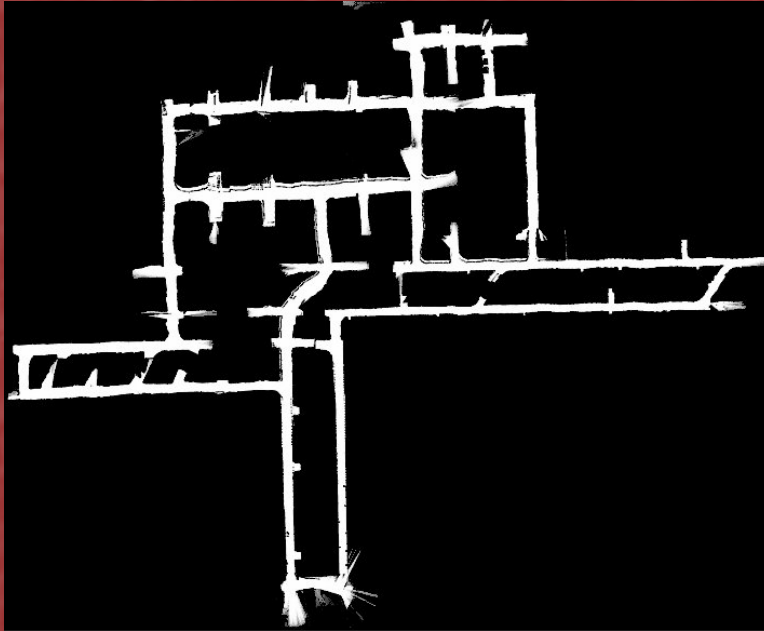
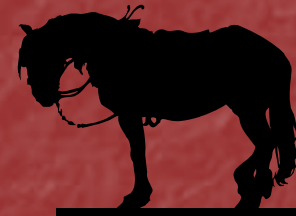
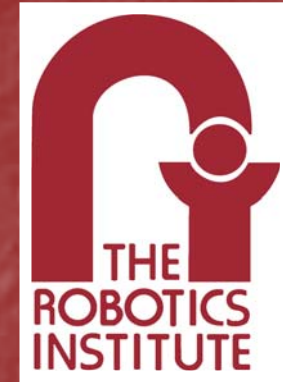


Robotic Characterization of Mine Voids



Robotically Generated Mine Map



- Carnegie Mellon University – Premiere Robotics Research
- Workhorse Technologies, LLC - Service Provider for Robotic Mapping of Underground Voids

Mobile Mine Void Exploration

- Autonomous corridor following
- May 30 – Mathies Mine
 - 300 meters of autonomous mapping
- October 1 – Mathies Mine
 - 3 runs totaling 260 meters of autonomous mapping
520 meters of traverse
- October 8 – Mathies Mine
 - 500 meter autonomous mapping run planned 1 km traverse

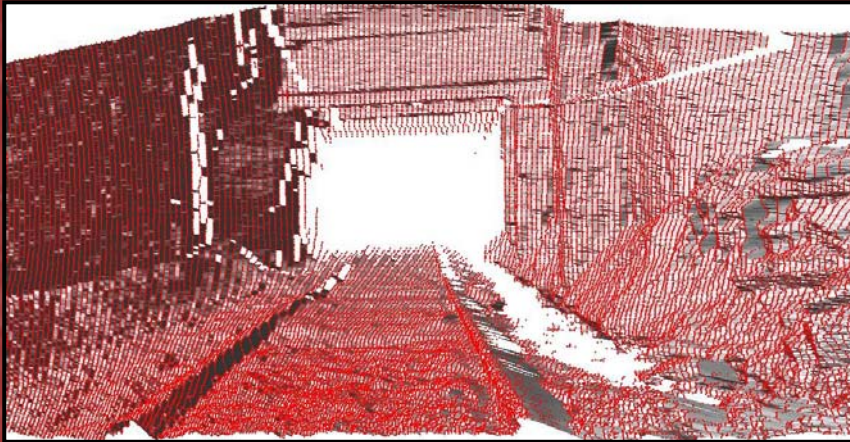
May 30 Results

500 meter Autonomous Driving

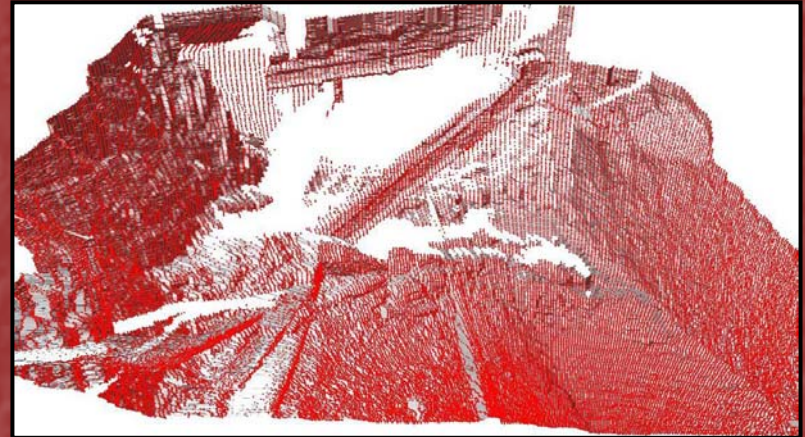


Mathies Mine
May 30, 2003

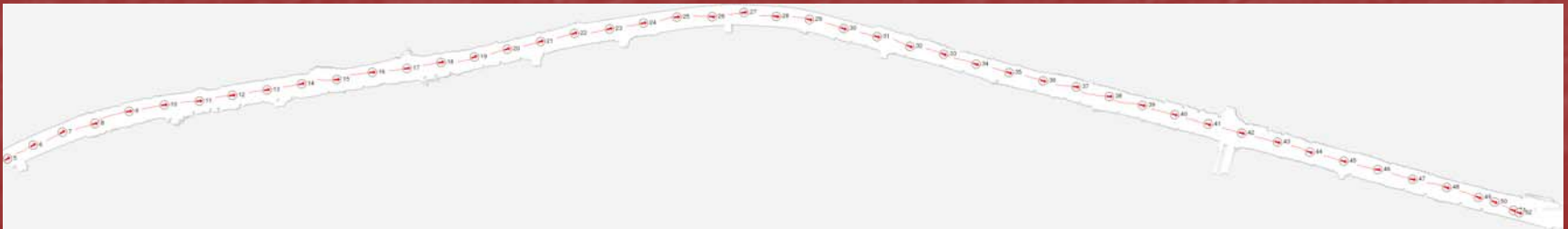
Exploration Results



3-D Model – Navigable Passage

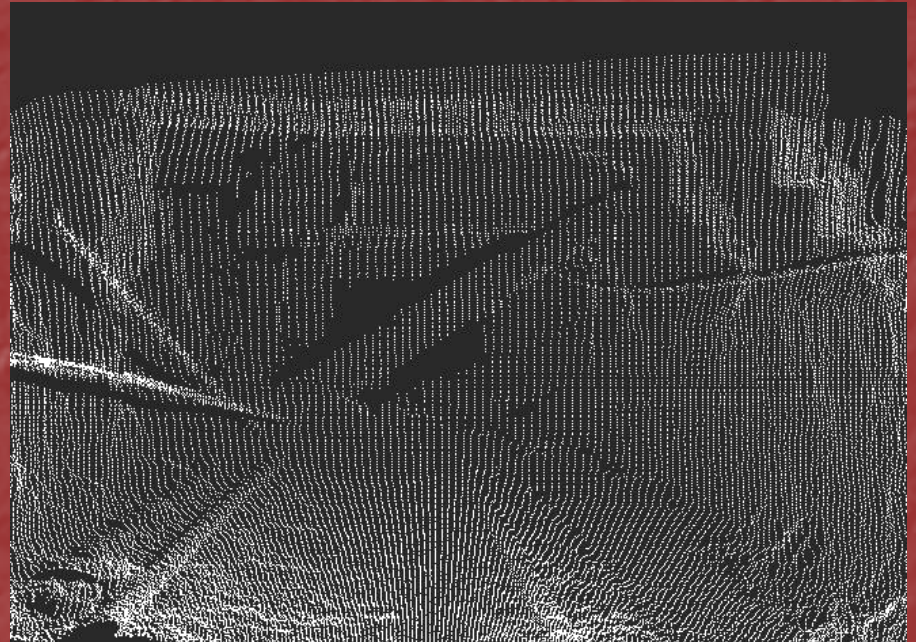


3-D Model - Fallen Roof
Timber Blocking the Passage

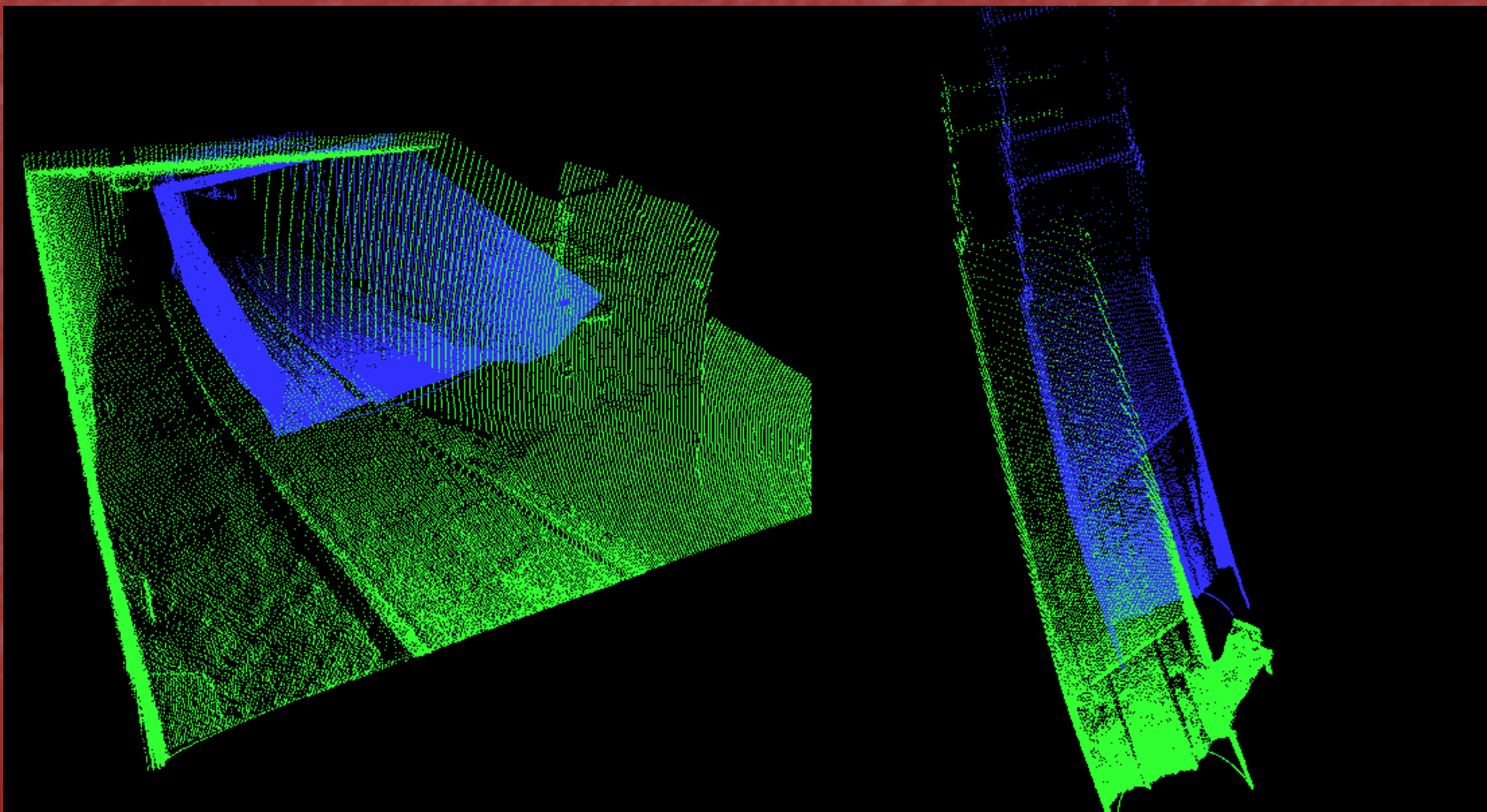


2-D Mine Map

Photo & Range Images



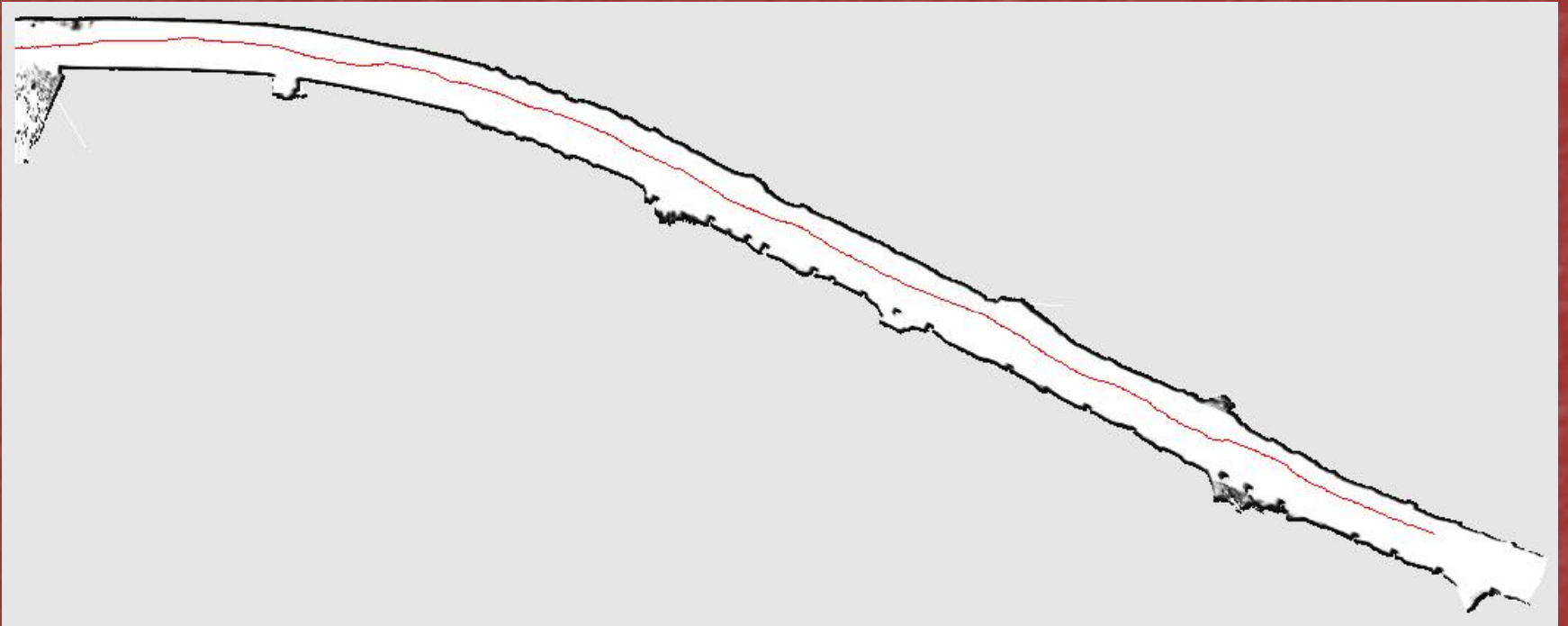
Matching Range Images



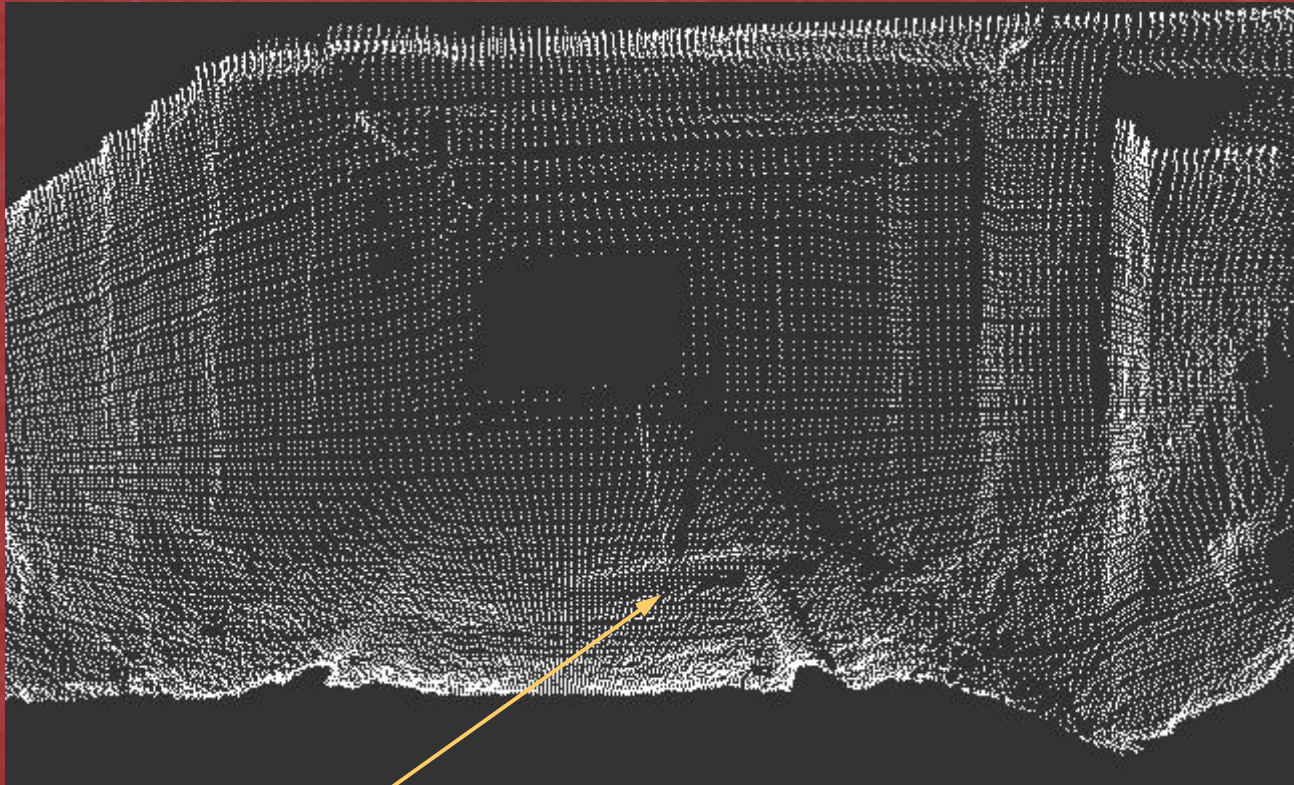
October 1 Results

- 3 autonomous runs in the Mathies Mine
 - Run 1 – 100 meters – Supply Yard East
 - Run 2 – 100 meters – Supply Yard West
 - Run 3 – 60 meters – Preparation Plant

Run 1-2D Mine Map

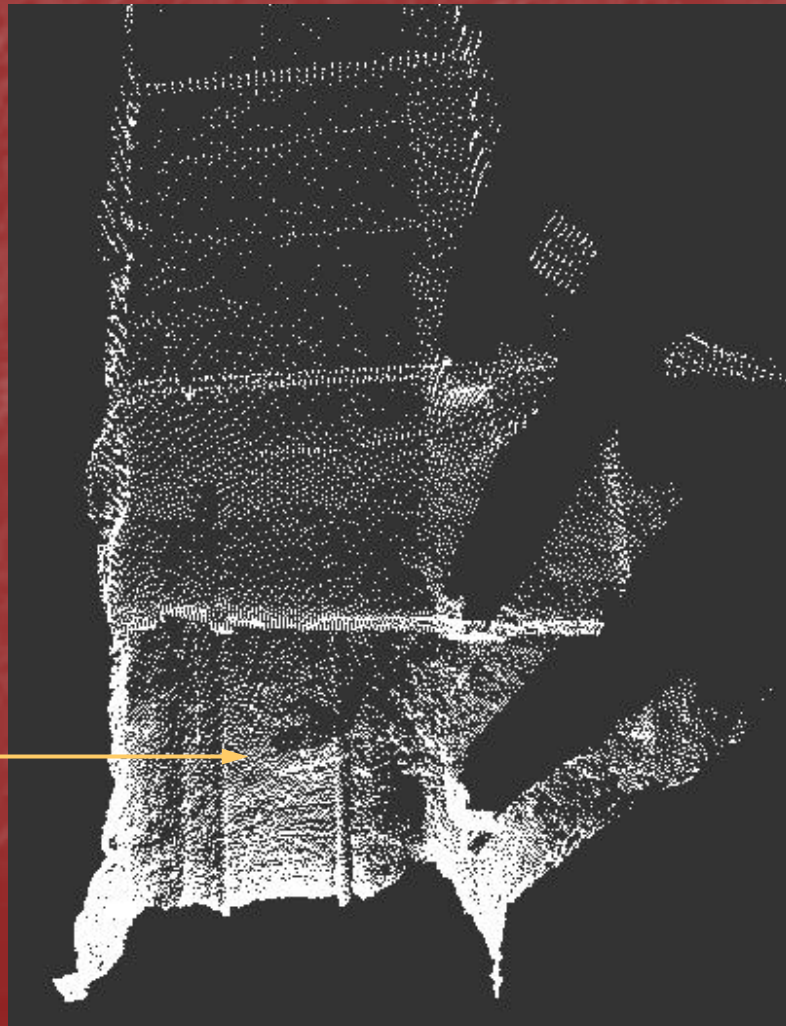


Run 1-Fallen Timber with Roof Bolt



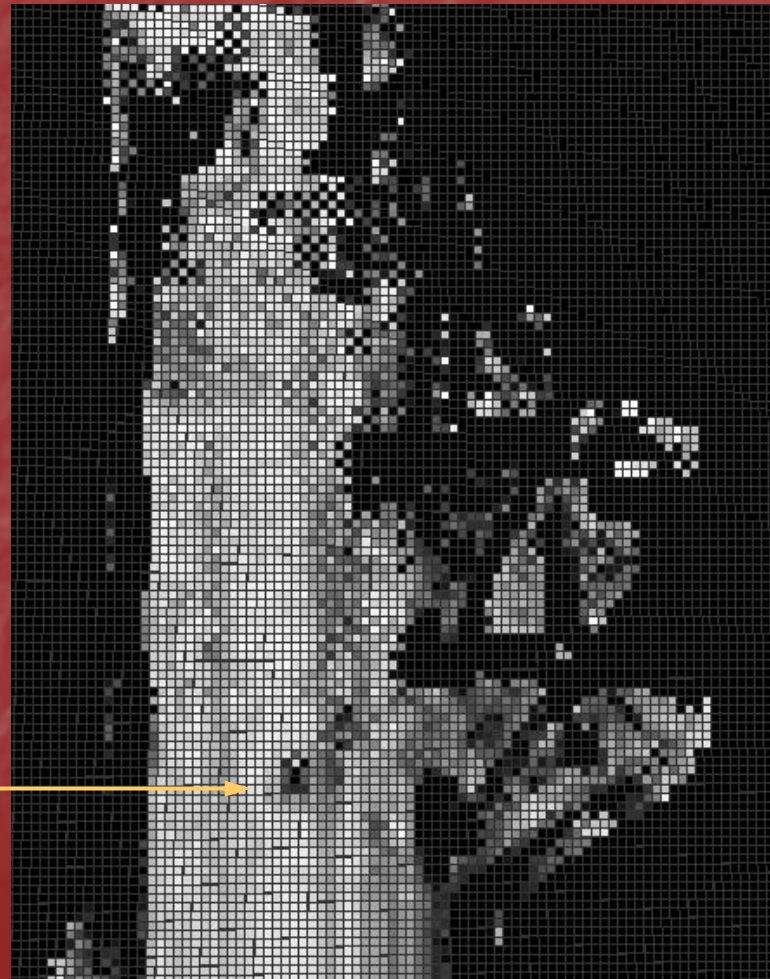
Timber with Roof Bolt

Run 1 - Top View of Timber with Roof Bolt



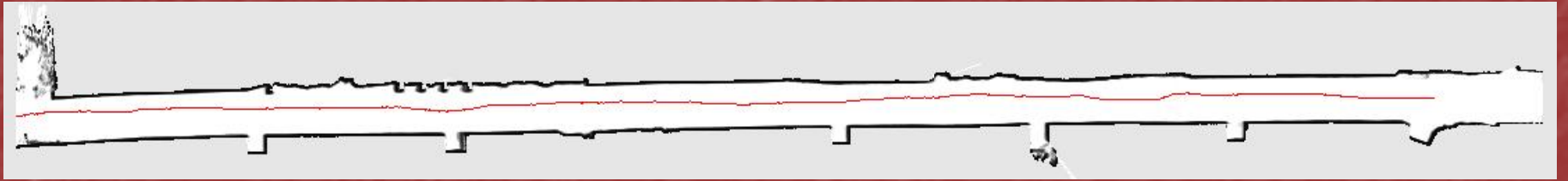
Timber with Roof Bolt

Obstacle gradient map used to generate the robot driving path

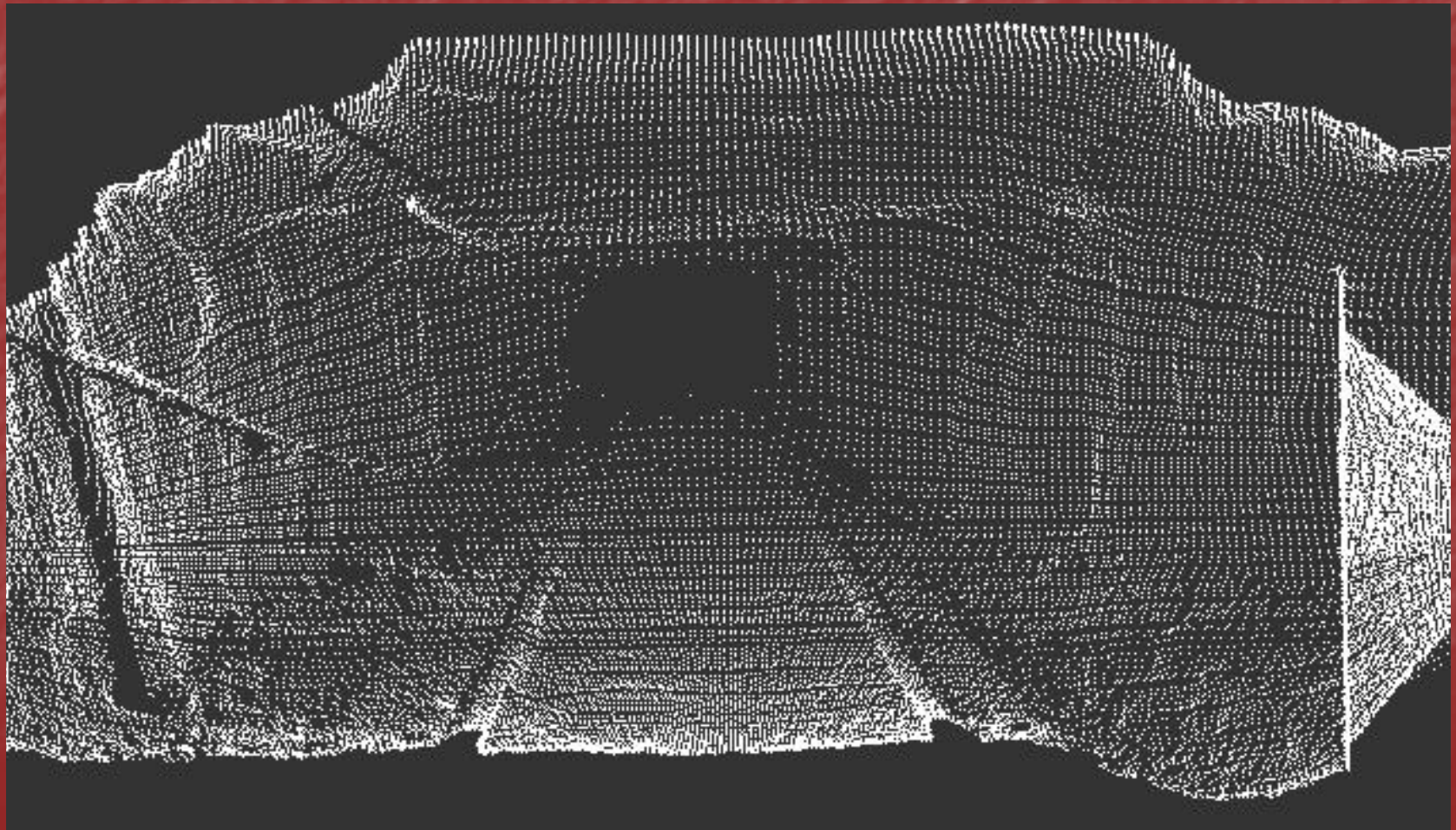


Timber with Roof Bolt

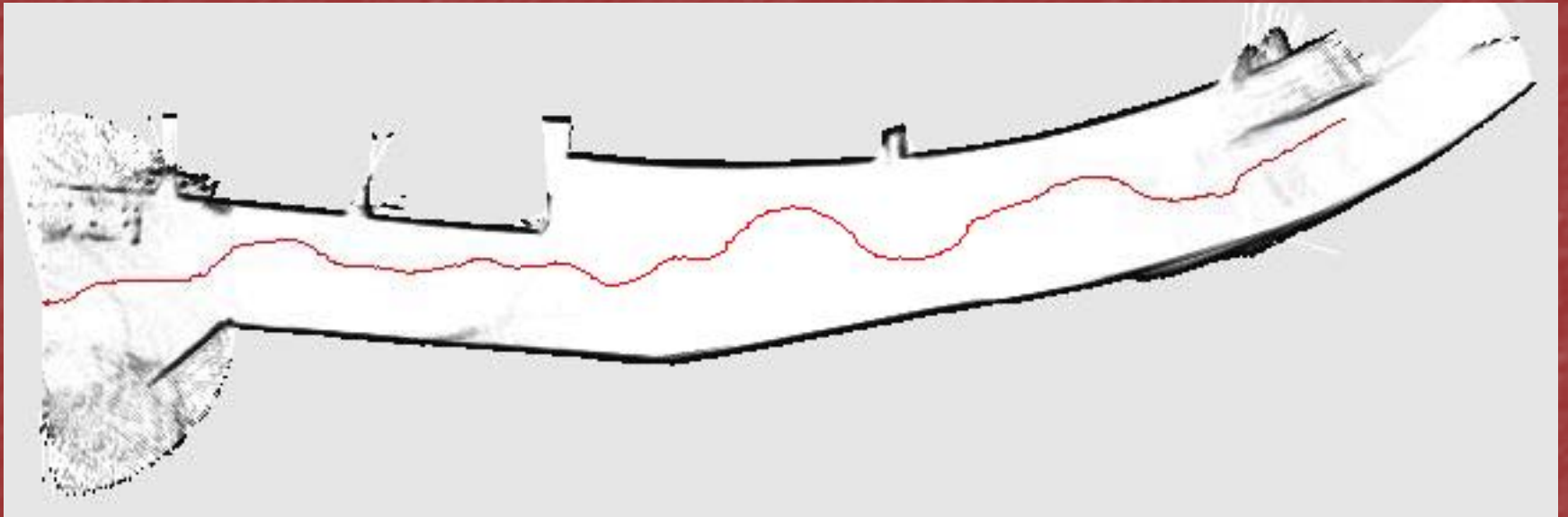
Run 2-2D Mine Map



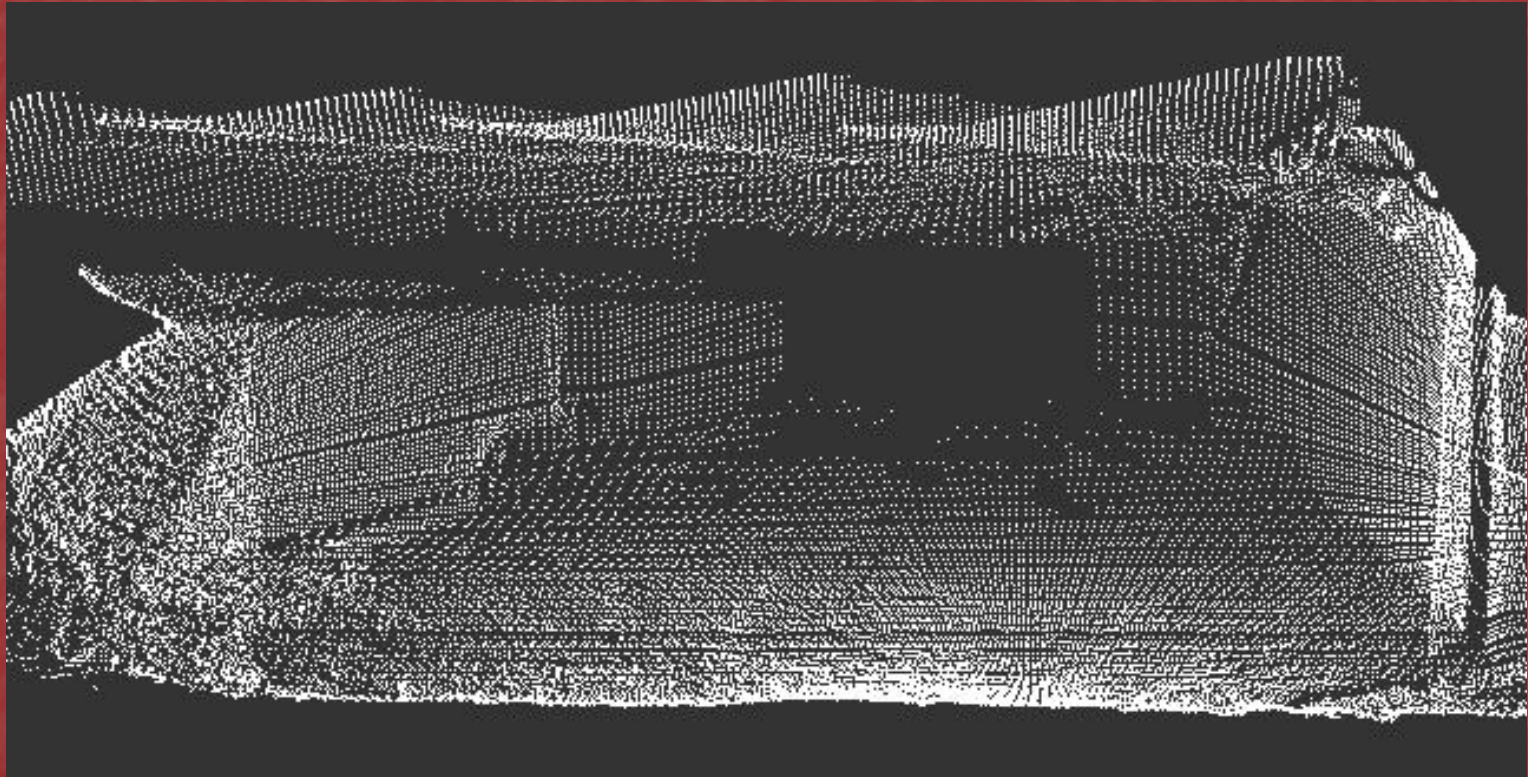
Run 2 - Farthest void model



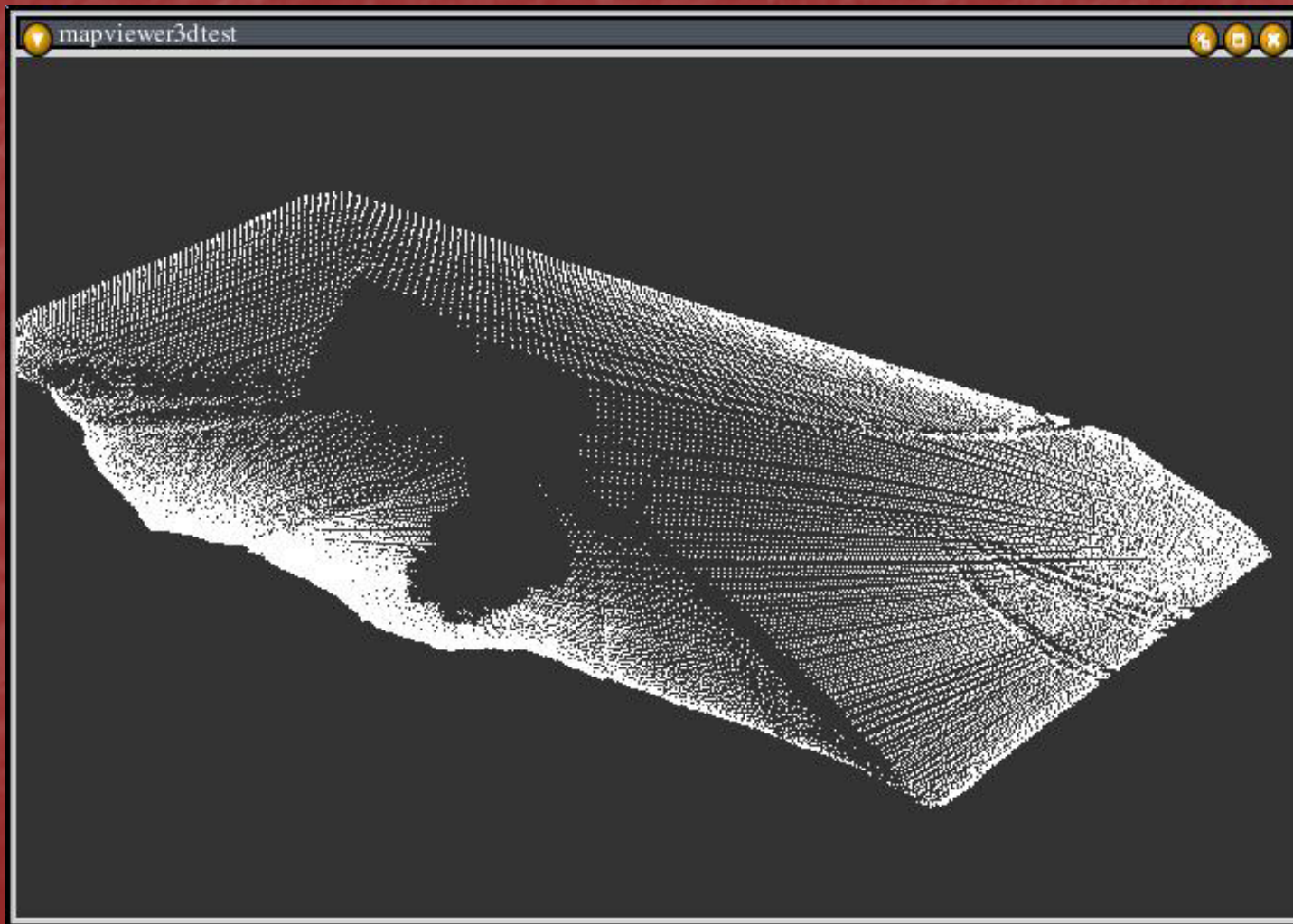
Run 3-2D Mine Map



Run 3 - Coal Cars in Corridor



Run 3 – Tilted robot scan



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