Remote Underwater Robotic Inspection

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Robotic Systems Technology Branch
• Overview of Robotic Systems Technology Branch
• Project Background – Robot Inspection
• Hardware Description
• Operator Console
• Testing

• Q & A
JSC - Robotic Systems Technology Branch

- Multi-disciplinary group
- Diverse Range of Robots
  - Dexterity
  - Mobility
  - Wearability
  - Sensing/Inspection
  - Teleoperation & Telepresence
  - Autonomy & Control Systems
Project Background

- Approached by O&G industry to map sediment layer in crude oil storage cells
- Space Act Agreement initiated 4/2013
- Two phase project
- Phase I - Map sediment layer in crude oil storage cell
- Phase II – collect sample of sediment layer
- 5 member project team at JSC
- Phase I hardware delivered 11/2013
Function of Inspection Robot

- Gain access to cell via existing 10” fill lines
- Introduce sonar mapping unit into fill lines through hot tap gate valve
- Tethered sonar propelled through pipe work via 4” forced water delivery
- Manual deploy and retrieval via tether spool external to gate valve
Utility Leg and Oil Storage Cells
Concept of Operation
Stuffing Box Internal
Inspection Hardware Description

- 9” diameter housing
- 900 MHz 2-D Sonar
- Dual cameras (forward and rear facing)
- Inertial Measurement Unit
- Temperature Sensor
- On-board power converter
- On-board microprocessor
- Video converter
- Ethernet to VDSL converter
- 100m Power/Data tether
- ATEX zone 1 ExD rated hardware
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• Sonar suspended top center of storage cell, looking down
• Sonar measurement provides a thin slice profile of the sediment layer (topography accuracy +/- 10cm) across entire width of cell
• Multiple profile images are created as sonar is incrementally rotated about the median-sagittal plane of the storage cell
• A Software composite of the 2D profile images creates a 3D volume (point cloud elevation map)

Top view looking down into Cell

Sonar incrementally (1°) rotates through 180°
Operator Console
Sphere data at stall point/bellmouth
Testing - Valhalla Missile Silo – Abilene, TX

Non-structured, scattered debris at bottom of silo
NBL Flow Testing
Flow rate vs. Forces

\[ y = 4 \times 10^{-8}x^2 - 1 \times 10^{-17}x - 1 \times 10^{-14} \]

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