Space Missions

Robotic Technologies For Lunar Exploration

LEAG
Houston Hobby Hilton
October 3, 2007

Frank Teti
frank.teti@mdacorporation.com

Key Messages

1. Robotics will play a large role in human lunar exploration.
2. Take advantage of robotic advances on earth and apply at reduced cost and risk.
3. There is ample evidence of the spin-up and spin-down of robotics in space.

Spin-Up / Spin-Down Benefits

- Terrestrial-Focused Technology Development
  - Spread cost over multiple applications
  - More design cycles and upgrades
  - Reduce risk (eg. EEE parts)

- Space-Focused Technology Development
  - Develop technologies that otherwise may not have ever been developed (Velcro, Satellites, Radiation Hardened electronics)
  - Create economic growth from these technologies

Recent Spin Up Examples

- US Airforce XSS-11 Lidar (2005)
- NASA Shuttle Ice detection (2006 & 2007)
- Control of robots (iterative)

Recent Spin Down Examples

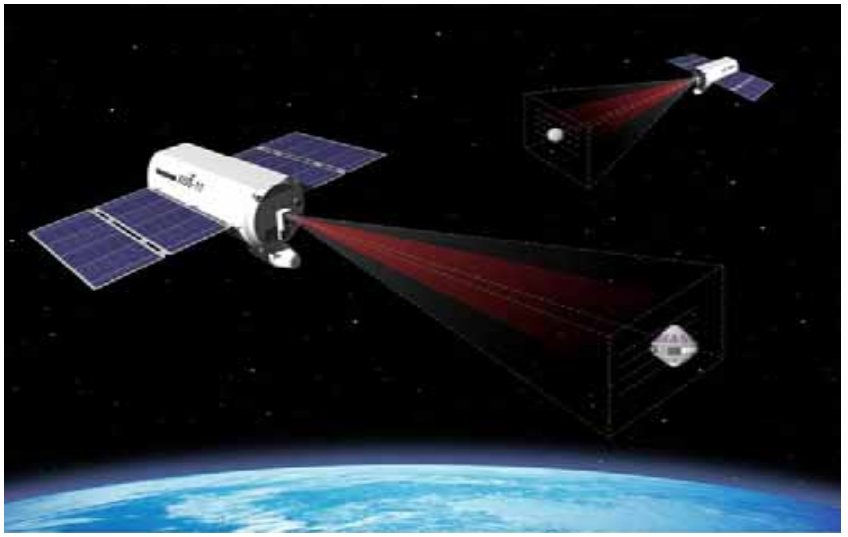
- 3D Vision - Mining
- 3D Vision - Homeland Security
- Autonomous Navigation – Mining
- Medical Robotics

LIDAR

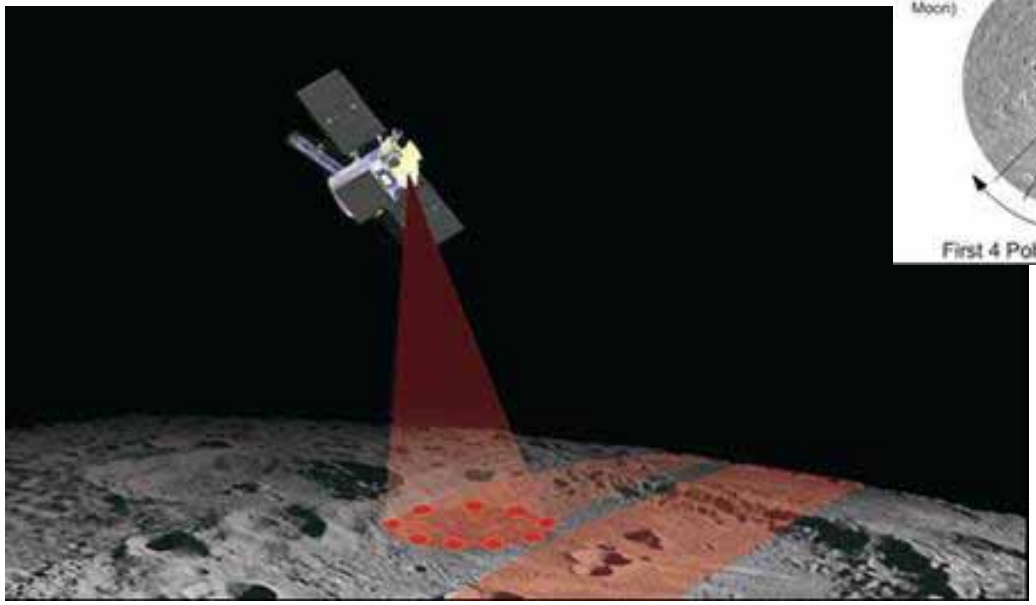
Terrestrial Lidar Images

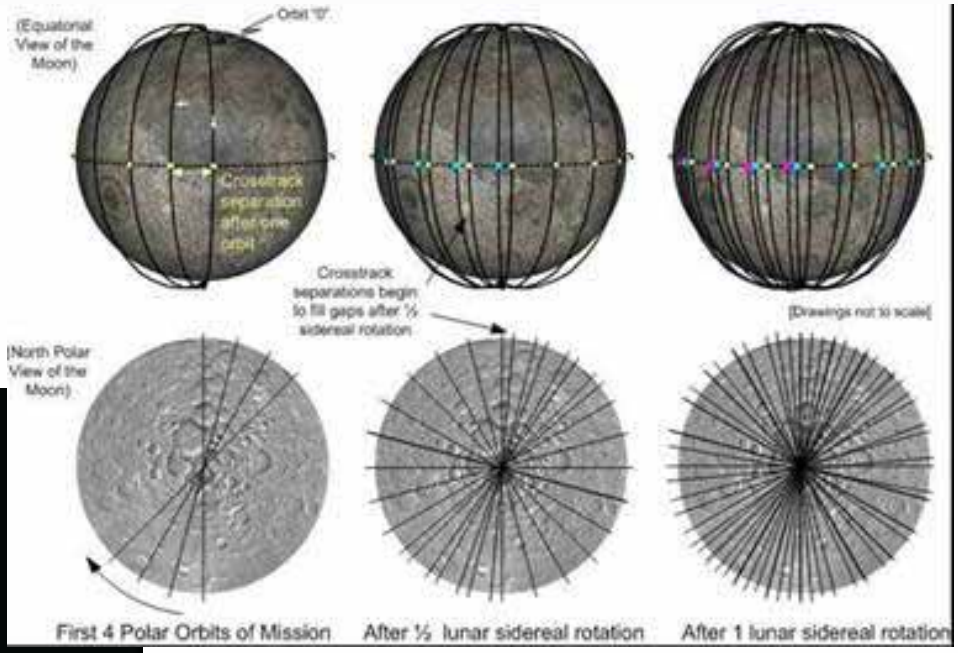
Spinup: XSS-11 Lidar

- XSS-11 Spacecraft
  - Launched April 11, 2005
  - Lidar is robotic vision system enabling target acquisition and identification
  - Based on proven terrestrial lidar product line from Optech

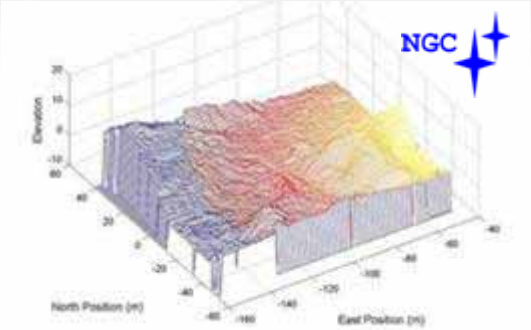


Future Spinup: Lidar for Lunar Surface Mapping

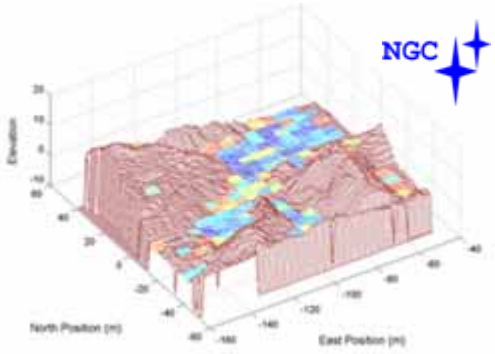




Future Spinup: Landing Lidar

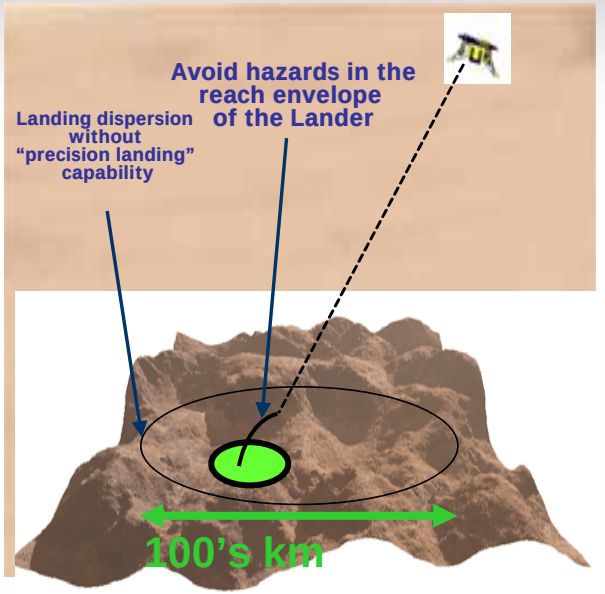


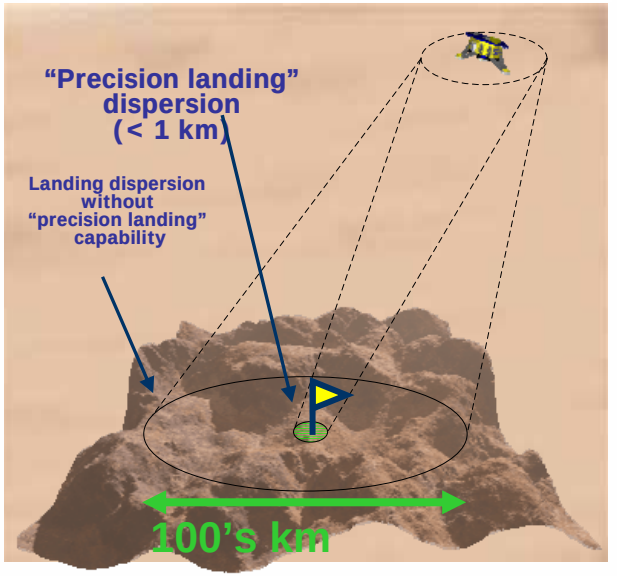
The “smart ” landing system autonomously selects and prioritizes safe landing sites illustrated in green



Navigation “cost maps” are produced.

Guidance, navigation and control commands fed to spacecraft propulsive system to safe landing site

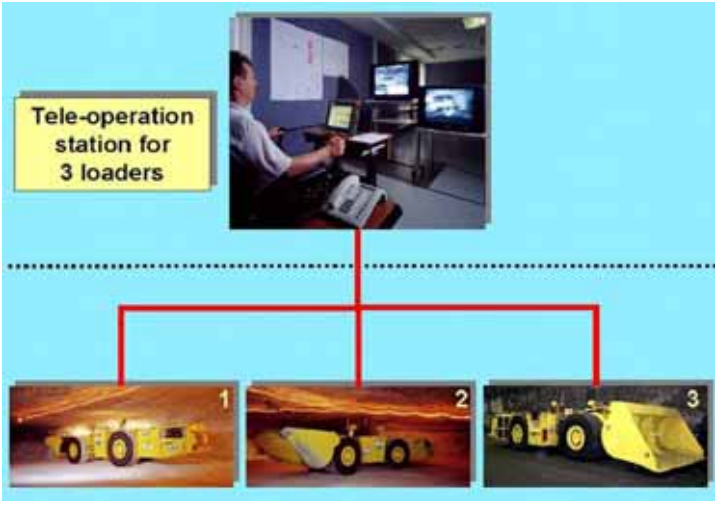




ROBOTIC OPERATIONS

Remote/Autonomous Operations

ISS ROBOTIC WORKSTATION



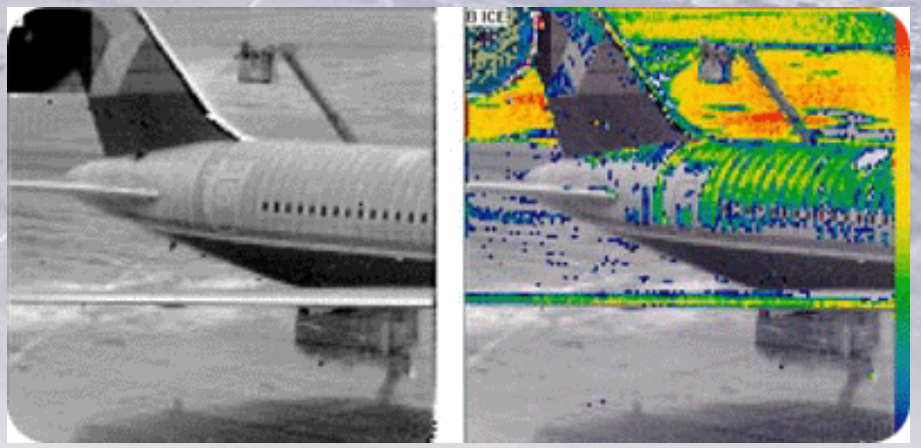
SALT MINE - GERMANY

ORBITAL EXPRESS

ICE DETECTION

Transportation Safety - Ice Cam Spectral Camera

- Original aircraft ice detection system has been tested on NASA shuttle flights (prototype)
- Detects ice on center tank and other surfaces prior to launch



NASA Ice inspection at shuttle launch

3D VISION - MINING

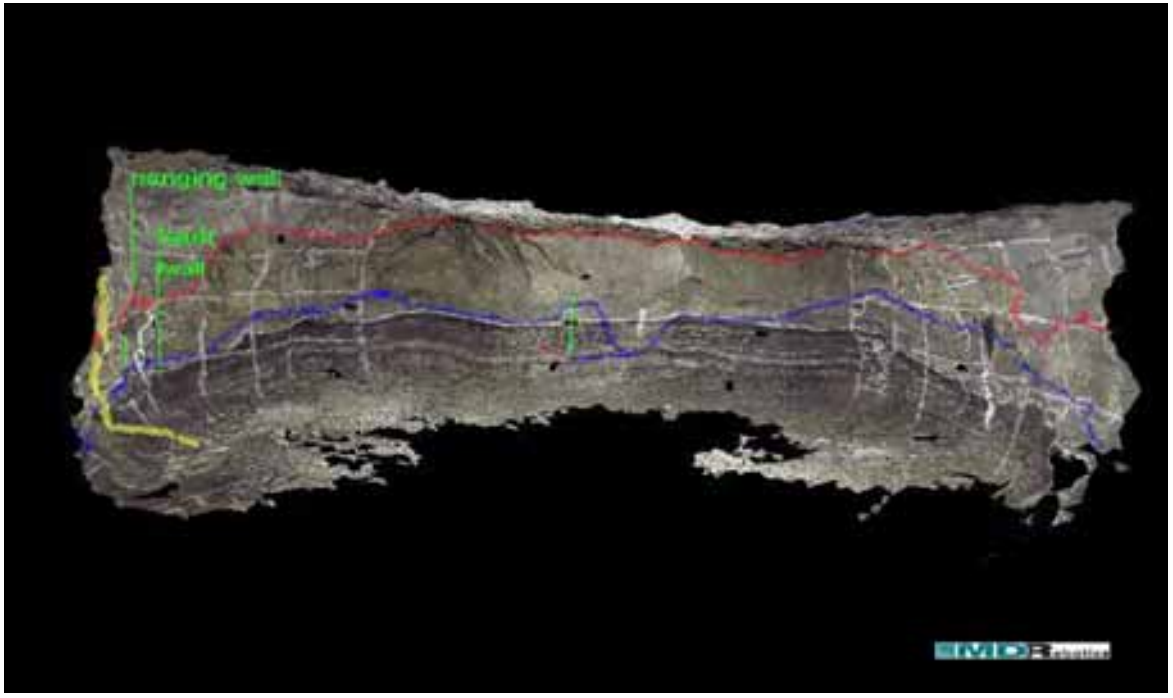
3D Instant Scene Modeler (iSM)

- Originally developed for use on a future Mars exploration rover
- Many terrestrial applications for 3D vision and imaging
- Terrestrial applications are outpacing those in space

Dynamic Earth Underground Mine Model

Remote Geology

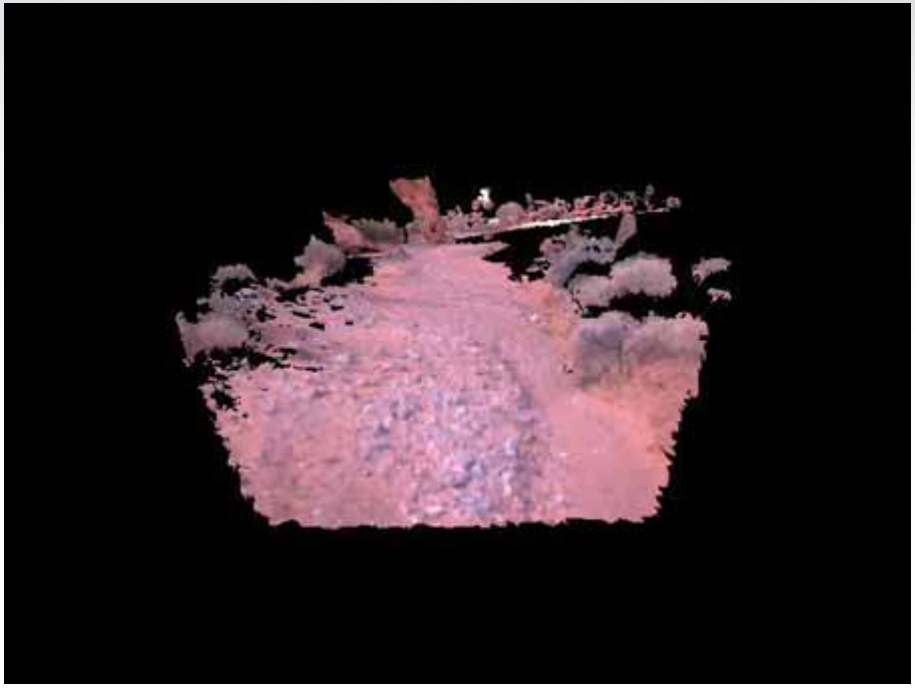
- **Instant Mine Modeler** will revolutionize the process of collecting **geological, geotechnical and survey information** from advancing mine work faces



3D Mine Cavity reconstruction

Future Spinup- Space Exploration

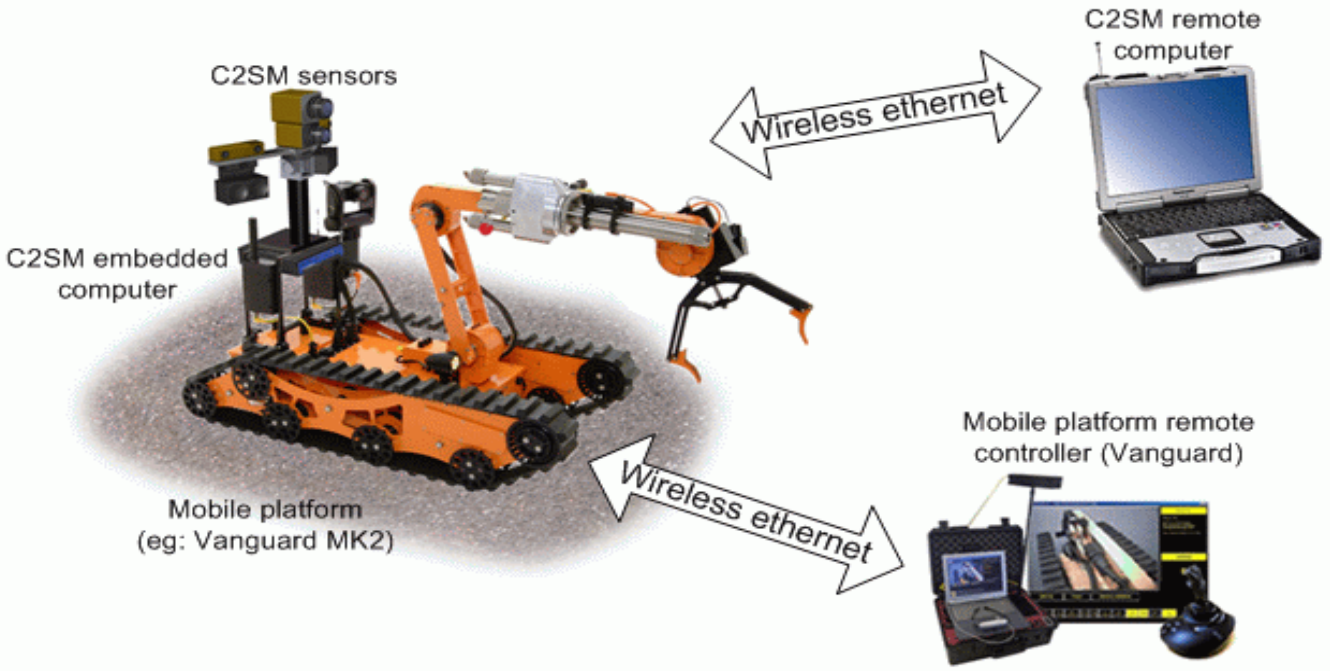
- Stereo images captured from a moving rover
- Creates 3D model and recovers rover trajectory



HOMELAND SECURITY

Military/Homeland Security

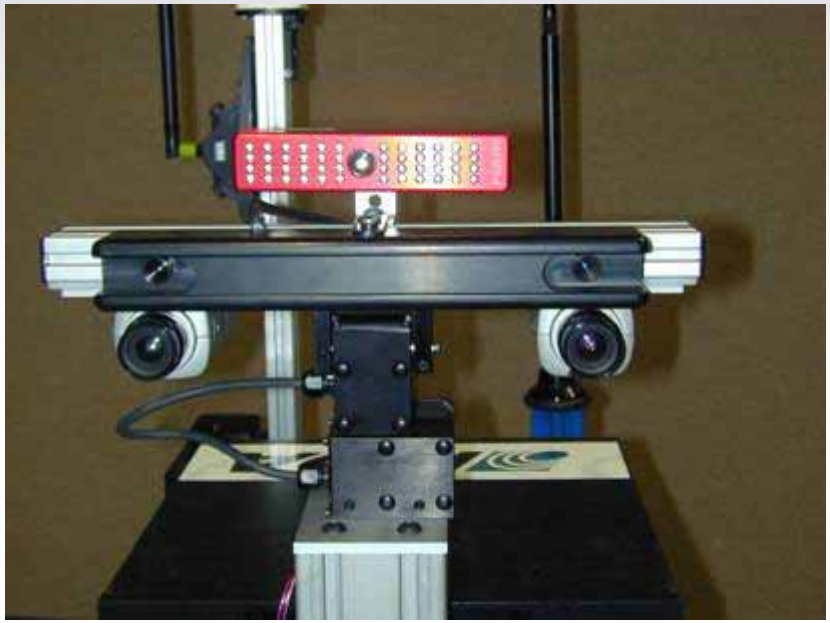
MDA is developing advanced sensor fusion information for early responders to terrorist incidents



AUTONOMOUS NAVIGATION

Rover Navigation

- Terrain assessment for planning in front of vehicle
- Expand to solve where is the robot problem



Autonomous Roving

Autonomous Vehicles

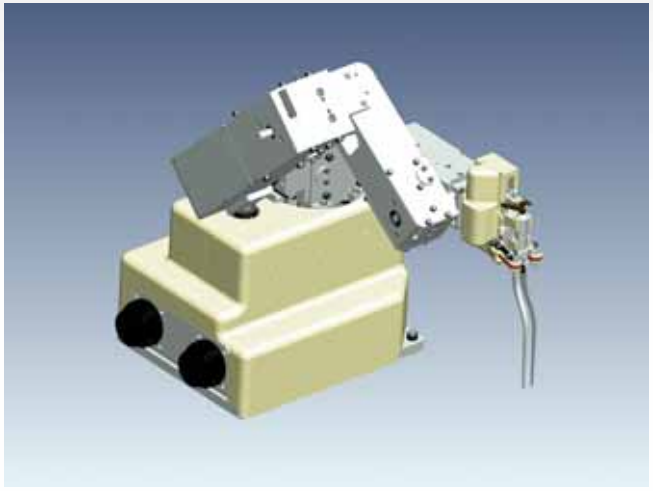
- MDA has successfully developed a **software and controls solution** for an underground autonomous vehicle to improve safety and productivity

Future Spinup – Autonomous Exploration

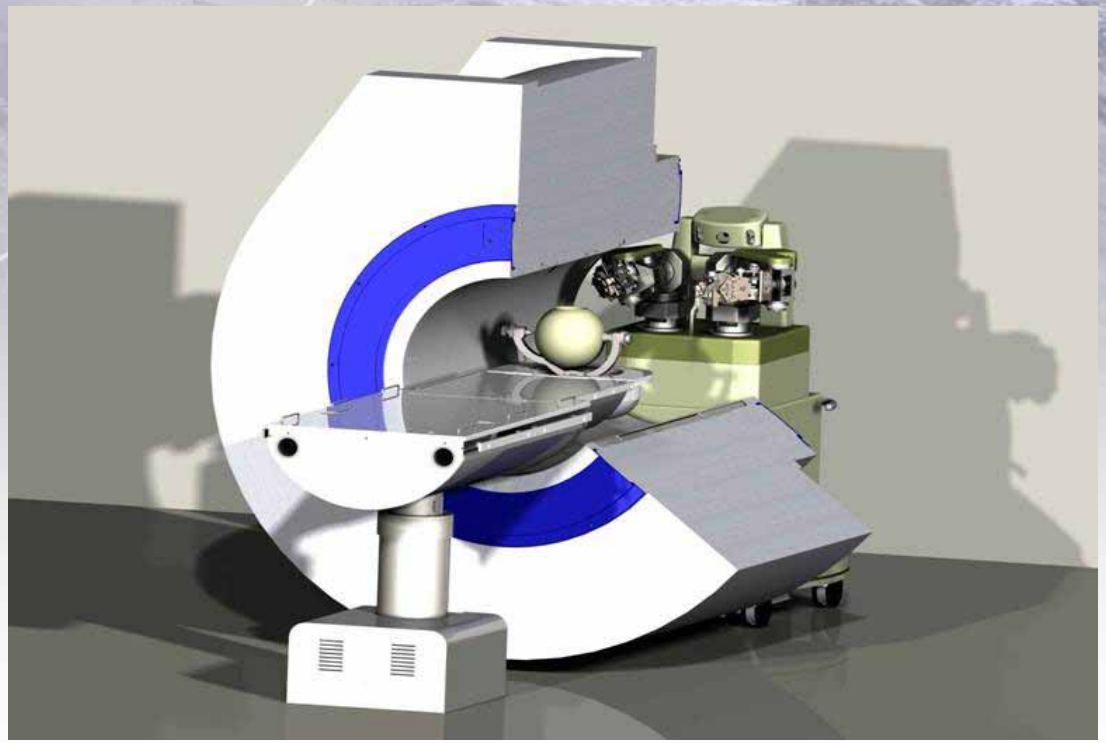
MEDICAL ROBOTICS

Computer Assisted Surgical Interface (CASI)

- **Requirements**
  - Safety
  - High precision & accuracy
  - Force feedback
  - Validation



Future Spinup – Telesurgery in Space



Other Examples

- Nuclear power plant inspection and repair manipulators
- Hazard waste transfer vehicles
- Animated dinosaurs

Hazardous Waste

Universal Studios

Lowered Costs & Risks

- Mobility
  - military and Intelligent Highways (eg Lexus)
  - fuel cells and storage (eg. BMW, Ford, GM)
  - autonomous operations
- ISRU
  - large scale mining automation
  - $billion investment on Earth
- Medicine
  - distance surgery (eg far north and battlefield)