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DEEP LEARNING OPTIMIZATION IN CARDIOVASCULAR DECONDITIONING MODELLING FOR LONG-TERM HUMAN SPACE MISSIONS.

Abstract

We applied deep learning optimization in the complex, multi-factorial process of human cardiovascular system deconditioning in different long-term missions. Microgravity exposure is known to be a major factor of in the degradation of cardiovascular health due to space travel. Experimental data availability is usually hard to find, and data obtained from different human long-term missions, particularly in the ISS are usually difficult to compare and assess. We herein report results from extensive numerical computations conducted at a supercomputing centre; aimed at assesing the risks arising from long-term mission scenarios. Numerical models are used to simulate the complex interactions between the environment and the cardiovascular system including thermal stress and different gravity loads in a long-term human space mission. Relevant characteristics of cardiovascular deconditioning, such as heart rate, mean stroke volume or cardiac pressure are calculated with a final estimation of the overall risk of putting a mission into jeopardy due to microgravity deconditioning eects. Thermic stress, aerobic or anaerobic exercise are taken into account in different realistic long-term space mission including, for example, Extravehicular Activities (EVA), or aerobic exercise as a countermeasure. Age and gender dierences are also envisaged. Results from this model had been validated in parabolic flight for different healthy volunteers and other available data. The simulation model is based on an electrical-like physiology model in which output variables of the body performance (vascular resistance, blood volume etc.) are calculated while step-by-step gravity load changes and thermal stress are applied. We considered different mission design including human missions to the Moon, Mars and other missions in the solar system. Precise values of gravity loads, thermal stress and countermeasures in different missions produce different deconditioning levels of the cardiovascular system. Deep learning training of the results of the simulation are very useful to optimize the mission length duration, aerobic exercise patterns as countermeasure and frequency of EVAs and thermal stress; so that the outcome on the astronauts health is minimized. Full results will be given which suggest that the gravity level on the surface of Mars or on the Moon is likely to have a potential to decondition the cardiovascular system at the same order of that in microgravity. This methodology combining physiology models with deep learning optimization of the cardiovascular system has shown to have the potential to be helpful in designing future human exploration missions of the solar system.