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NEAR REAL-TIME STATE MODELS: A FOUNDATIONAL TECHNOLOGY FOR SPACE AUTOMATION, AUTONOMY, AND ROBOTICS

Abstract

An evolving set of commercial Technology Development, Demonstration, and Deployment (TD3) Missions can help foster an evolution of space automation, autonomy, and robotic systems. This paper provides a substantive update on the mission development work that has been accomplished since the original conceptual presentation to the NASA Future-In-Space-Operations (FISO) Colloquia June 22, 2016.

Near realtime state models are N-Dimensional interaction problems (i.e., an arbitrary number of objects interacting in an arbitrary number of ways), a class of problems for which the generalized solution space is typically computationally intractable in any time frame. Space automation, autonomy, and robotics present a subset of these problems that exacerbates the situation by requiring near real-time solutions in many instances.

Solving these challenges requires the ability to structure and order complex knowledge sets in both a computationally tractable manner and in a framework coherent and accessible to human understanding. This paper examines how near real-time state model development work by XISP-Inc can expand further opportunities for the international cooperation and collaboration:

• Extra Vehicular Robotics (EVR)/Systems of Systems Automata – Teleoperation to Autonomous Operations;

• Intra Vehicular Robotics (IVR)/Systems of Systems Automata – Earth control to full automation and/or autonomy from Earth;

• Interaction with novel environments – emergency conditions, exploration rovers, etc.;

• Supporting transportation to as well as living and working in Low Earth Orbit, Cis-Lunar space beyond;

• Implementing the Advanced Vision and Task Area Recognition (AVaTAR) near real-time state model (autonomic nervous system) and dynamic world modeling capability for use with EVR IVR systems (e.g., DEXTRE, Robonaut, Spheres) on the ISS.

This mission proposes to further develop and demonstrate the use of NASA Ames Mission Control Technologies software (Open MCT) as an extensible implementation tool set for near real-time state models. We address the characterization, optimization, and operation of near real-time models being developed as part of the XISP-Inc integrated ISS TD3 mission set under an existing Space Act Agreement with NASA and evolving public-private partnerships.

Open MCT is an open source framework for developing web-browser-based systems for visualizing and analyzing telemetry data, as well as formulating and processing command streams. The advanced parametric state models proposed will generate system status in near real-time, even over low-bandwidth and high-latency connections. Such models can be used to provide rapid fault detection, autonomous operation, and other applications that could benefit from complete near real-time information of a remote system's state.