Canada's Technology Development in Space Robotics*

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Abstract

Canada is currently investing most its effort in space robotics in the developement of the Mobile Servicing System (MSS) for the International Space Station (ISS). The development of this new system has been based on the success of the Shuttle Remote Manipulator System (SRMS). The SRMS is currently the space robotic system with the longest flight experience. The MSS comprises the Mobile Base (MSS), the Space Station Remote Manipulator System (SSRMS) and the Special Purpose Dextrous Manipulator (SPDM). The SSRMS and the SPDM will be teleoperated from inside the Space Station. The SSRMS will be launch in 2001 while the SPDM is supposed to be launched in 2003.

The goal of this paper is to describe the Canadian technology plan for space robotics as developed by the Space Technology Branch of the Canadian Space Agency (CSA) in collaboration with other CSA Branches and industrial partners. The objective of the plan is to explore the new technologies required to grasp future space robotics opportunities. The first part of the paper describe technology opportunity for space robotics. The second part will concentrate more on the current project in space robotics technology development.

Technology development will be required in the following area: MSS operation and evolution, ISS Science, Planetary exploration, Manipulators for next generation launch vehicles or space reusable vehicles and Ground facilities.

To remain competitive in addressing these SR&A market opportunities, Canadian industry will need to take the following market drivers into account:

Low mass, small size, robust technologies: nano-technologies (including rovers), advanced materials, auxiliary devices such as core drills Adaptability and versatility of systems: re-configurable space manipulators, modular design of structures joints for simplified assembly, situational assessment Autonomy of mission operations: automatic planning and monitoring, automatic re-planning, advanced control algorithms, decentralized and autonomous control systems, high performance data bus, high reliability software and computers, inertial guidance Advanced sensors systems: contact & proximity, range, robust force-moment, capability to operate in structured and unstructured environments, Stereo vision/3D perception, embedded processors, small cameras, multi-sensors integration Higher task complexity: haptic devices for advanced tele-operation of space robots, Dexterous end-effectors, automatic capture and berthing technologies Advanced simulation tools: non real-time and real time simulation, modeling and simulation of complex phenomena likes contact dynamics, real-time simulation for predictive control.

The Space Technology branch of the Canadian Space Agency and MD-Robotics are currently involves in projects to open new opportunities for space robotics. The following projects will be described: - MSS Ground Control: development of a test-bed to test the technolgies for ground control of the SSRMS and the SPDM. A first goal is to demonstrate the feasability of the ground control. A second goal is to develop more advanced control system using for example 3D-vision. - SPDM Task Verification Facility: Hardware-in-the-Loop simulation to verify the capabilities of space robots to perform required task. This technique will also be applied to develop a satellite simulator to study satellite servicing. - Advanced Design for Robotic System: The development of a robotic system required will benefit of development in arm design, sensors (internal and external), actuators, end-effector (including tools), data bus, low-level and high level controllers, supervisory controller, ground control station, and simulation tools. We will describe some projects targeting these different areas. - Activities in planetary exploration including identification of near-term international planetary missions assessed for use of Canadian robotic manipulators and design reference tasks for the robotic activities. The driving requirements and constraints for the manipulator design and the preliminary characteristics of robotic arms for specific target missions will be discussed. Key technology development and prototyping activities will be presented.

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