# TSDF Surface Reconstruction in ROS

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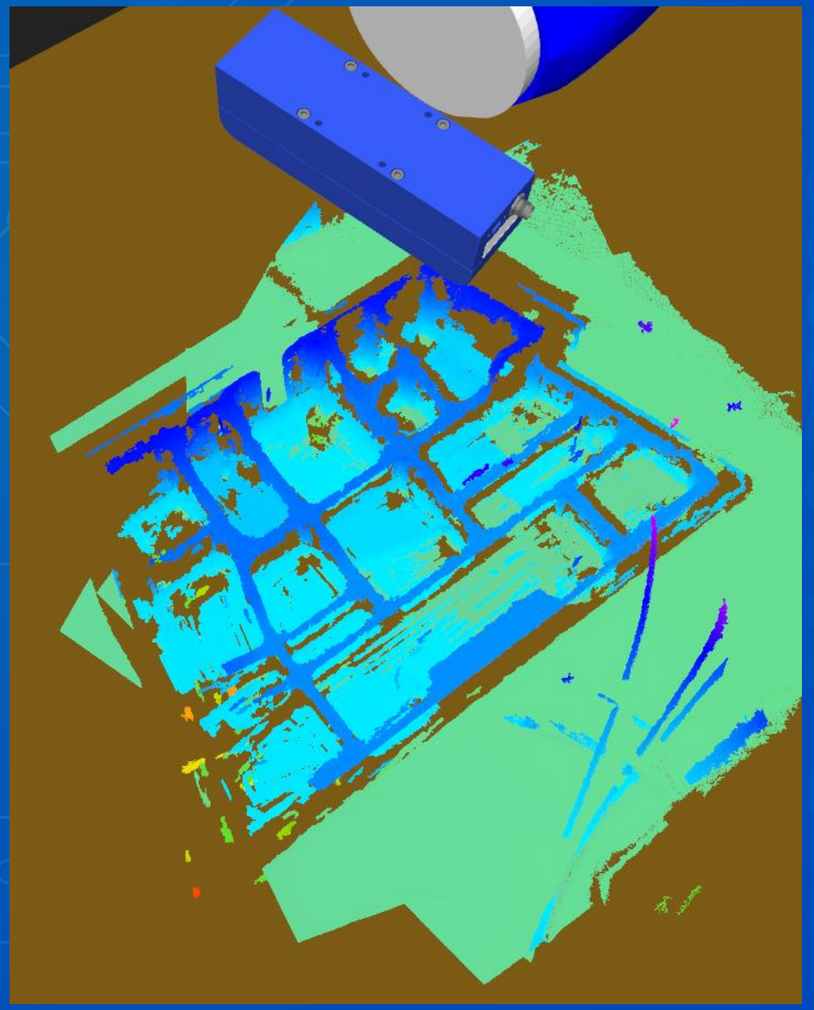
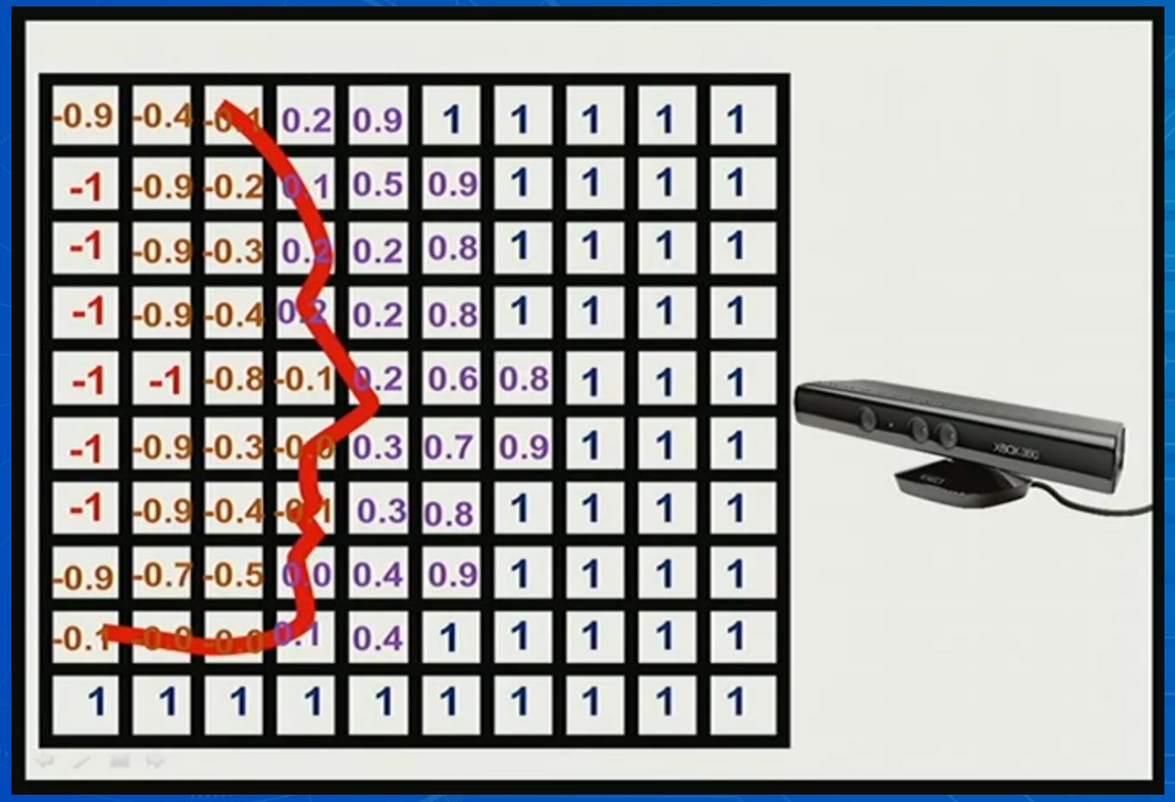
# Motivation: Shiny objects are hard to see in 3D



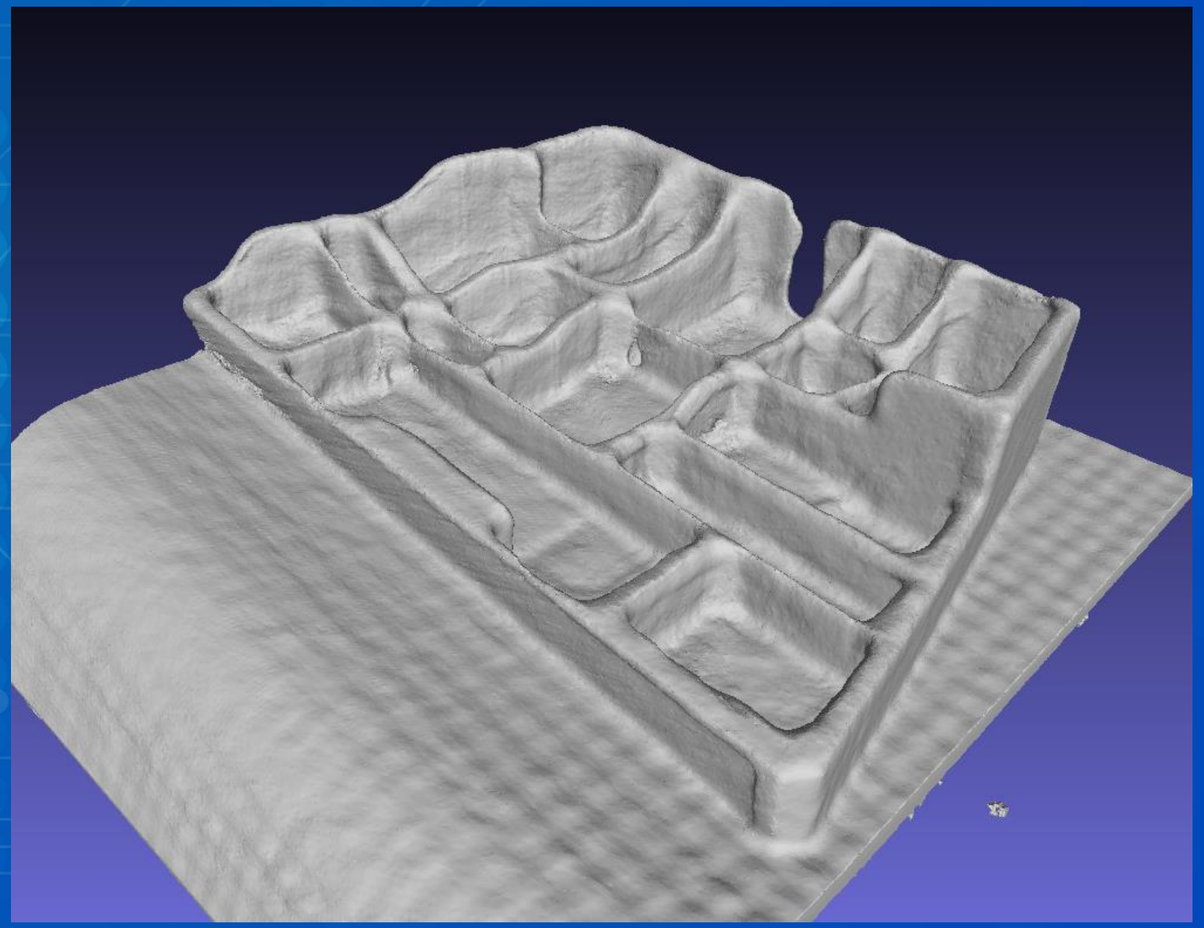
# Solution: Truncated Signed Distance Field (TSDF)




http://pointclouds.org/documentation/tutorials/using_kinfu_large_scale.php

- Discretize the region of interest as a voxel volume.
- Each voxel stores the distance between itself and the closest surface.
- Frequently integrate new depth data.
- Voxels near isosurface store precise values, distant voxels truncated.
- The object surface is represented implicitly as the isosurface of the signed distance field's gradient.

# TSDF fuses many incomplete images into a decent model



# Several open-source TSDF packages available

- kinfu – open-source version of original KinectFusion
- kinfu_ros – ROS nodes to interface with kinfu
- kinfu_large_scale – included with PCL
- OpenChisel – open-source version of Chisel, from Google's Project Tango
- VoxelHashing – from TUM Visual Computing Group

- Several obstacles limiting use in industrial applications
  - Very old code (ca. 2011!), state-of-the-art algorithms not represented.
  - Designed for a human holding a camera, rather than a robot.
  - Challenging to use alongside ROS due to implementation quirks.

# Yak (Yet Another Kinfu)

- C++ library optionally wrapped by a ROS node
- Compatible with CUDA 9.0+
- Structured as a **library** instead of an **application**
  - More options for when and how to integrate data
  - Allows both real-time reconstruction and offline batch processing
- Sensor pose can come from multiple sources
  - Calculated from Iterative Closest Point between depth image and volume
  - Provided by robot kinematics or external tracking via a TF subscriber

# Upcoming work (a.k.a, moving beyond 2011)

- Upgrade using algorithms from recent academic research
- Replace dense voxel volume with voxel hashing data structure
  - The TSDF is sparse, so we don't need to store empty voxels
  - Allows storage of larger volumes in same amount of memory
- Improve camera localization and pose refinement
  - ICP alone introduces drift, which reduces reconstruction accuracy
  - Use ICP, RGB image features, and robot kinematics together to produce a more robust pose estimation
- Refine isosurface using color image data
  - RGB image usually has higher resolution than depth image
  - Lets us fix geometric artifacts introduced by fusion process