Robotic Technologies For Lunar Exploration

LEAG
Houston Hobby Hilton
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Frank Teti
frank.teti@mdacorporation.com
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

- 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
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

Space Missions
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.
Future Spinup - Space Exploration

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