Dextre Deployable Vision System (DDVS)

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Objective

Identifying needs and solutions within our reach

Mapping CSA Technologies (short term and future)

Concept of Operations

System Concept

Schedule

Benefits
Objectives

Maximize benefits between developing technologies for Canadian key industrial capabilities, and supporting ISS

Considerations

- Support or increase MSS capability and services
- Focus on mature technology to comply with urgency to launch as quickly as possible
- Provide service to ISS through 2024
- Advance technology needed for future space exploration missions and multiple destinations
- Demonstrate return on investment to the Government of Canada
Short Term: Continue to address requests for current MSS Camera systems

Medium Term (2020): Enhance MSS Capability in Surface Inspection with DDVS

Long Term: Continue to invest in technologies and tool development

- Sub-surface:
  - Backscatter X-Ray Technology
  - Terahertz Imaging

CSA proposes to enhance MSS capabilities with a surface inspection tool for Dextre containing a suite of mature technologies: DDVS.

Participate in inspection community developments (InSpace Inspection Workshop and others)
Past Events – ISS Inspection

ISS Radiator damage – MMOD (Credit: NASA)

April 2010 image of MBS Mast reveals what appears to be MMOD damage (Credit: NASA)

Credit: NASA

Progress Collision with MIR, 1997 – solar panel damage (Credit: NASA)

EVA Handrail Impacts - sharp edges
Inspection Requests - MSS

- MSS is currently involved in the following inspection activities:
  - Berthing interface survey, payload surveys, vehicles
  - LEE Snare cable photography
    - Currently done by Crew from Cupola
  - Configuration checks
    - Make sure ground tools match with on-orbit config, e.g. Dragon trunk
  - Soyuz inspection
    - MSS cameras have been used to inspect the Soyuz vehicle.

- Areas where CSA may contribute and augment capability:
  - Reduce Crew time required for imagery support
  - MMOD Impact Damage Inspection
    - Pressurized Modules, Primary Systems, ORUs, Window, Re-entry TPS, etc.
    - ORDEM 3.0 (new Orbital Debris Model) may raise new concerns
  - System Trouble-shooting
    - Mechanisms, Leaks (e.g. ammonia) and Corrosion
  - Periodic surveys of external ISS surfaces
    - Blind spots not visible from ISS IVA
    - Previously accomplished by Shuttle, 2+ yrs since last survey – CAIB report suggests yearly
  - Future Visiting Vehicles
  - Automation of Inspection
    - Both for operations, and in post-processing of data for damage detection
Concept of Operations

• Goal: cover the spectrum of damage detection from coarse inspection up to focused inspection (surface)

• Concept:
  1. Detection*: detect potential damage
  2. Coarse inspection phase: from a distance, perform a localized inspection on the potential damage.
  3. Focused inspection phase: if deemed necessary, perform a focused surface inspection, at sub-millimeter resolution.

• Operation:
  • Will be operated via the 1553 bus (s-band)
  • Will also be operated via the ISS wifi infrastructure (EWC) via the Joint Station LAN network, enabling real-time downlink of the data and HD video stream.
  • Dextre payload with ops support from CSA
  • Preview over existing MSS video infrastructure for out of EWC coverage areas.

*Detection is performed while the operator is moving Dextre with the sensor (on OTCM) acquiring images. Detection would be performed using a combination of HD, IR cameras and/or long range LiDAR, with automated damage detection.
Operating from Dextre
Operating from Dextre
Operating from Dextre

OTCM (gripper) to grab DDVS.
Coverage
Deployment and Stowage Location

- Launched pressurized, deployed through JEM airlock.
- Install and stow on Mobile Transporter Relay Assembly (MTRA).

(Credit: JAXA)
Operated from Ground
Concept Overview
Coarse Inspection LiDAR

- Working range: 2m to 1km.
- Centimeter resolution
- Use cases:
  - Configuration validation
  - Long range damage assessment.
- Preview available through current ISS Video System
Coarse Inspection LiDAR

• Example of damage assessment:
  • 7mm damage surveyed at 7.6m.
Fine Inspection LiDAR

- Working Range: 1-2m
- Resolution: sub-mm
- Similar inspection functionality to LCS on OBSS/IBA
- Main use case is focused inspection
- Preview available through current ISS Video System (NTSC).

Textured 3D Point Cloud
High Resolution Cameras

• 2 High resolution cameras
• One near field: resolve a 1mm damage @1m.
• One far field: resolve a 10mm damage @ 30m.
• Current concept has 12 Mpx sensors.
• Preview available through current ISS Video System (NTSC).

Photo from Cupola, credit: NASA

MSS Camera Image (NTSC)
Infrared Camera

• Long-Wave (6-12μm) Infrared Camera
• Resolution should be 1024x768 (although, the requirement is 640x480).
• Main use cases: solar array, radiator inspection.
• Currently, only EVA IR camera available.
• Preview available through current ISS Video System (NTSC).

Example of an IR application:
- Lighter lines are shut-off solar array strings (getting hotter)
- As they are shut off in a known order, damage detection could be identified on failed strings
- Other potential applications
- Capable of detecting changes in heat flow due to damage, voids or cracks and can be pointed for a long period of time. Heat sources can be, Sun, Laser.
Currently between Phases A and B.
Benefits to the ISS

- Enhanced robotic inspection capability will reduce risk, address challenges and increase efficiency:
  - Introduce new capability and new technology combinations
  - Address “Blind” Spots
    - Address external ISS surveys, including unexpected damage (handrails)
    - Reach areas not accessible from windows
  - Reduce Crew Time – transfer tasks to robotics
  - Reduce Operations Time
    - Automatically detect damage, followed by coarse or focused inspection
    - Less motion – detection at a greater standoff distance
  - Detect early, potentially reduce wear and tear on hardware
  - Improved response time to issues, easier than current ops
  - Visiting Vehicles
  - New Crew Vehicles
  - Unknowns