Robots for Hazardous Environments

Natural Gas Pipeline & Nuclear Applications

Matt Gryniewski
Project Manager, ESI
matt@esit.com

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Who is ESI?
What does ESI do?

- **Custom Robotics**
  - Nuclear
  - Utilities
  - Laboratory

More on this later

- **Products**
  - Mobile Robots
  - Medical Robots
  - Space Robotics
  - Software for Terror Counter-measures

- **Technology**
  - Micro-fluidics
  - Smart Materials
  - Mini-Sensors Network
  - Modular Robots

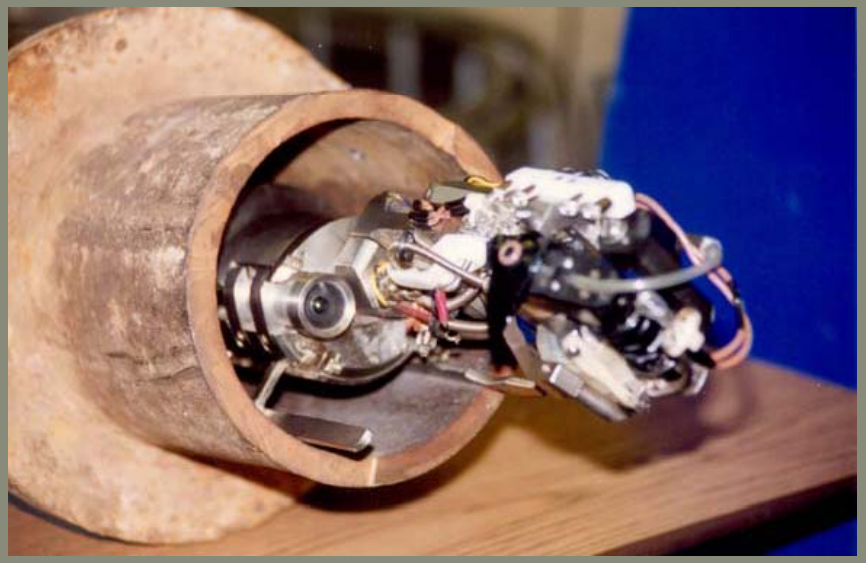
Underground Gas Pipes

CISBOT: Robots for Internal Service of Underground Gas Pipes

Hazardous Environments

- Robot enters live gas pipe
- "No Blow" Operation
- No sparks
- No trapped pockets of air (O_2)
- Pump anaerobic sealant
- Extremely confined space

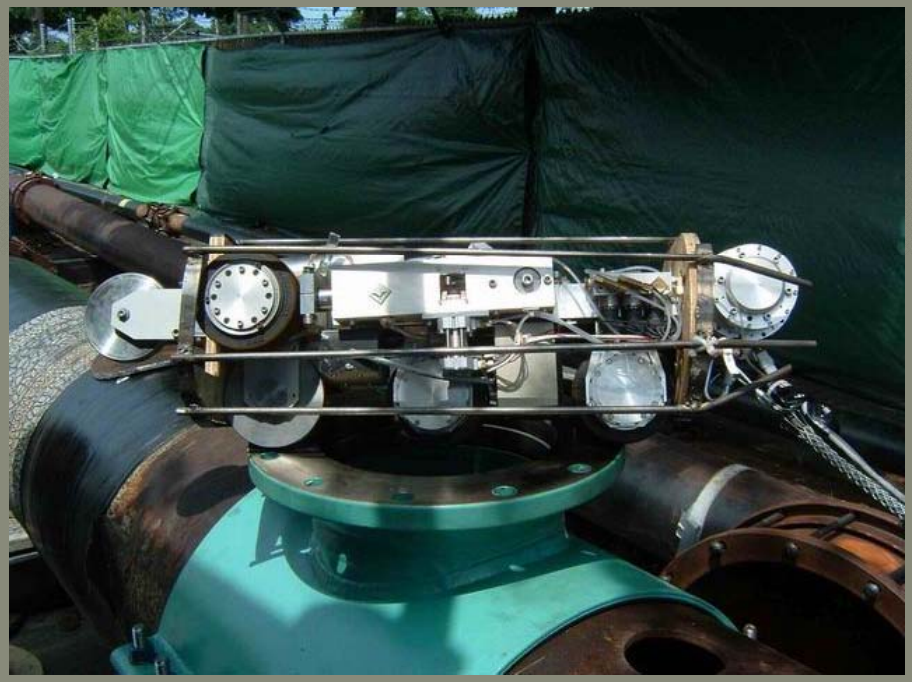
6” and 12” Pipe



Requirements:

- Motorized push-rod umbilical for robot locomotion
- Precisely adjustable injection point
- Adjustable sealant pressure and volume
- Monitoring of repair process and pipe condition

16” to 36” pipe

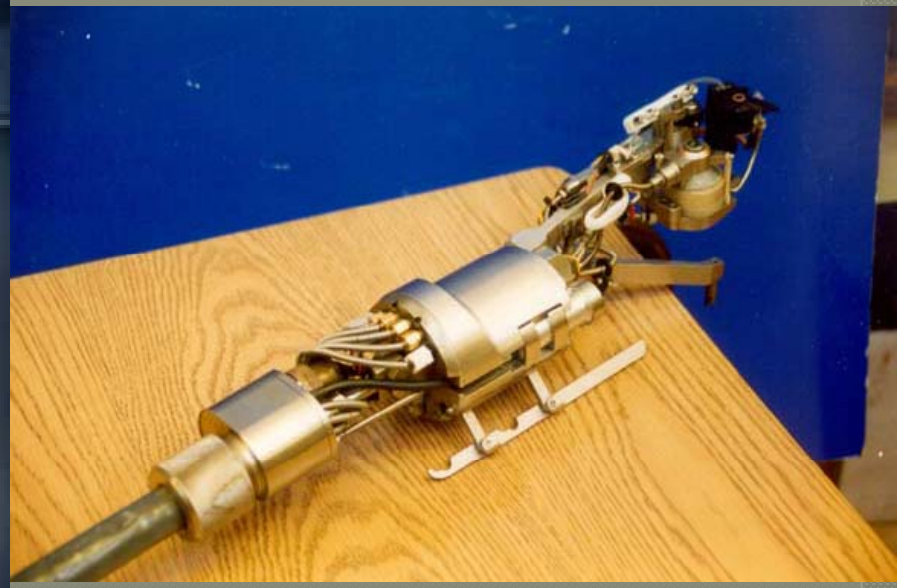


Operates in live mains 16” to 36” in diameter
Self-propelled robotic tool head
Can reach over 1,000 ft from the launch point
High Pressure pneumatics

16” to 36” pipe

Robot launched through 12” opening
Must unfold and then generate traction against the pipe wall
High-capacity, maneuverable locomotion system

6” and 12” Pipe



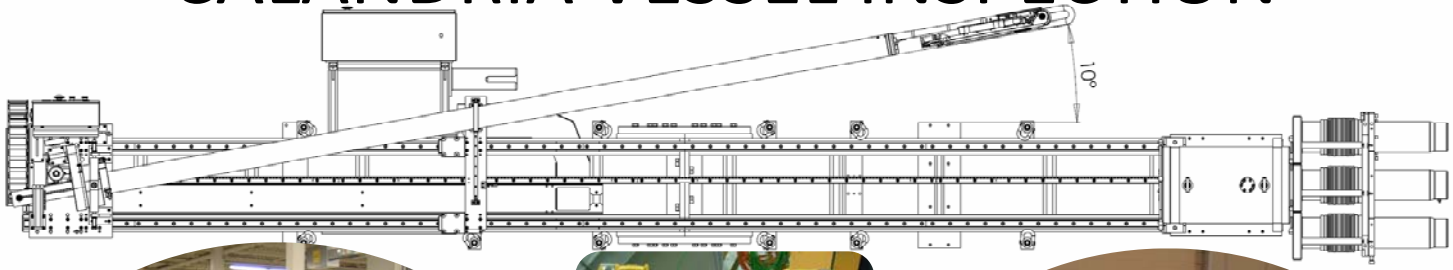
Motorized push-rod for robot locomotion
Precisely adjustable injection point
Adjustable sealant pressure and volume
Monitoring of repair process and pipe condition

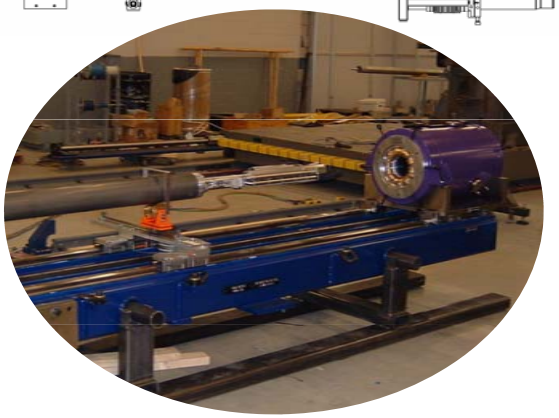
Nuclear Applications

AARM: A Robot Arm for Internal Operations in Nuclear Reactors

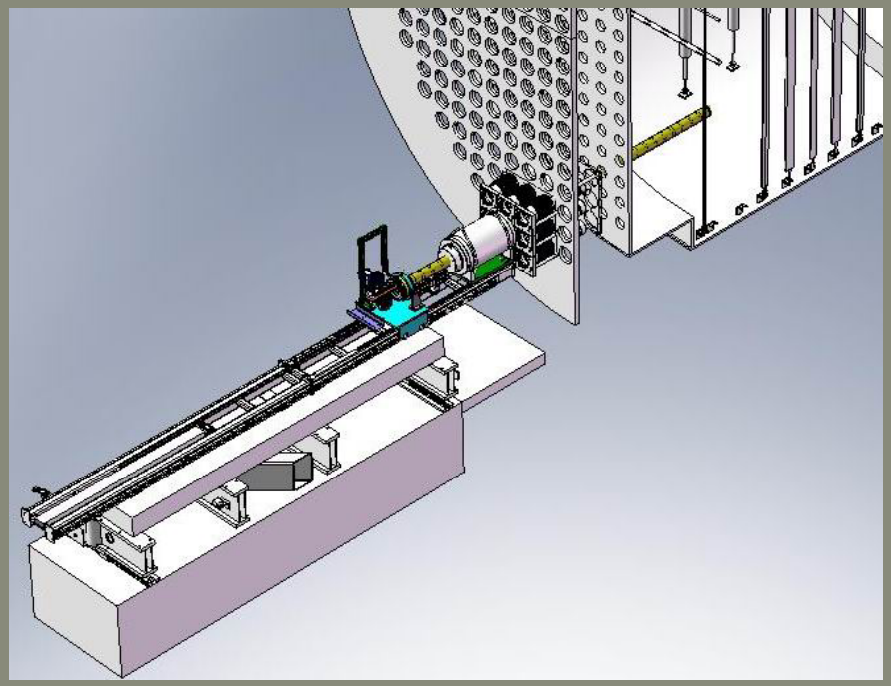
Arm for Nuclear Reactor

CALANDRIA VESSEL INSPECTION





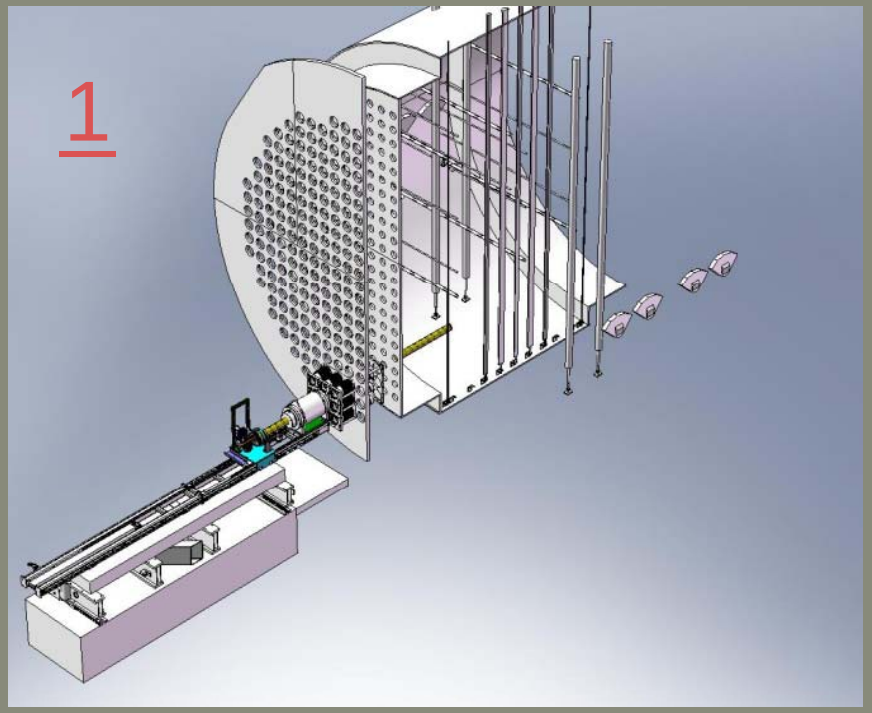
Arm for Nuclear Reactor

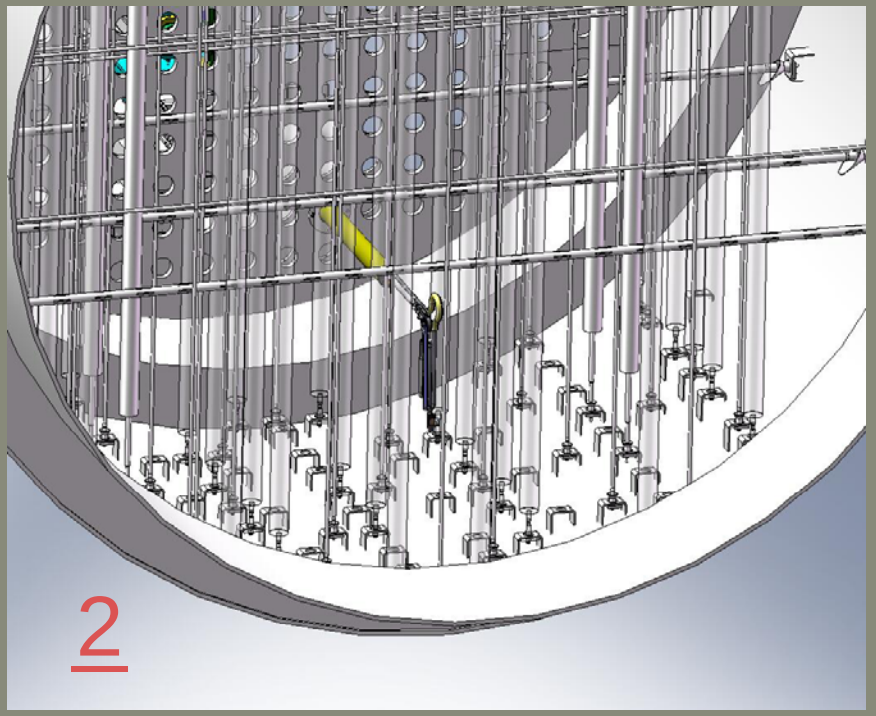


Requirements:

- High Radiation levels
- Severe material restrictions
- Small access hole (130mm)
- Long reach (6,000mm) (46:1)

Arm for Nuclear Reactor





Robot designed for operation ***inside*** the Calandria vessel
Two systems currently deployed at Point Lepreau generating station
Two more systems deployed in Wolsong, Korea
System performs inspection (visual and UT-hardness) and physical removal of debris

Why am I here

What does a natural gas pipe robot and a nuclear robot have to do with the Planetary and Terrestrial Mining Sciences Symposium?

Not much...

But...

Canadian Space Agency: MRPTA

Micro-Rover Platform with Tooling Arm

- Small lightweight rover
- Autonomous navigation
- Mapping and scientific exploration of Moon or Mars
- Definitely a hazardous environment

Canadian Space Agency: MRPTA

The MRPTA rover carries:

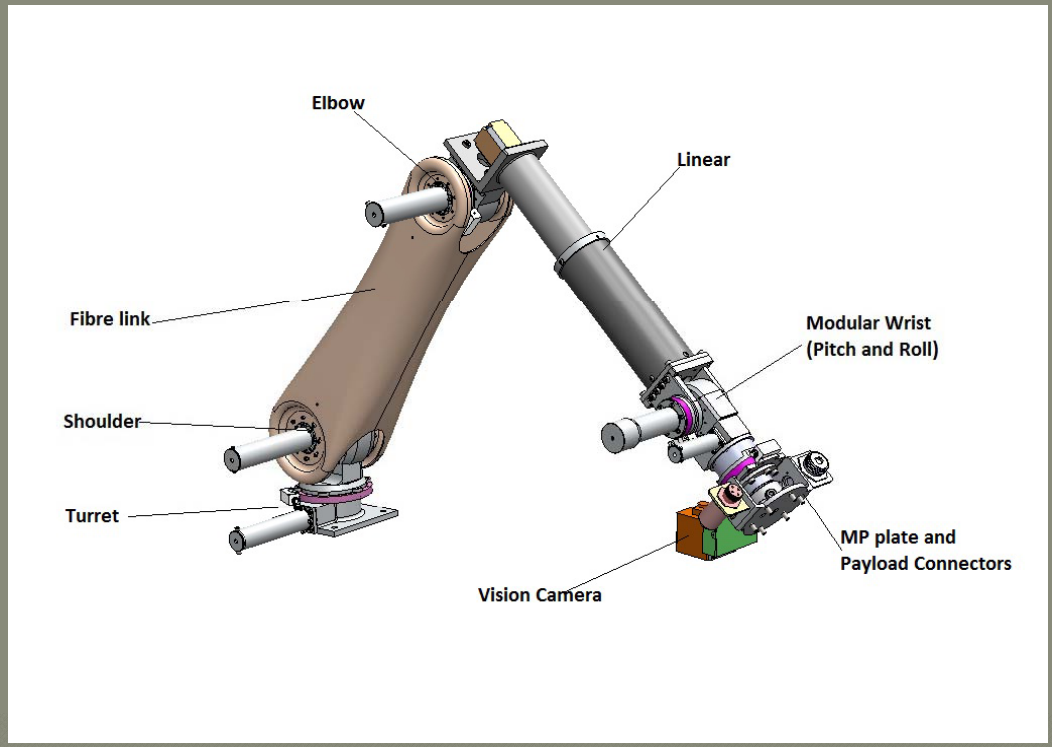
1. XRF instrument
2. Laser Induced Fluorescence and Raman Spectrometry
3. A scoop to acquire a surface regolith sample

Canadian Space Agency: SMA

Small Manipulator Arm

- Lightweight
- High payload to mass ratio
- Vision guided robot
- Mounted to Mars exploration rover

Canadian Space Agency: SMA



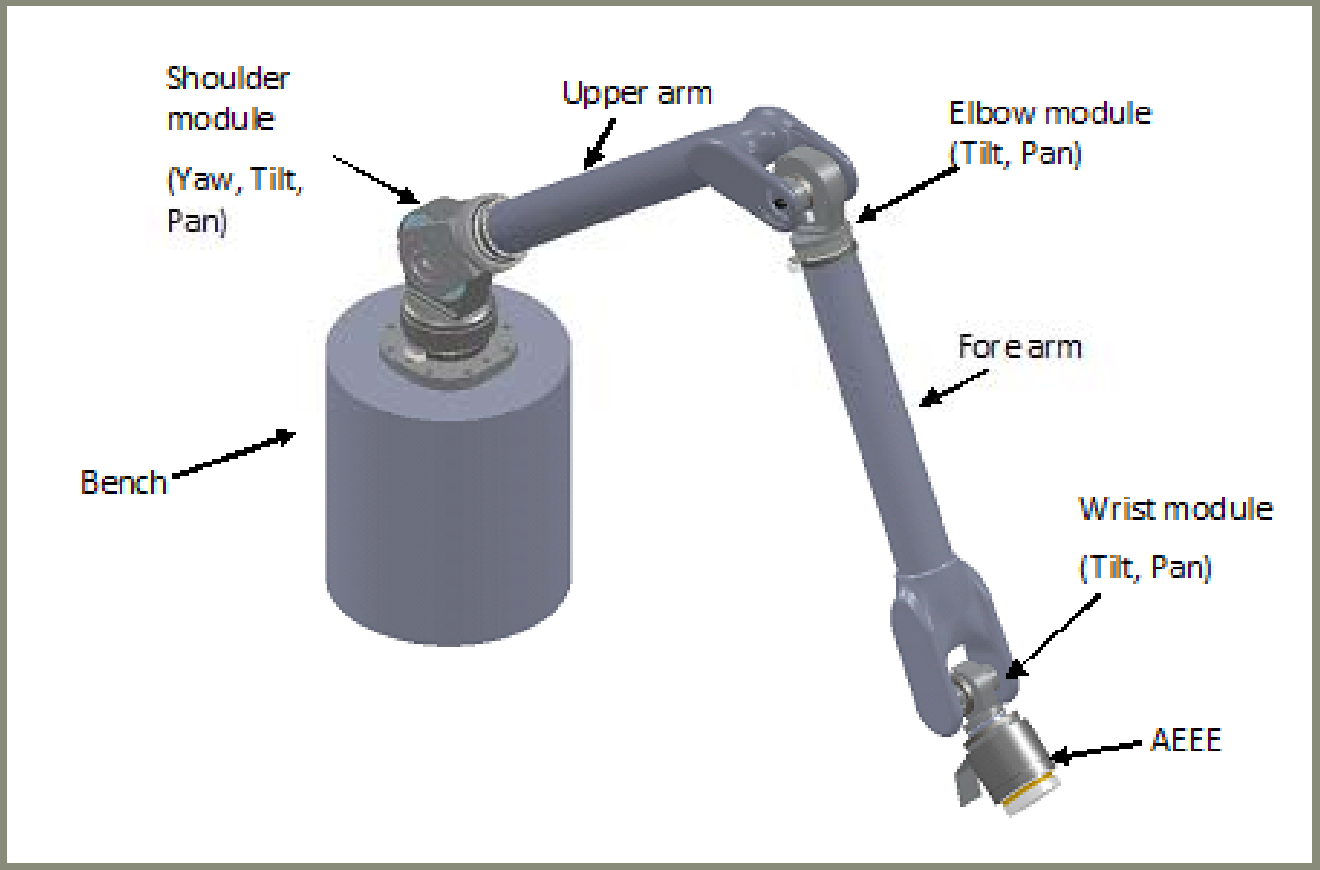
Designed to carry the mini-corer and microscope that are part of the ESM projects

Canadian Space Agency: PMM

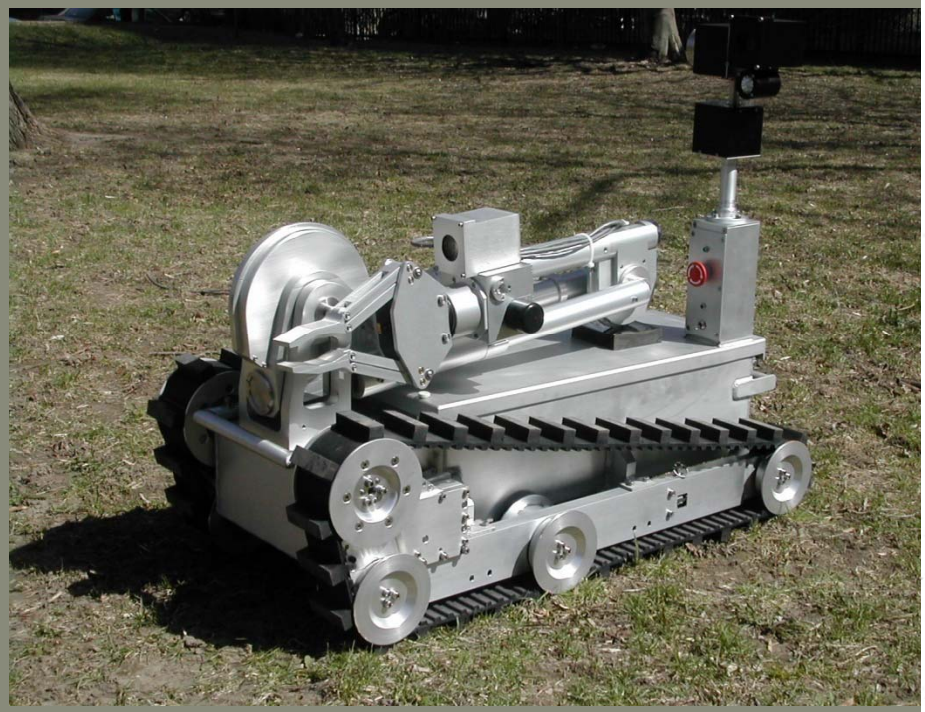
Planetary Medium Manipulator

- Advanced Control
- Multiple and Interchangeable End Effectors
- Redundant Arm
- Large Normalized Workspace
- Modular Design
- Lunar science, construction and maintenance

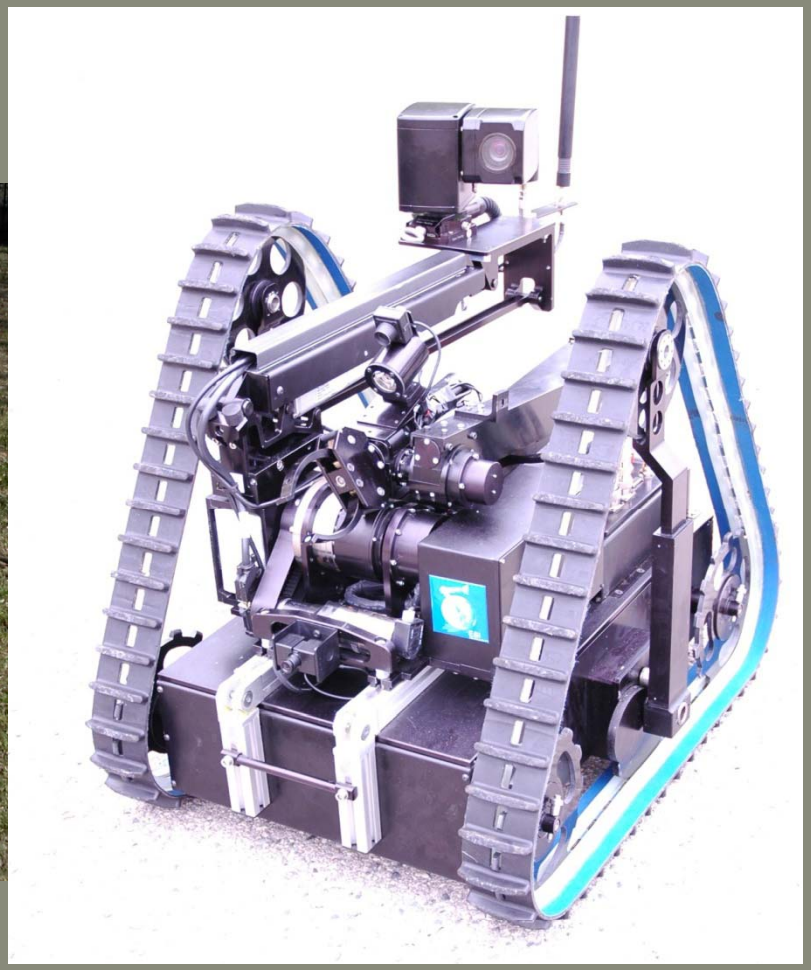
Canadian Space Agency: PMM



Tech Demo tomorrow: Robots on Display



MR-7



Tracker

Tech Demo tomorrow: Robots on Display

And possibly MRPTA