

Understanding and Mitigating Adverse Health Effects in Space Using a System Physiology Software

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Identification and Significance of Innovation

- Space flight is associated with profound changes in physiology (fluid-shift, orthostatic intolerance and electrolyte imbalance)
- Multitude of experimental data, but little understanding of clear cause-effect relationship
- Better understanding will enable long term space exploration
- Network-based System Physiology Software Proposed
- Innovative Physiology based component selection
- Multiscale approach with “two-way communication” interfaces to high-fidelity models (to understand effect of local hemodynamic stresses on vascular dynamics), Systems Biology (cellular regulatory networks) and Baroreflex models
- Leveraged on an on-going NASA funded lab-on-a-chip system design software development effort

Technical Objectives

- Develop overall architecture for System Physiology software
- Component identification, characterization and validation
- Simulations to understand fluid-shift and effect of hemodynamic stress on vascular endothelial cell structure

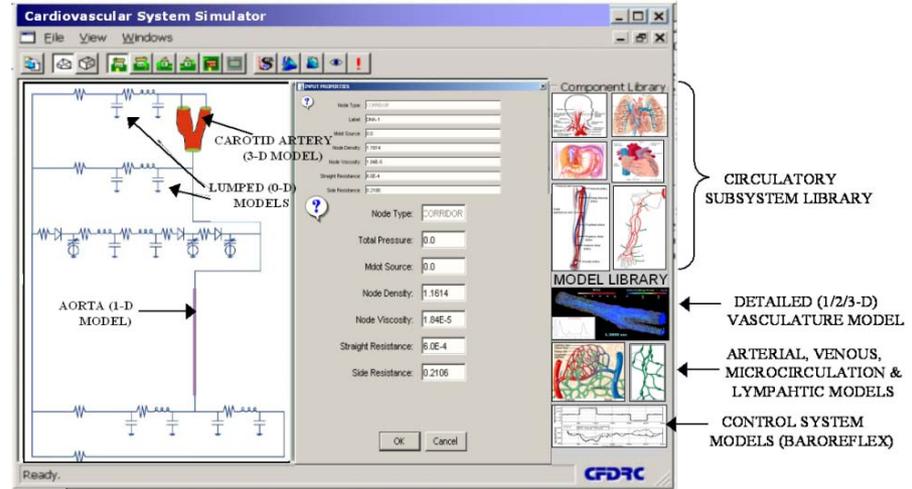
Work Plan

Phase I

- Development of Circulatory System Component Models
- Adaptation of lab-on-a-chip system software for the proposed software
- Integration of high-fidelity software (CFD-ACE+) to study the effect of fluid stresses on vascular endothelial cell structure
- Development of GUI
- Proof-of-Concept Study on fluid-shift

Phase II

- Detailed characterization of component models
- Incorporation of metabolite transport and baroreflex models
- Interfaces to Systems Biology software
- Software delivery to NASA



Graphical User Interface of the System Physiology Software

NASA Applications

- Predictive Software tool for NASA to implement knowledge-based practices and deploy preventive countermeasures against adverse health effects in space environment
- Detailed understanding of space environment on physiology
- Understand role of fluid physics in cellular signaling; Digital Astronaut program

Non-NASA Applications

- Computer aided diagnosis and Disease management
- Biomedical device manufacturers (Drug delivery, device design, etc.), Pharmaceutical companies (Drug discovery, etc)

Firm Contacts

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