A NETWORK CENTRIC APPROACH TO ROBOTIC OPERATIONS ON MARS

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The systems level requirements for preparing a planetary site for human occupation are not fully defined. Defining these requirements has the challenge of fitting within a heterogeneous, multiple stage mission. Current methods of planetary mission design are very component specific and therefore not robust to handling the changes expected in a long duration dynamic mission. Prior to human arrival of Mars, for example, primary system tasks will be preparation for the human crew's arrival. Upon arrival of the human component, additional system tasks such as scientific mission support, communications relay, and navigation support may require dynamic reconfiguration of the system.

The solution may be realized with a network-centric approach to systems design. Creating a "system of systems" to handle this complexity requires a method of understanding how a given set of assets and command hierarchy can be conducted in an information decentralized fashion. The first step in solving this problem is to model a system in a mathematical fashion to qualitatively determine differences between systems containing different assets and organizational structures. This self reflection, called mission analysis, is a prerequisite of optimal, systems level mission planning.

The method works as follows: groups of robots execute a sample mission in a simulator to record system level ***metrics*** of the system's state over time. Without a priori information on metric interactions, a Dynamic Bayesian Network (DBN) is used to determine probability distribution functions over each metric, with the parameters representing metric interactions. The interactions form the abstraction called a ***system map***. A system map is created for each set of platform and organization combination. If the mission statements and requirements are also represented as a system map, then finding the best system to solve the mission problem becomes an optimization problem solvable in a pareto-optimal fashion. A discussion of initial results will be presented.

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