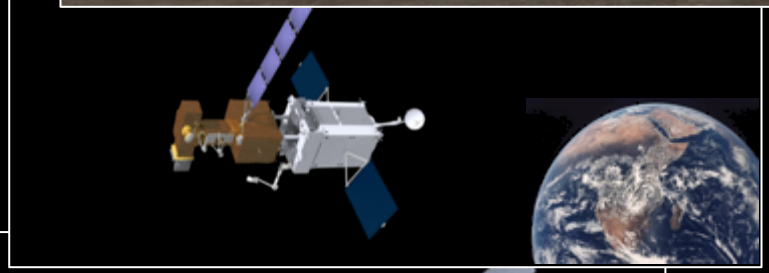

Challenges of In Space Robotic Servicing

Presented to The Next Generation of Space Robotic Servicing Technologies Workshop at the International Conference on Robotics and Automation

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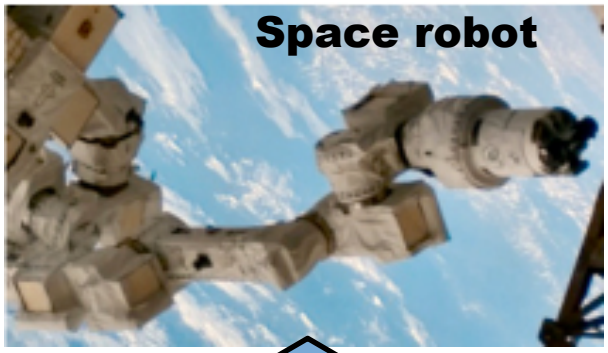
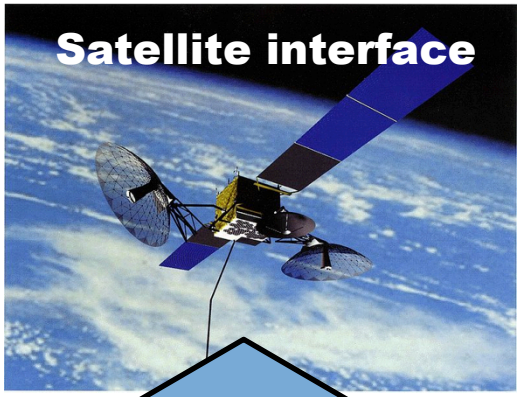
Overview

- The Satellite Servicing Capabilities Office is responsible for overall management, coordination, and implementation of satellite servicing technologies and capabilities for NASA. To meet these objectives it:
  - Conducts studies
  - Fosters technology development
  - Conducts demonstration experiments in orbit and on the ground
  - Manages satellite servicing missions
  - Advises and designs cooperative servicing elements and subsystems
- We use over a dozen 6- and 7-DOF industrial and flight-like robots to
  - Provide motion platforms to determine envelope of sensor performance
  - Provide platform for teleoperation and autonomous operations
    - Tool engineering development
    - Procedure development
    - Training
    - On-orbit robot support
  - Simulate robot-satellite contact dynamics
  - Simulate on-orbit robot kinematics/dynamics

Ground simulations





Orbital contact dynamics

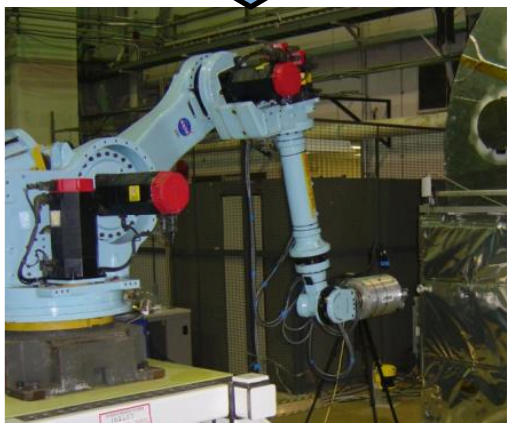
Robot dynamics

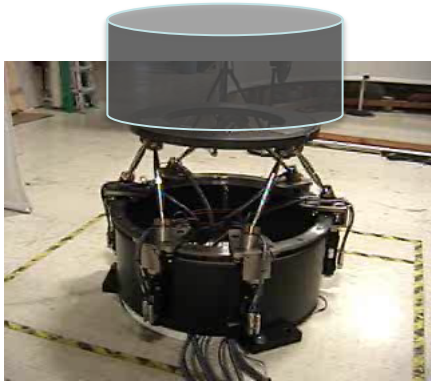
Satellite Dynamics

HIGH VELOCITY LARGE WORKSPACE

HIGH FORCE/ STIFFNESS FAST RESPONSE

1-g contact dynamics





Motion-based platform

Servicing technology highlights

Challenges

- Synchronizing data across multiple sources (se[illegible]ors, robots, metrology, etc.)
- System lag
- Simulating zero-g and on-orbit lighting or[illegible]
- Accurately simulating space kinematic[illegible]
  - Using stiff industrial robot systems t[illegible]s
  - Software-based kinematic and dy[illegible]
  - Compliment with tests using D[illegible]d flight-like robot
- Validating contact dynami[illegible]aring table, zero-g, impact tests, computer models[illegible]
- Simulating compliar[illegible] robot
  - In some cases, c[illegible]rques of industrial robot
  - In other case[illegible]bot controller are proprietary
- Developin[illegible]ight processors
- Unknown [illegible]

Interested in engaging others in the space robotics community to help address these challenges