3D Sonar Image Processing and Mapping of Solid Surface in HLW Tanks

Gene Yllanes

DOE Fellow – B.S. Electrical Engineering

Abstract

A commercial 3D profiling sonar is being tested at FIU for applications to high level waste (HLW) tanks at the Hanford DOE site. The sonar data is filtered to remove all but the settled solids layer. The post-processing of the solids layer is done with collected 3D voxels and exported for visualization and volume calculation of the HLW layer. Effort to automate the sonar image collection and post processing is ongoing in order to allow the sonar to be used as a monitor within Double-Shelled Tanks (DST s) at Hanford.

Long Term Challenges

Tank Transfer

- Currently high level waste (HLW) is being transferred from single-shell to double-shell tanks.

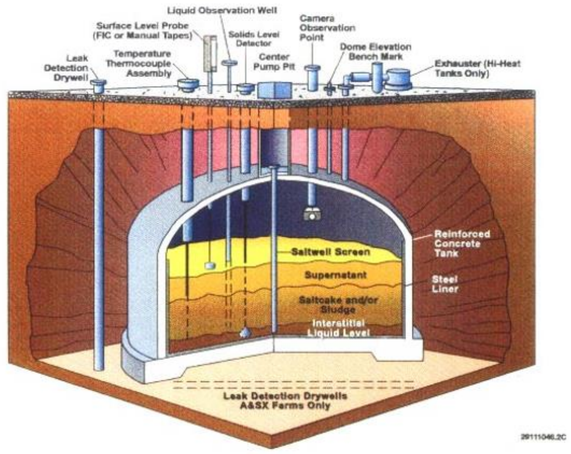
Gas Accumulation

- The possibility of Deep Sludge Gas Release Events (DSGREs) has raised safety concerns.

Over Filling

- These tanks are being filled with more sludge than original safety basis design.

Fig 1: Schematic Diagram of a Million Gallon HLW Tank



Applied Technology

- 3D Remote Profiling Sonar
- 3D Profiler Software
- MATLAB® Image Processing Toolbox

How It's Made

- Rotating Transducer
- Titanium Casing
- Polyurethane Cap
- Split head design with most electronics in external unit

Test Parameters

- Swath Arc
- Rotation Step Size
- Velocity of Sound
- Transmit Pulse

Fig 2: Sonar and Controller

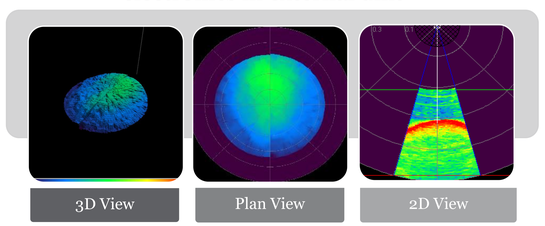


Fig 3: Different views within the commercial 3D Profiler Software

Fig 4: Diagram of 3D acquisition

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Current Tasks

Experiment With Gas Retention in Sand

Procedure for modeling gas retention:

1. Tape bladder to weighted plastic lid
2. Add 1 cm of sand to cover bladder
3. Submerse lid inside experiment tank
4. Collect baseline image with empty bladder
5. Take scan after each air increment

Fig 5: Bladder taped to weighted plastic lid

Fig 6: Taped bladder covered with sand

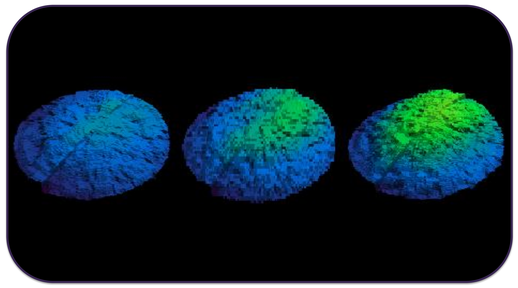

Fig 7: Experiment with gas retention in a bladder

Using 2D Swaths for Precision

- Data collected from 2D swaths is the most accurate
- Distance is from the sonar tip to the target imaged
- Gas retention distances were measured by hand to verify the sonar accuracy

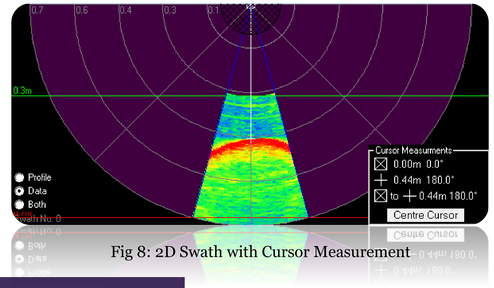

Fig 8: 2D Swath with Cursor Measurement

Height of Bladder in Retained Gas Experiments

# of Air Additions	Distance from Sonar	Height Difference
0	46 cm	0
1	45 cm	1 cm
2	44 cm	2 cm

Differential Measurement

- Data from sonar is converted into voxels and the 3D data points are iterated into arrays
- Voxels are represented in meshes of triangles and then plotted to form convex hulls (surfaces)
- The difference between the base to the final hull represents the volume of gas retention

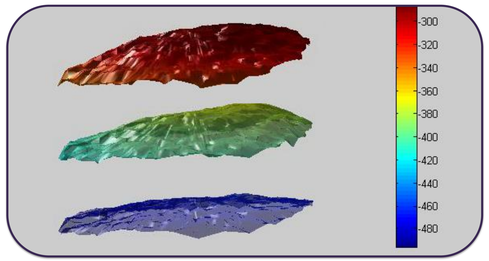

Fig 9: Side-view of post-processed images from Fig 7

Future Research

Software

- Development of continuous monitoring with batch processing
- Measure changes in the surface down to 3-6 mm
- Automate the post-processing in order to generate the data

Testing

- Test accuracy at greater distance
- Develop filtering algorithms to map with higher accuracy
- Design experiments to better simulate the waste in HLW tanks