineers, Volume 3354-127. https://spie.org/Publications/Proceedings/Paper/10.1117/12.317238

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More Information

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