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SIMULATING THE GRAVITY BY ROTATION AS A MULTI-OBJECTIVE DESIGN PROBLEM. A METAHEURISTIC APPROACH TOWARD THE DESIGN OF A SPACE STATION WITH ARTIFICIAL GRAVITY.

Abstract

Long term human Space exploration requires appropriate design strategies to deal with the extraterrestrial conditions, including the perception of zero-gravity. Studies have shown how microgravity impacts negatively on human body (Patricio, 2019). To mitigate its effects, G. O'Neil from Princeton University has been one of the proposer for a Space station that creates an artificial gravity by rotation (Hall, 1999; O'Neill, 1974). In particular, the so generated fictitious force is related with the object mass, its distance from the rotation axis, as well as the angular velocity, by the formula F = m*r*omega*omega. To achieve an artificial gravity similar to the terrestrial one, the design problem consists in balancing the inversely proportional relationship between the radius and the angular velocity. In particular, by increasing the radius it could be convenient since the G value can be achieved with a relatively lower angular velocity, but it would also increase significantly the station's circumference and therefore, the launch effort. Vice versa, a low radius requires high angular speed which impacts negatively on user experience (Meliga et al., 2005).

The present work investigates the adequate combination between the mentioned parameters using metaheuristic algorithm based generative design strategy, proposing the layout of a Space station with artificial gravity. It will be defined objectives to lead the research of the (near) optimal configuration including also crew member number, adequate internal space for a hypothetical long-duration in-orbit staying, as well as the number of modular units. In addition, it will be considered the Space station's connectivity performance in terms of internal functions organisation by the use of adjacent matrix. The resulting design problem is featured with intertwined and conflictual interests between the parameters, requiring multi-objective optimisation.

References:

Hall, T. W. (1999). Artificial gravity and the architecture of orbital habitats. JBIS - Journal of the British Interplanetary Society, 52(7–8), 290–300.

Meliga, P., Hecht, H., Young, L. R., Mast, F. W. (2005). Artificial gravity - Head movements during short-radius centrifugation: Influence of cognitive effects. Acta Astronautica, 56(9–12), 859–866. https://doi.org/10.1016/j.actaastro.2005.01.011

O'Neill, G. K. (1974). The colonization of space. Physics Today. https://doi.org/10.1063/1.3128863

Patricio, J. J. E. (2019). Effects and Solutions on the Human Body After Long-Duration Space Flights. 15, 20. http://files/225/Patricio - 2019 - Effects and Solutions on the Human Body After Long.pdf