

Working Toward a Better Vision- Based Obstacle Acquisition Method

Roman Geykhman – University of Pennsylvania (Dept. of ESE)

Advisor: Dr. Dan Lee

SUNFEST

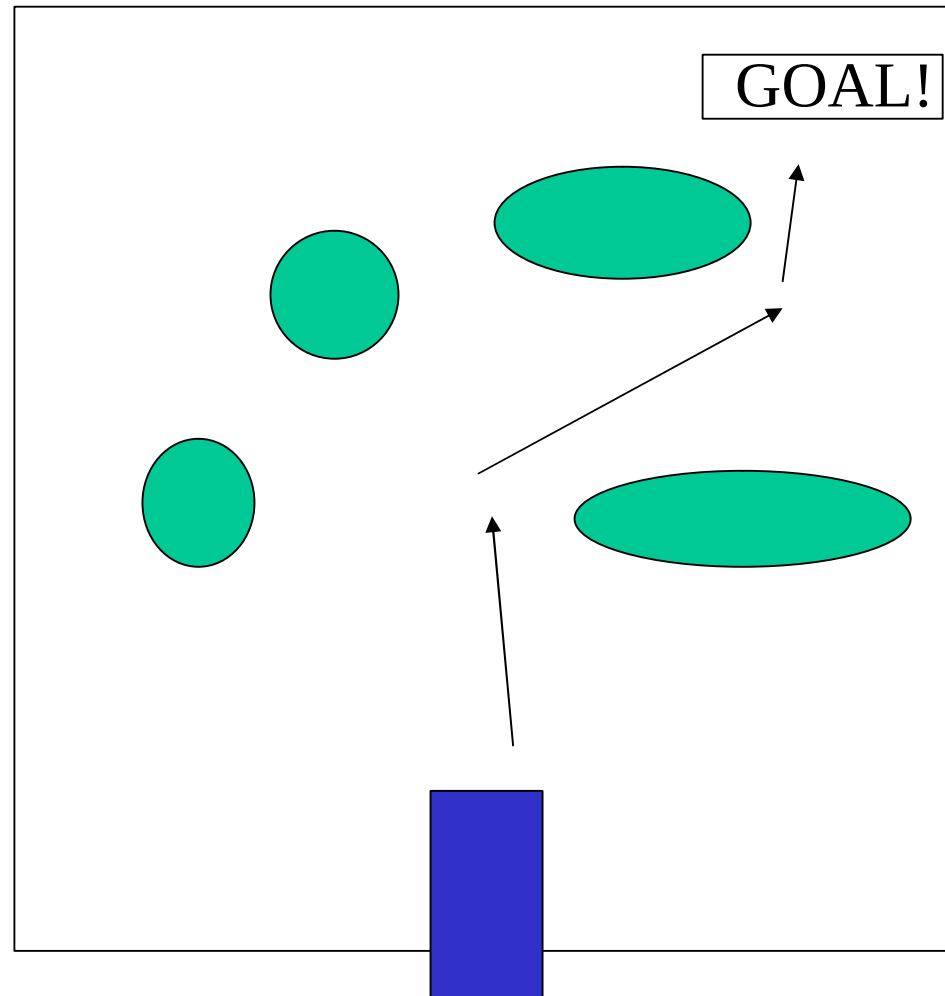
July 29, 2005



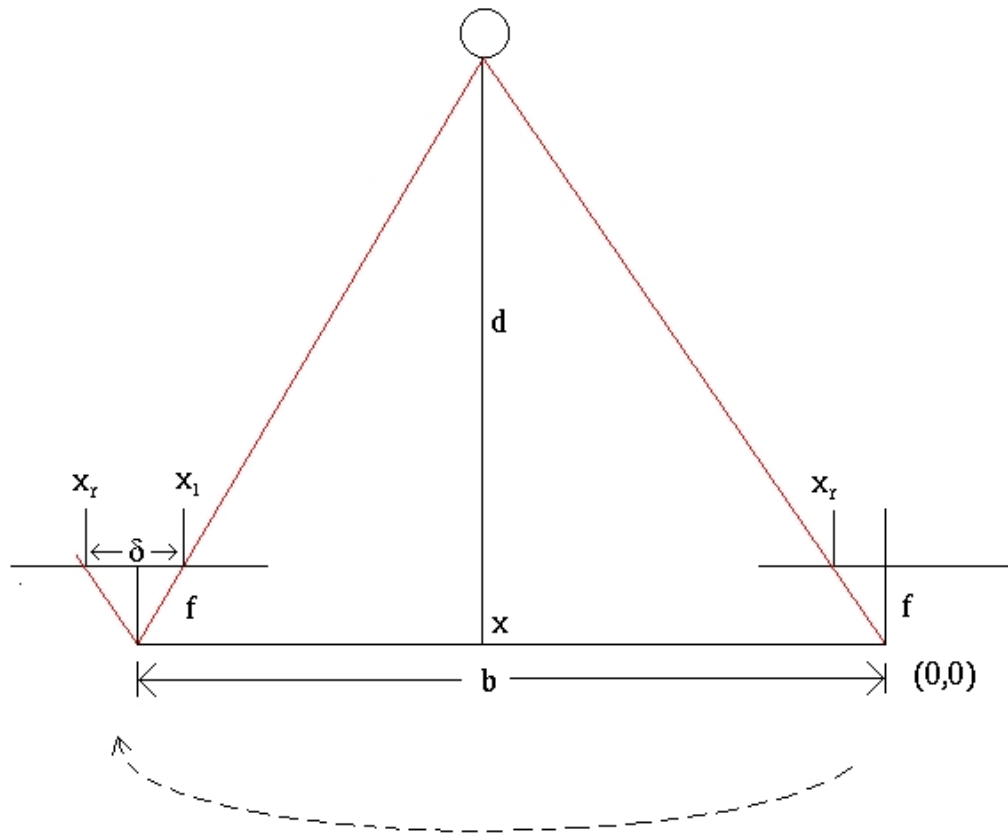
Hardware: LAGR Test Platform



Design Task: Obstacle Detection



Method: Stereo Vision



$$\frac{x}{d} = \frac{x_r}{f}$$

$$\frac{b+x}{d} = \frac{x_l}{f} = \frac{x_r + \delta}{f}$$

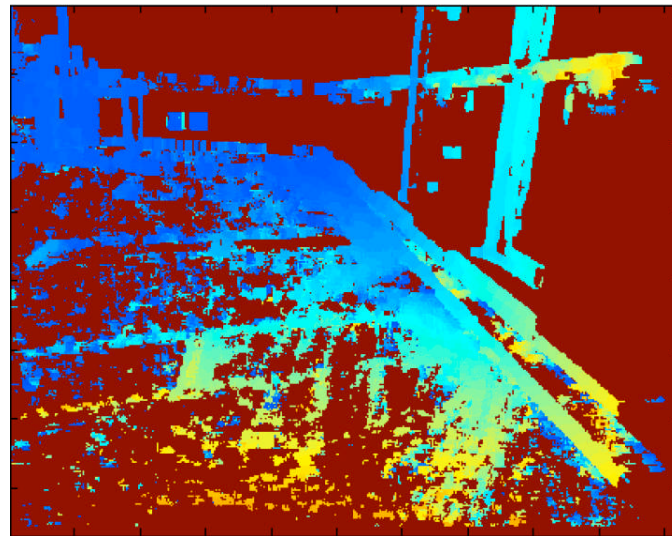
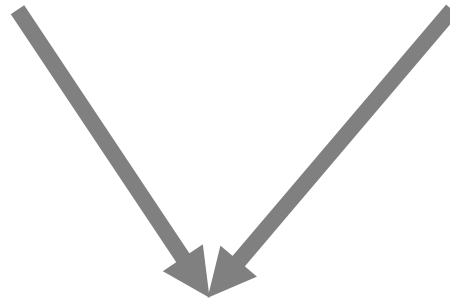
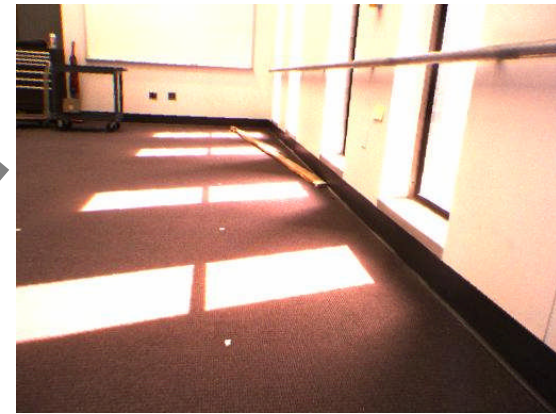
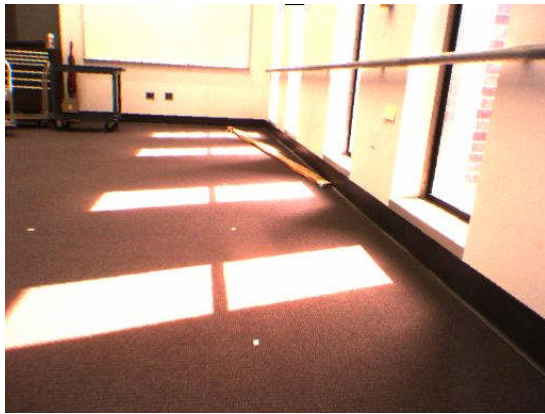
...

$$d = \frac{fb}{\delta}$$

$$x = \frac{x_r d}{f}$$

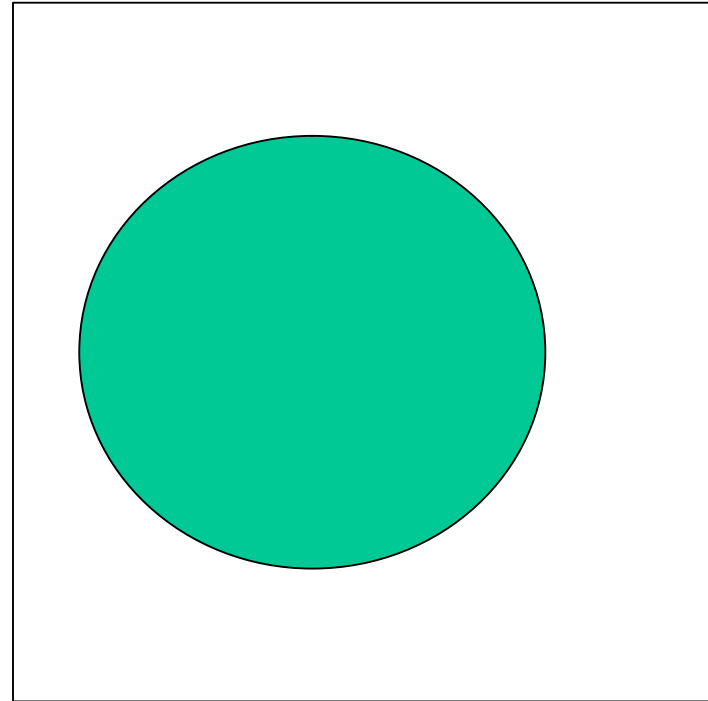
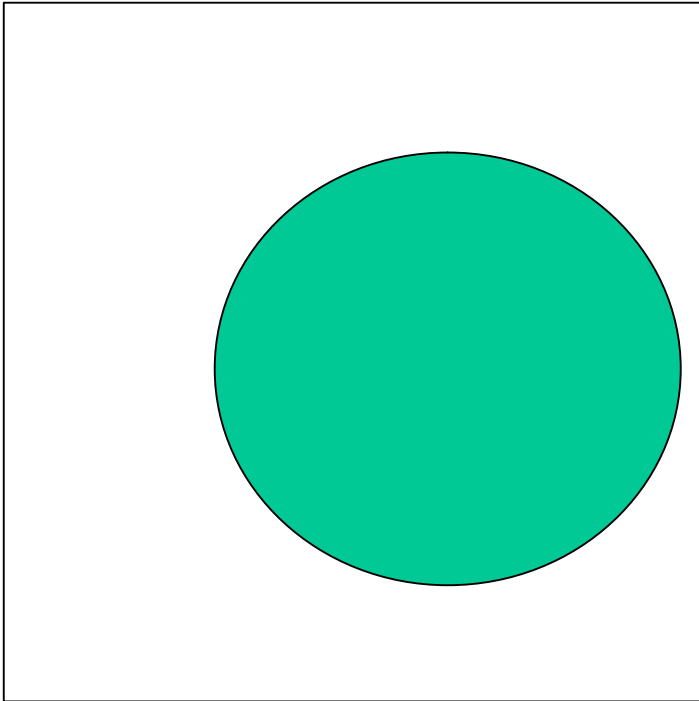
$$y = \frac{y_r d}{f}$$

Stereo Vision: Disparity Image

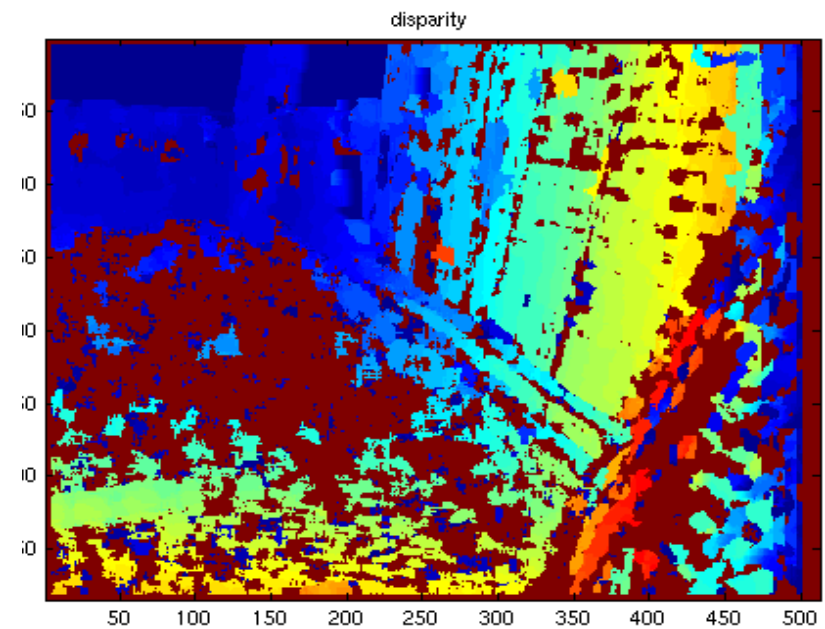
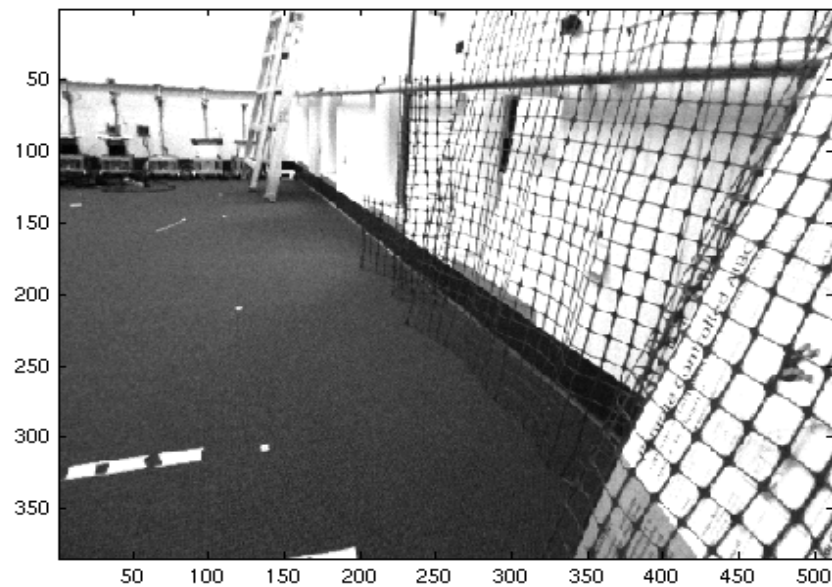


Problem

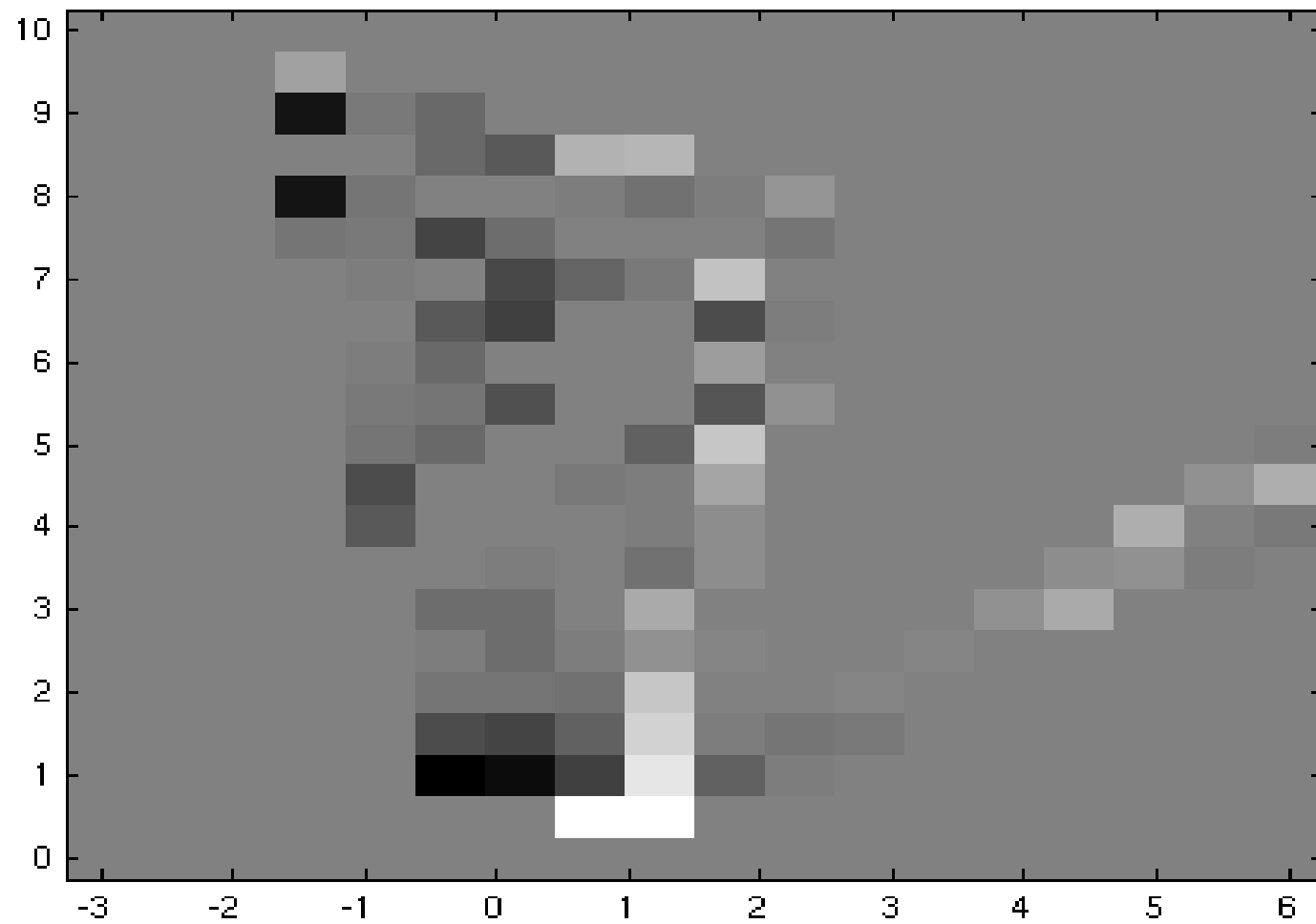
solid objects



Idea: Use Raw Range Data

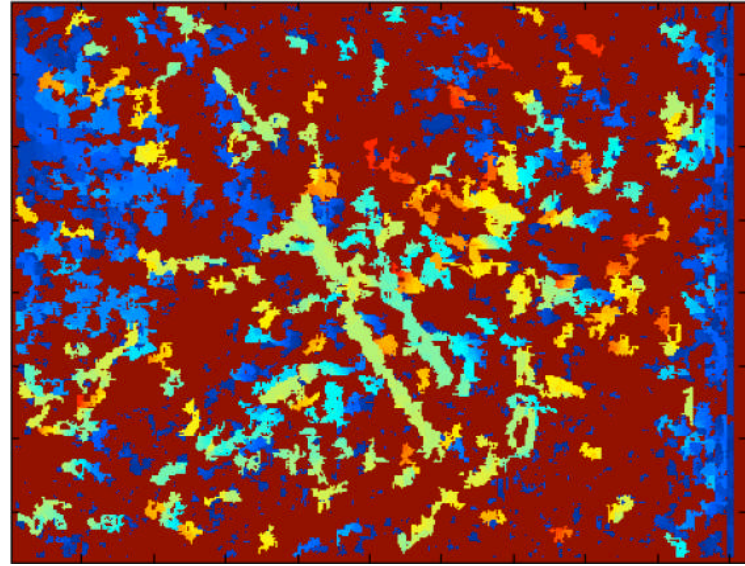


Raw Range Data

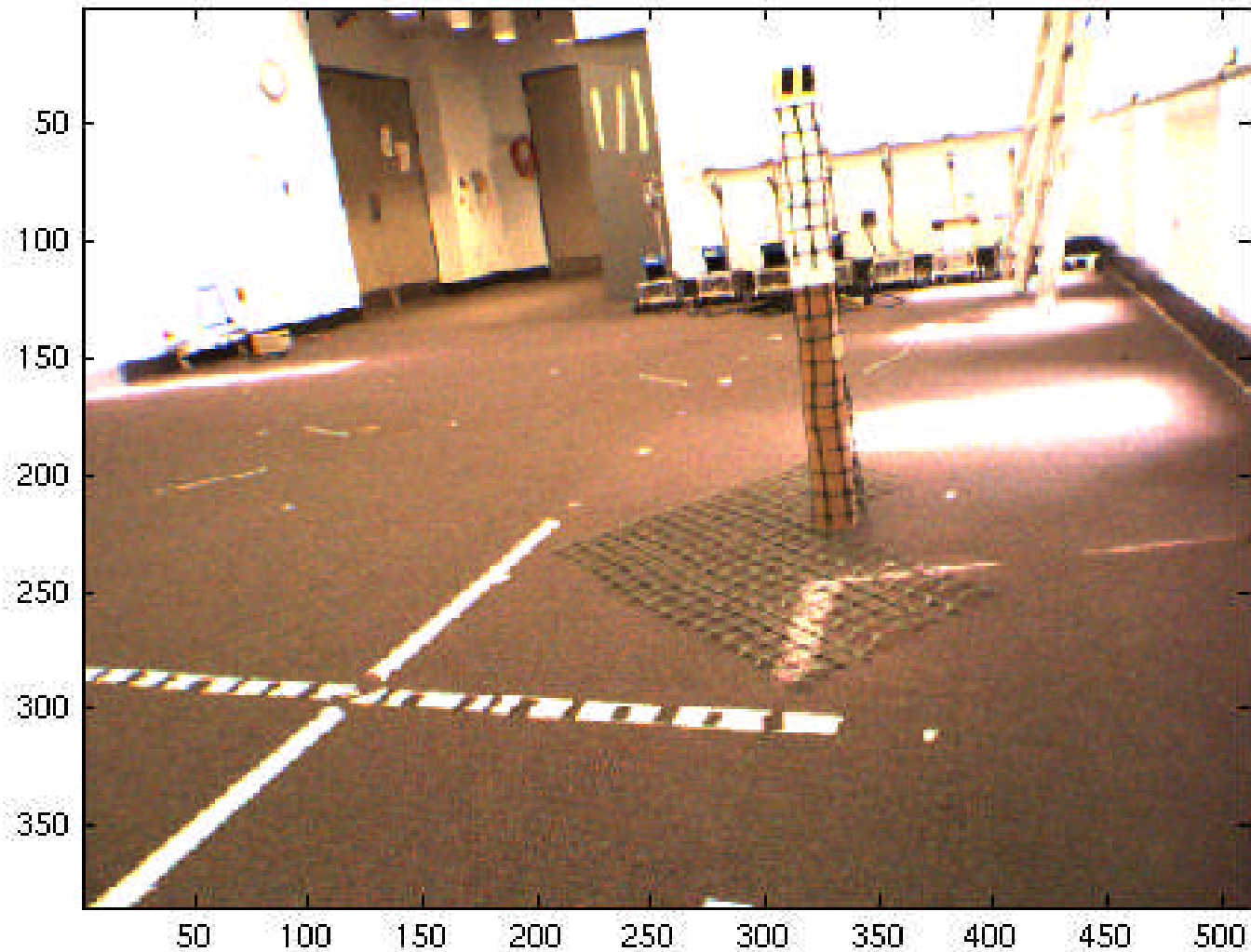


Raw Range Data: Problem

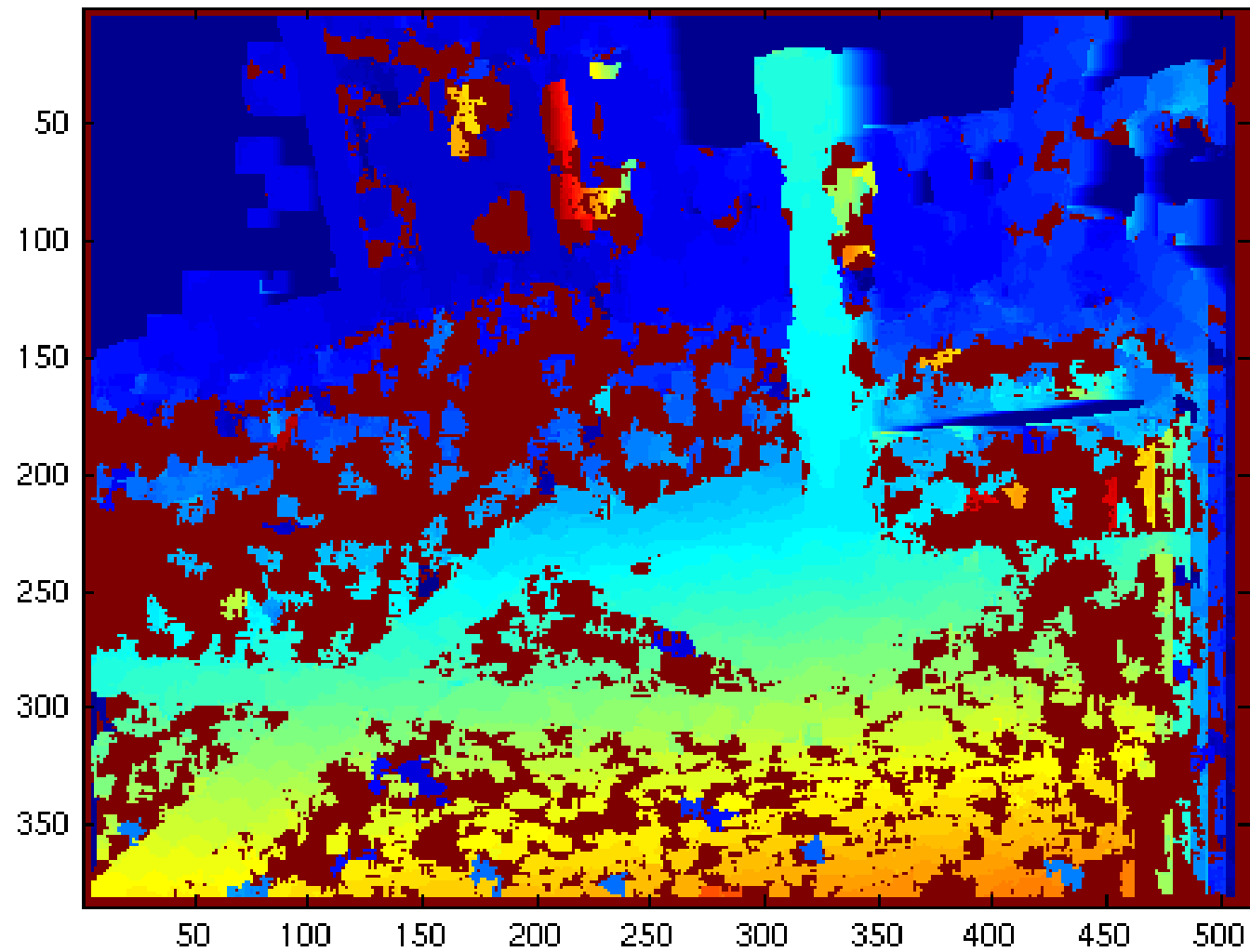
Bad matches, occlusions, ... (NOISE!)



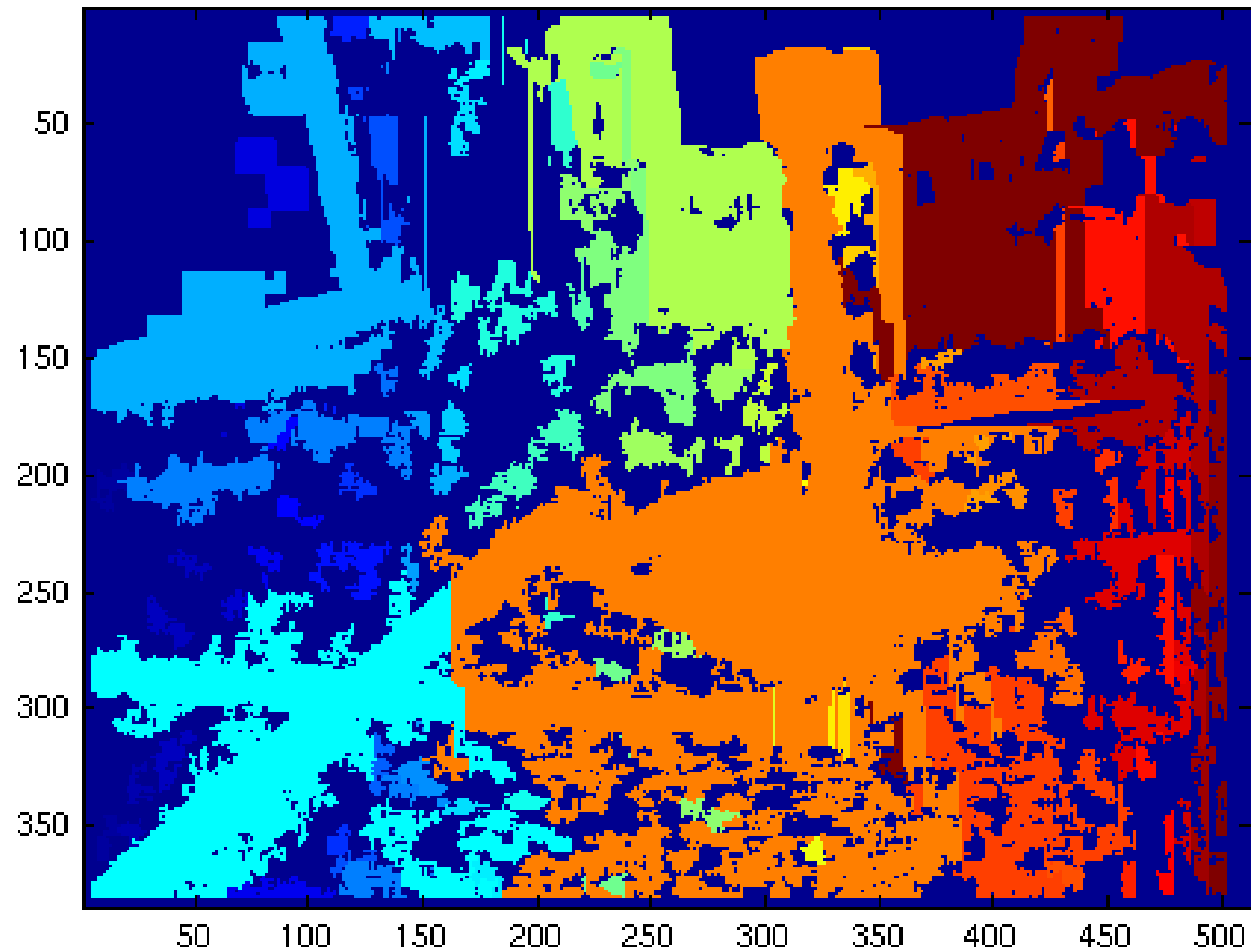
Idea: Use Surfaces



Surfaces

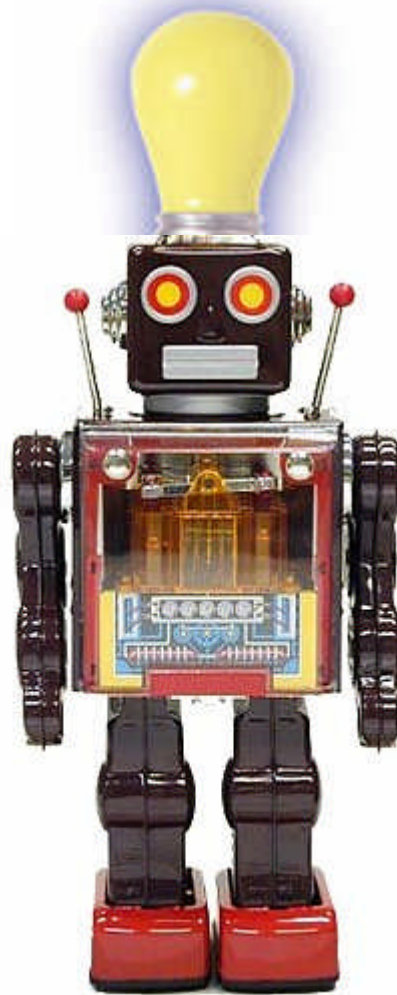


Surfaces

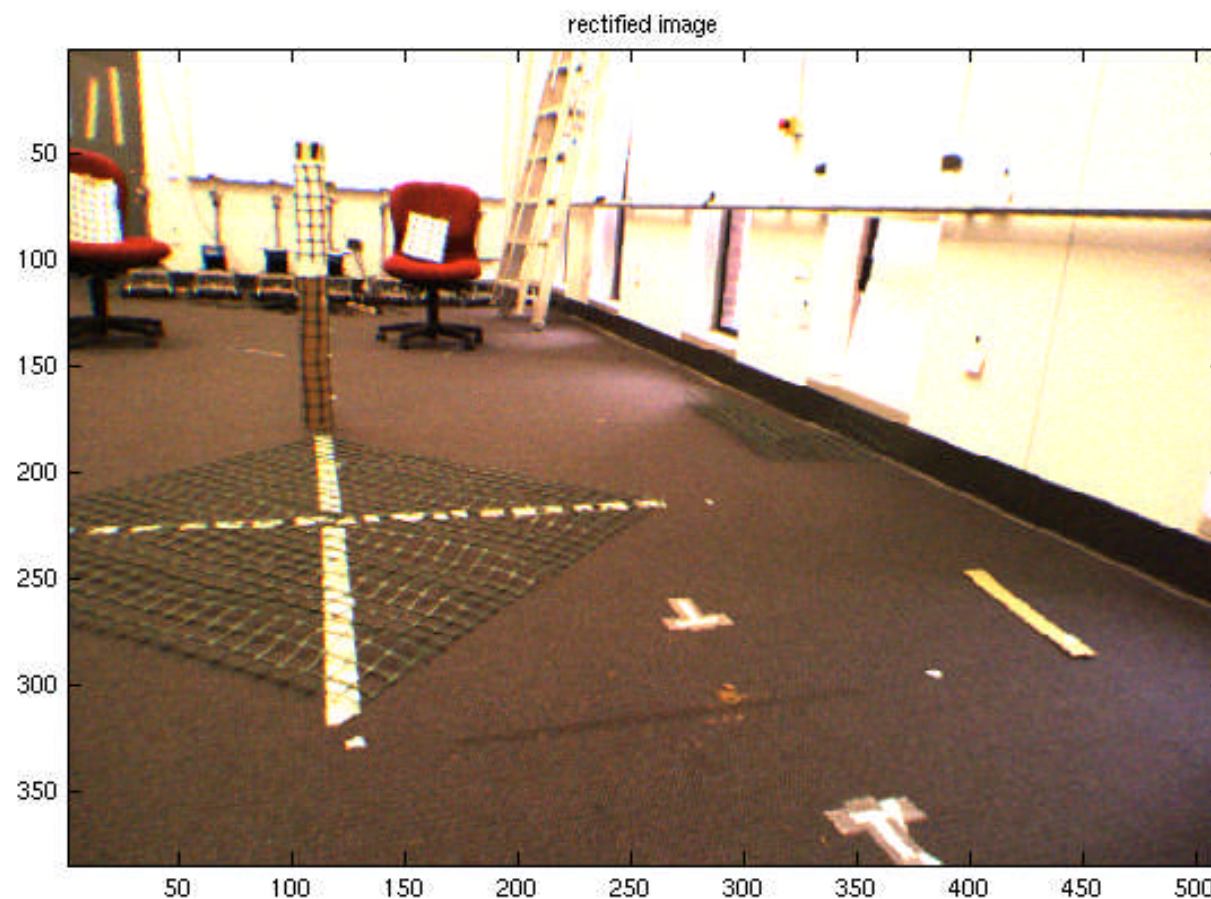


Idea!

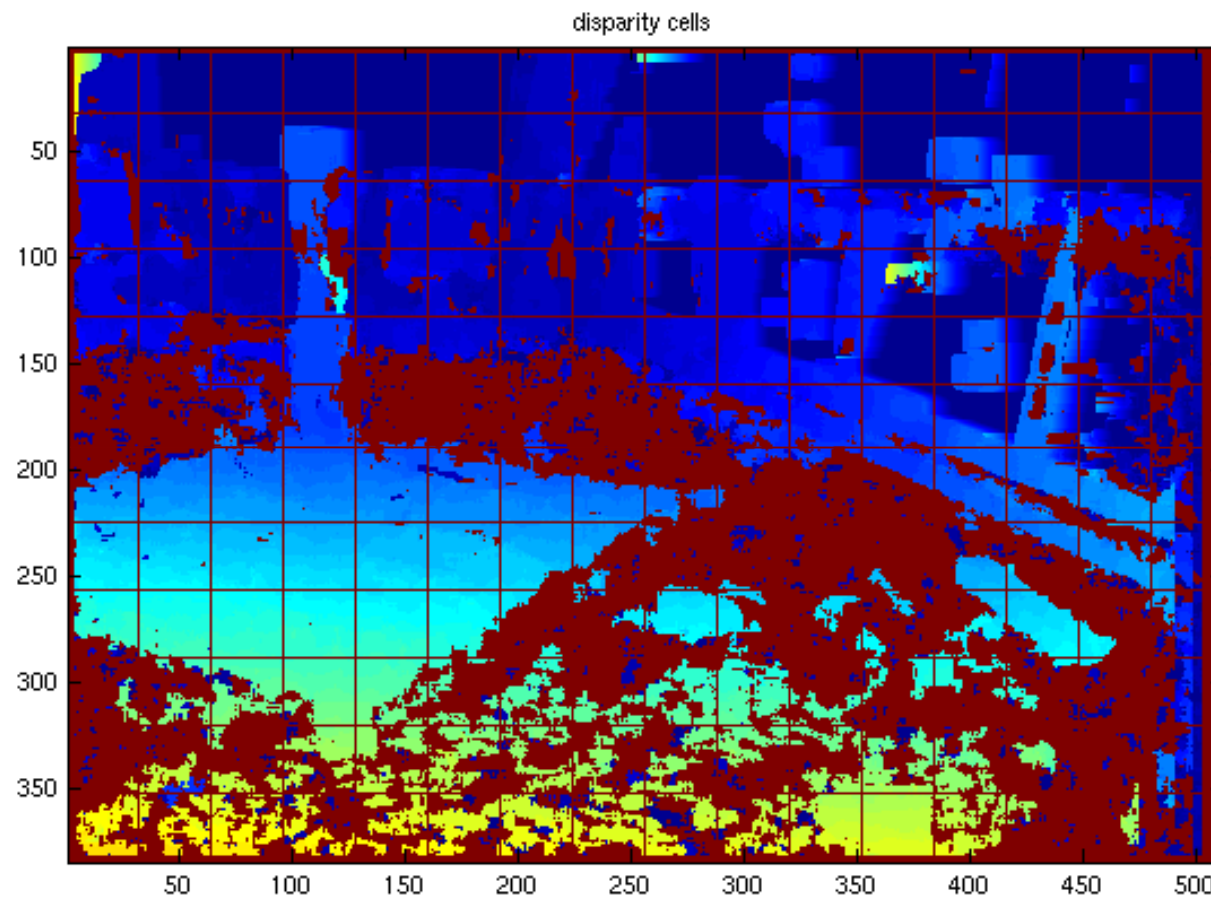
Use Surface Orientation!



Surface Orientation: Motivation

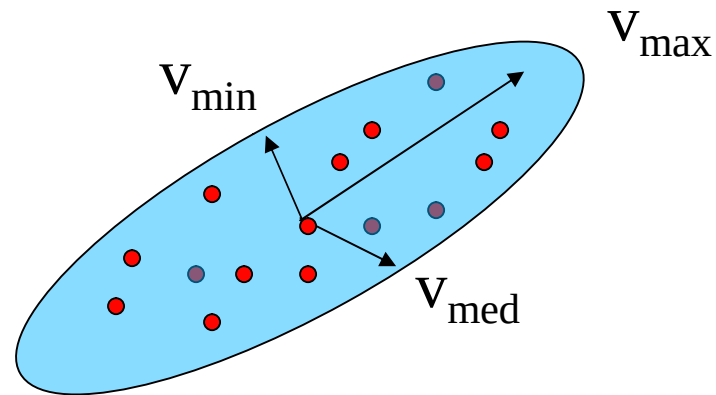


Surface Orientation



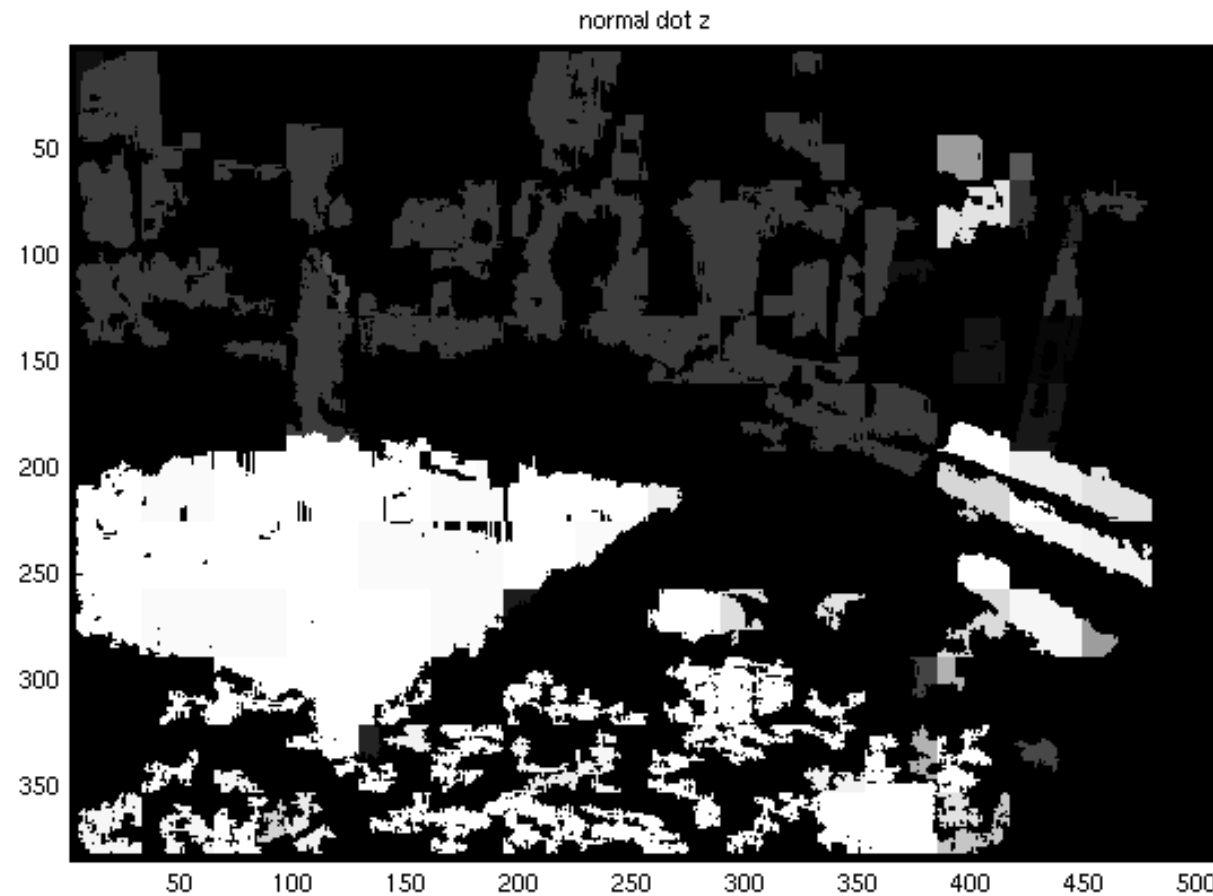
Surface Orientation

Orthogonal Distance Regression

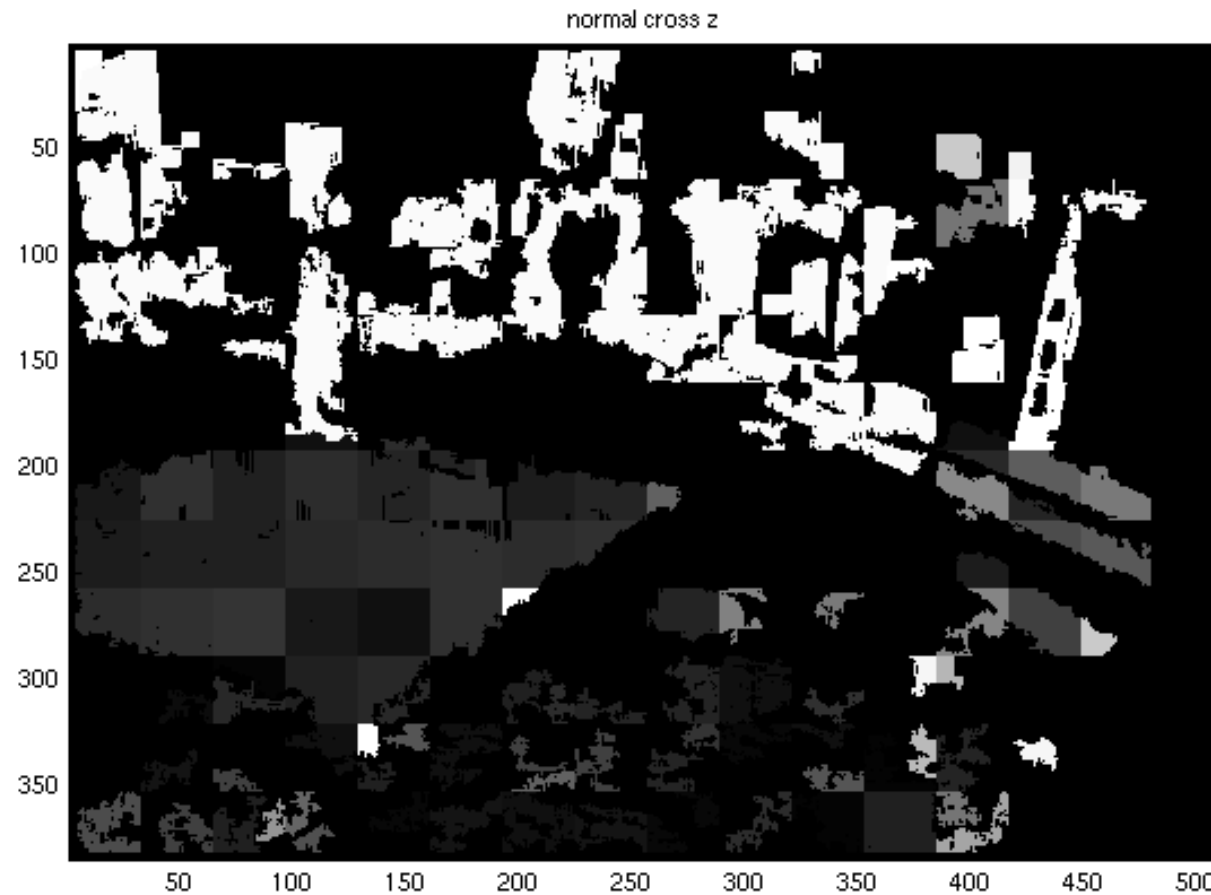


$$\begin{bmatrix} \frac{1}{n} \sum dx dx & \frac{1}{n} \sum dx dy & \frac{1}{n} \sum dx dz \\ \frac{1}{n} \sum dy dx & \frac{1}{n} \sum dy dy & \frac{1}{n} \sum dy dz \\ \frac{1}{n} \sum dz dx & \frac{1}{n} \sum dz dy & \frac{1}{n} \sum dz dz \end{bmatrix} = \begin{bmatrix} \overrightarrow{v_1} & \overrightarrow{v_2} & \overrightarrow{v_3} \end{bmatrix} \cdot \begin{bmatrix} \lambda_1 & 0 & 0 \\ 0 & \lambda_2 & 0 \\ 0 & 0 & \lambda_3 \end{bmatrix} \cdot \begin{bmatrix} \overrightarrow{v_1} \\ \overrightarrow{v_2} \\ \overrightarrow{v_3} \end{bmatrix}$$

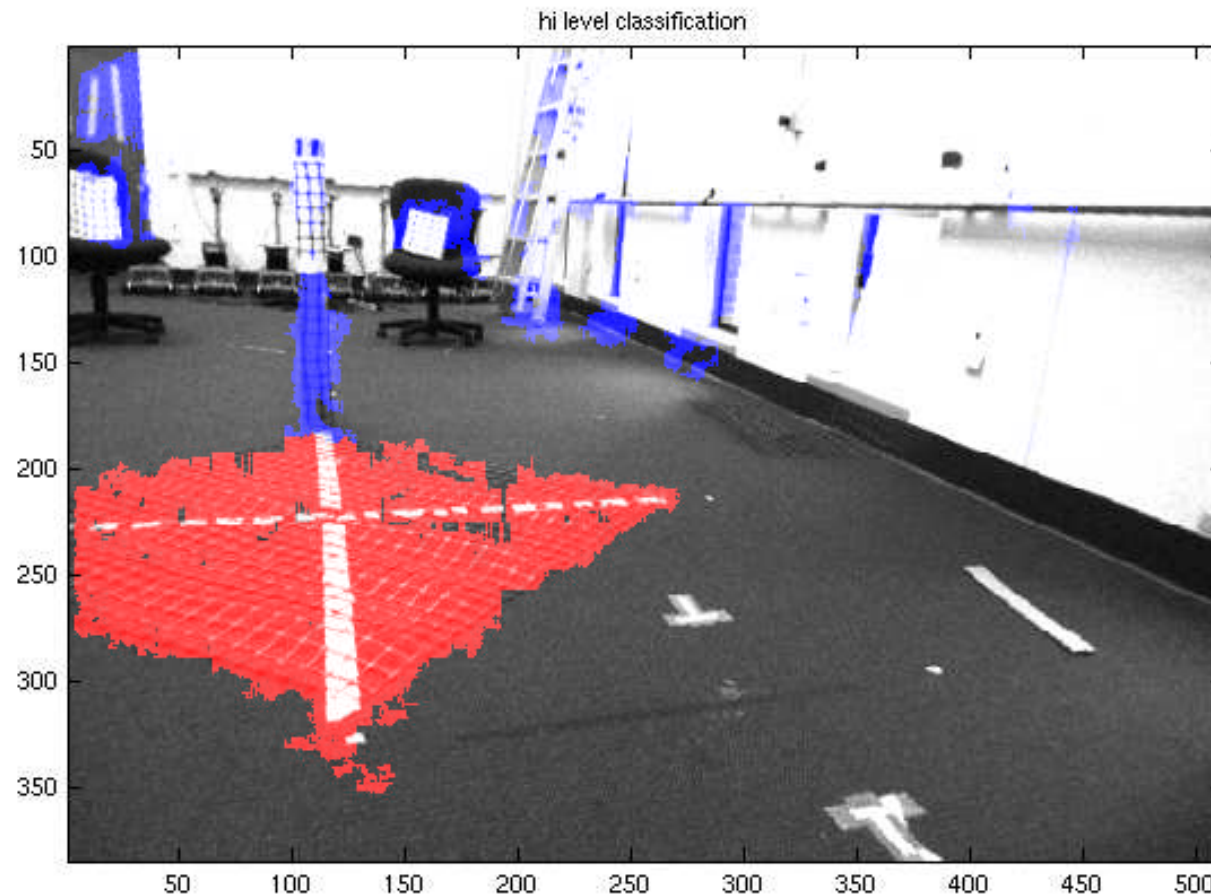
Surface Orientation: First Pass



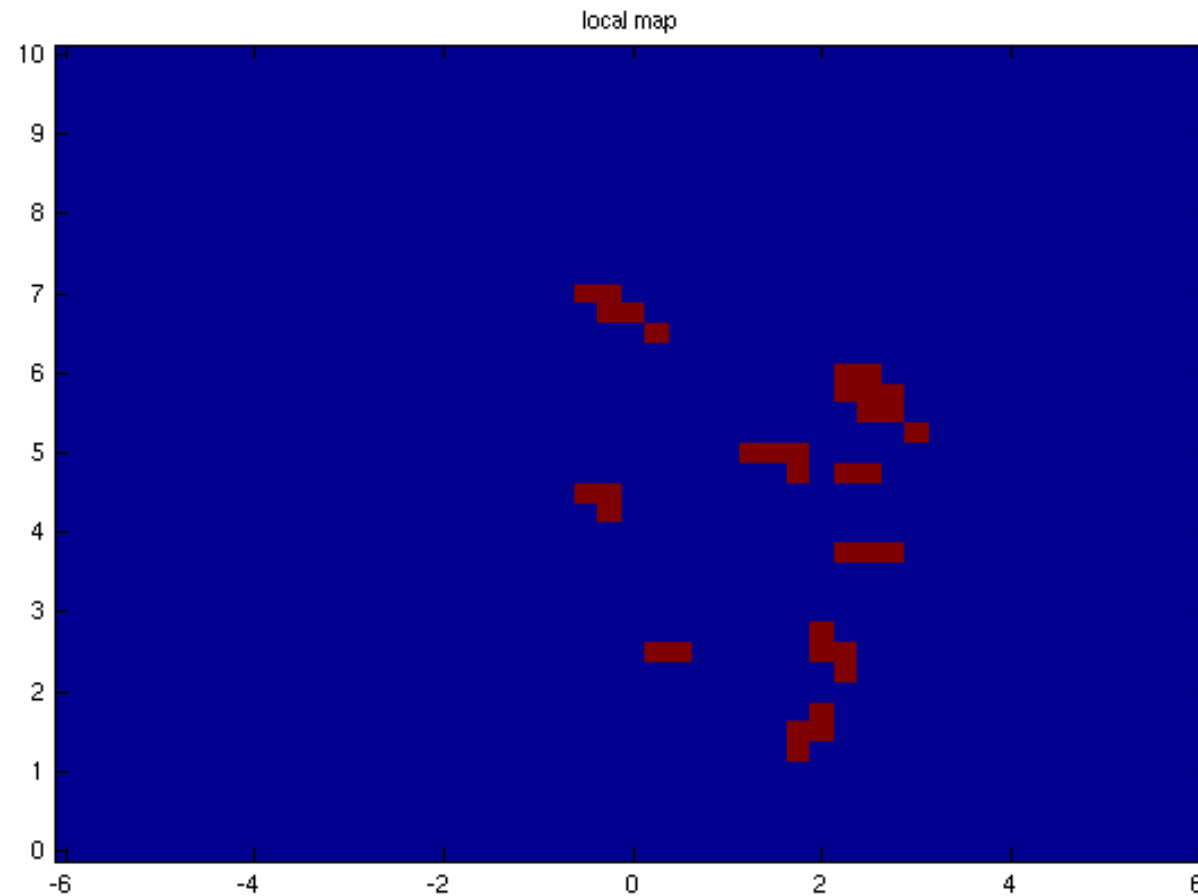
Surface Orientation: First Pass



Surface Orientation: Result



Surface Orientation: Result



Current State of the Project

- To do:

10: Optimize code

20: Test

30: GOTO 10

