



NASA STTR 2007 Phase I Solicitation

T5.02 Algorithms for Autonomous Robotic Materials Handling

Lead Center: JSC

The focus of this subtopic is to solicit new technologies that will increase the flexibility and efficacy of robots deployed to the surface of the Moon and Mars. Robots are expected to make an important contribution to future Moon and Mars missions by decreasing the EVA time required to set up and deploy outposts, habitats, science packages, etc. An important part of this robot activity will be autonomously or semi-autonomously handling a variety of materials such as cables, connectors, solar arrays, inflatable modules, samples, payloads, and trusses. Semi-autonomous robot handling will allow these activities to be controlled from Earth so that they can take place before astronauts arrive and to continue after they leave.

Based on the above planetary applications, proposals are solicited for the development of algorithms that address one of the following:

- Autonomous robotic grasping, manipulation, and dexterity;
- Tool use; or
- Combining mobility and manipulation.

Emphasis should be placed on techniques that can be effective in unmodeled or unplanned for situations. Some important issues related to autonomous robotic grasping, manipulation, and dexterity include: positioning of the manipulator and grasp contacts relative to the object, determining good manipulator configurations for grasping, adhering to grasp and task constraints on action sequencing during grasping and manipulation, using whole-arm/body contact surfaces, sensing relevant data, simultaneous sensing and action, and the control of forces during manipulation. Some important issues relating to tool use are: representing and utilizing the affordances of tools, representing the task constraints on grasp, modeling the interactions between the tool and the environment, representing the function of the tool in a larger (planetary repair) task, and using tools to adapt to contingencies imposed by the task or environment. Some important issues related to combining mobility and manipulation are: coordinating the use of mobility and manipulator DOFs to achieve a common manipulation purpose, coordinating multiple mobile manipulators so as to achieve a common goal, grasping or manipulating an object so that it can be transported.

Some areas of research and development that are expected to be relevant to the above problems are:

- Continuous or discrete control;
- Machine vision or tactile sensing; and
- Machine learning and robot development.

The proposal should target advancements in aspects of the above areas of research and development that are relevant to robotic materials handling. The proposed approach should take advantage of the specific constraints and simplifications that result from the materials handling problem.

Proposals should identify the specific problem(s) that are to be addressed and a brief outline of the proposed approach. In addition, proposals should outline a plan for testing key aspects of the approach on robotic hardware. Preference will be given to approaches that appear to be practical given realistic sensor and hardware limitations.