FROM RGB-D TO LOW-RESOLUTION TACTILE: SMART SAMPLING AND EARLY TESTING

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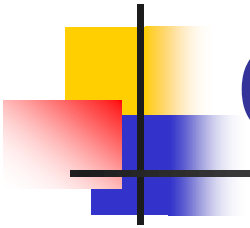

Outline of the Talk

- **Background & Motivation**
- **Related Work**
- **Sampling and Rendering Methods**
- **Experimental Results**
- **Conclusions**

Background & Motivation

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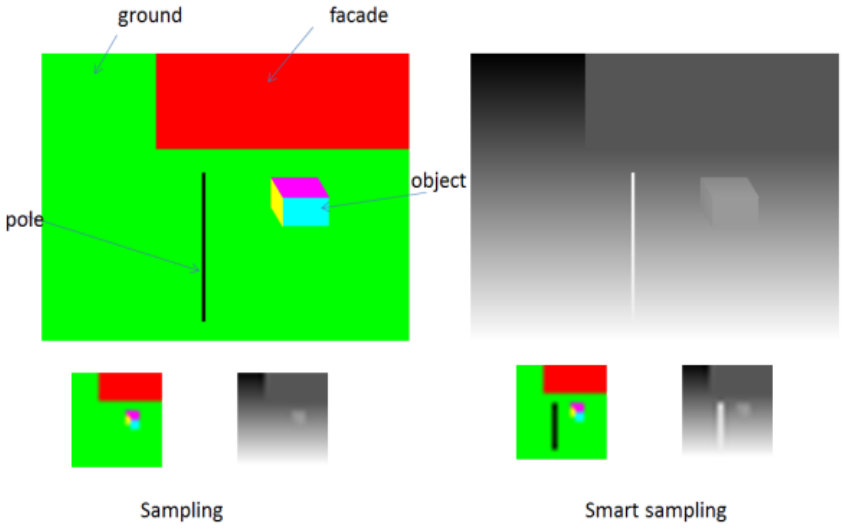
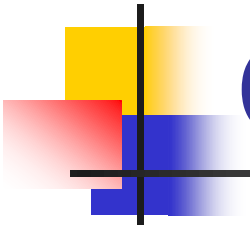
Background and Motivation

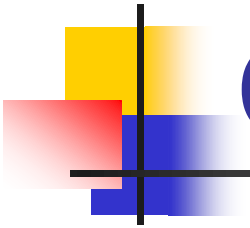
- Visual prostheses
  - Retinal prostheses (RP): partially restore vision
  - Tongue stimulator (TS): transduce the shape, size, and location of objects
- Challenges and limitations
  - Low resolutions
    - RP: <10x10 channels
    - TS: 20x20 channels
  - Rendering difficulties
    - Omitting small objects
    - Highlighting important objects





Our Solutions

- **Smart sampling**
- Background removal
- Parallax simulation
- Object highlighting
- Path directions



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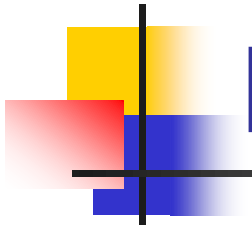
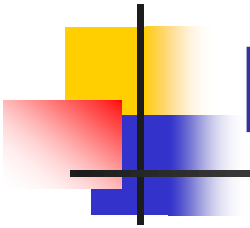


Related Work

- **Background & Motivation**
- **Related Work**
- **Sampling and Rendering Methods**
- **Experimental Results**
- **Conclusions**



Related Work

- Computer Vision algorithms
  - Use cell phone to find machine-readable signs (Coughlan et al. 06, 08)
  - Depth maps from stereo cameras to aid navigation (Audette et al. 00, Gonz´alez-Mora et al. 09)
  - Staircase (Se and Michael 00, Lu et al. 05, Pradeep et al. 08) and zebra-crossing detection (Se 00)
  - Obstacle detection using stereo vision (McCarthy et al. 2011)

Sampling and Rendering Methods

- **Background & Motivation**
- **Related Work**
- **Sampling and Rendering Methods**
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System Pipeline

RGB-D image acquisition and segmentation

Smart Sampling
1. Smart sampling
2. Background removal
3. Parallax simulation
4. Object highlighting
5. Path directions

Visual Prosthesis (retinal prosthesis, tongue stimulator)

retinal prosthe-

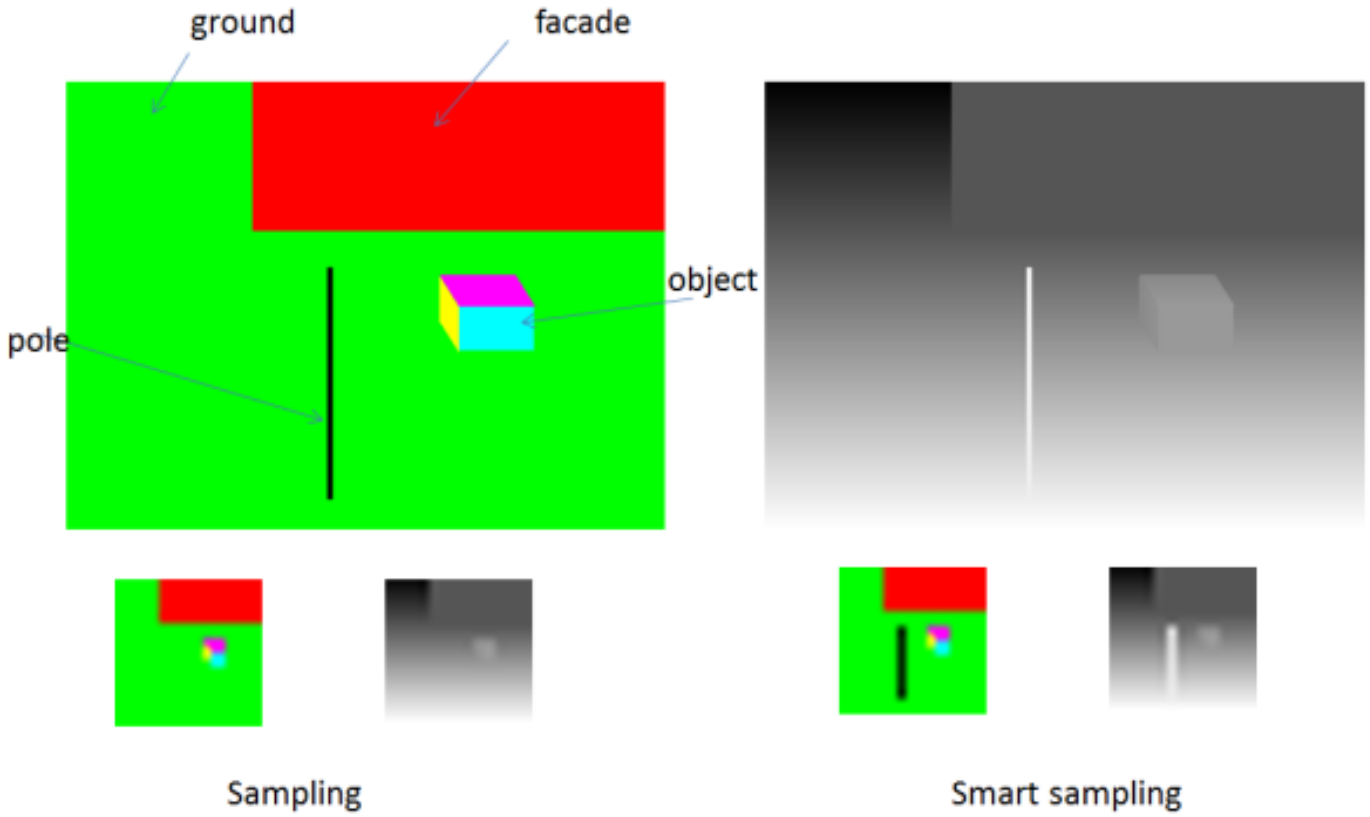
Brainport tongue array

RGB-D Image Acquisition and Segmentation

- Input: stereo images
- Algorithms: Patch-based stereovision (Tang & Zhu TCSVT'12)
  - Patch and interest point extraction
    - Color segmentation and feature extraction
  - Three-step stereo match
    - Global match – match of a group of feature points
    - Local match – match of individual feature point
    - Plane fitting – RANSAC
  - Plane merging and parameter refinement
- Output: RGB-D + Segmentation

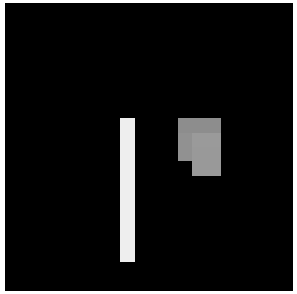
Sampling and Rendering Methods

- Smart-Sampling



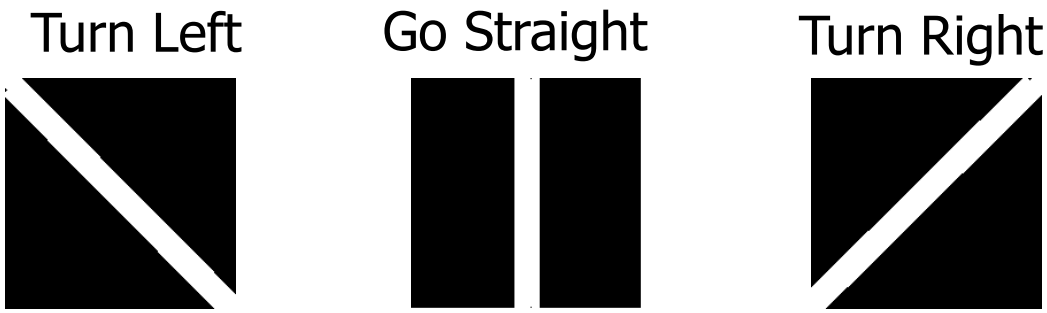
Sampling and Rendering Methods

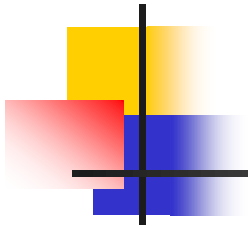
- Background removal based on scene labeling
- Motion parallax simulation using 3D
- Dynamic object re-illumination and highlighting



Sampling and Rendering Methods

- Path Directions
  - 3D locations of obstacles are available
  - Discriminating orientations of straight lines is easy





Experimental Results

- **Background & Motivation**
- **Related Work**
- **Sampling and Rendering Methods**
- **Experimental Results**
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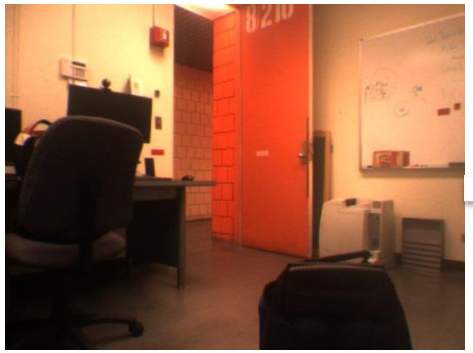
Tongue Stimulator – Brainport by Wicab, Inc.

- BrainPort Vision Device
  - Non-surgical assistive visual prosthetic device
  - Translates information from a digital camera to your tongue
  - Includes: a tongue array, res: 20x20; size: 3cmx3cm, a digital video camera and a hand-held controller (zoom and contrast inversion)
  - Functionalities: recognize high-contrast objects and their locations



Original image

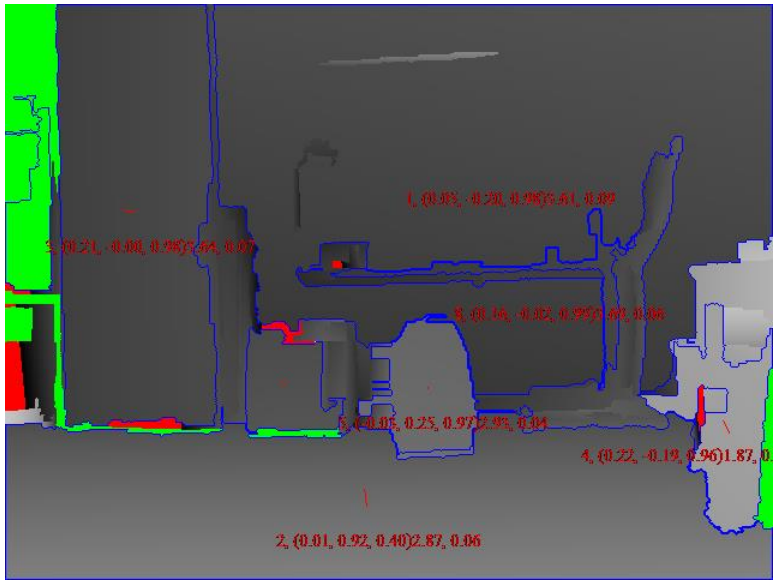
Sampled image

Inversed Sampled image

Experimental Results

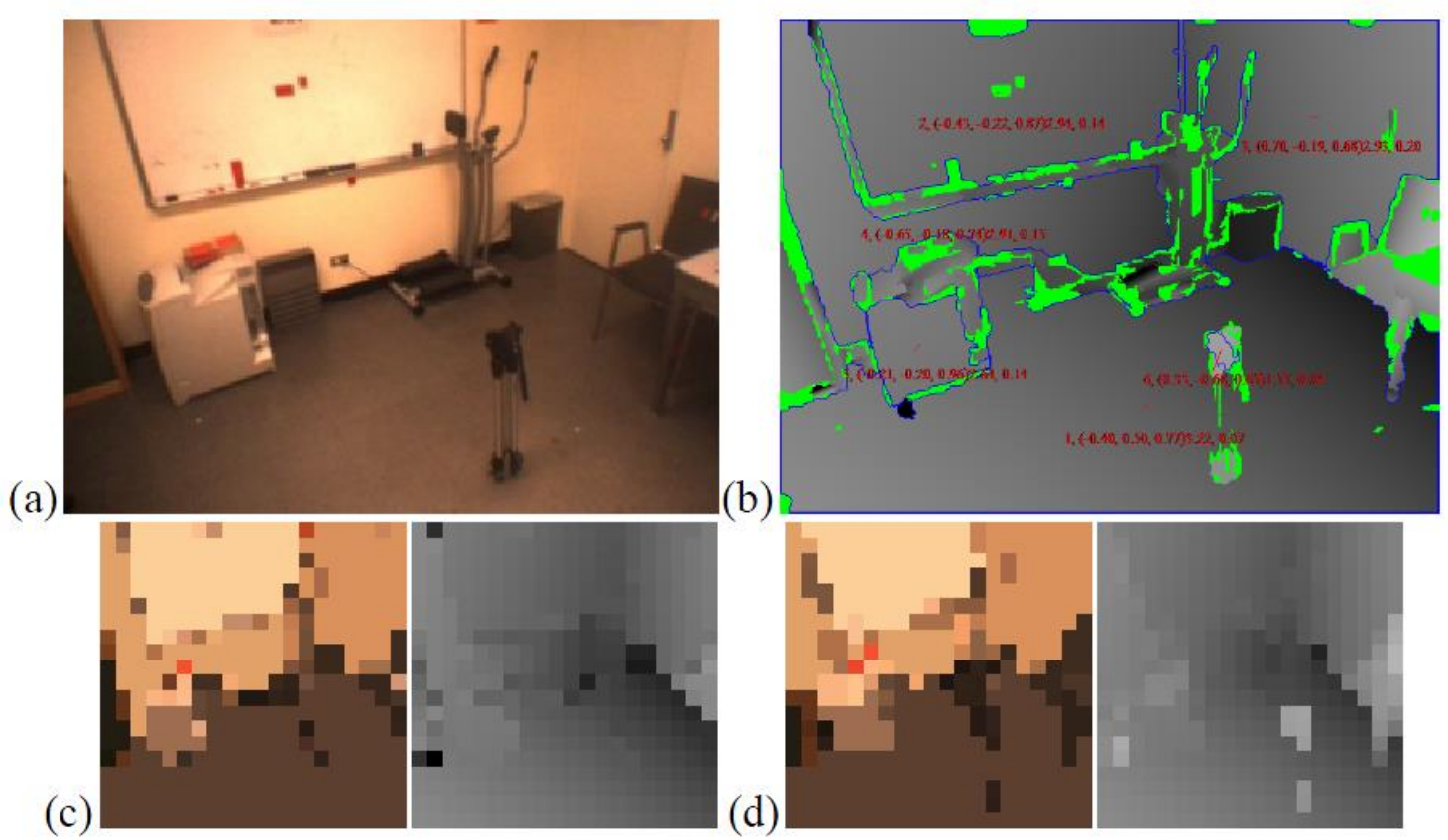
- RGB-D image data

Reference image



Depth image

Result of Smart Sampling



Real scene: tripod in the middle

Highlight Object of Interest

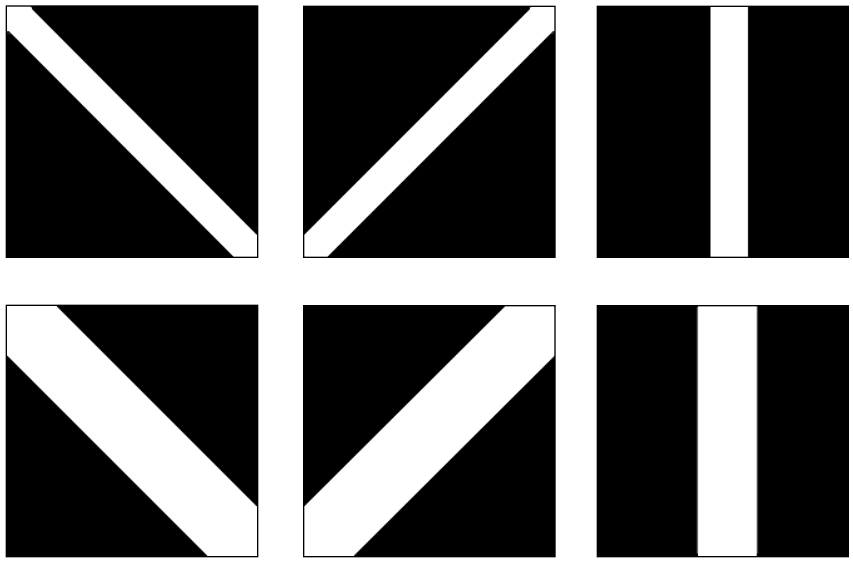
- Background removal
- Motion parallax simulation

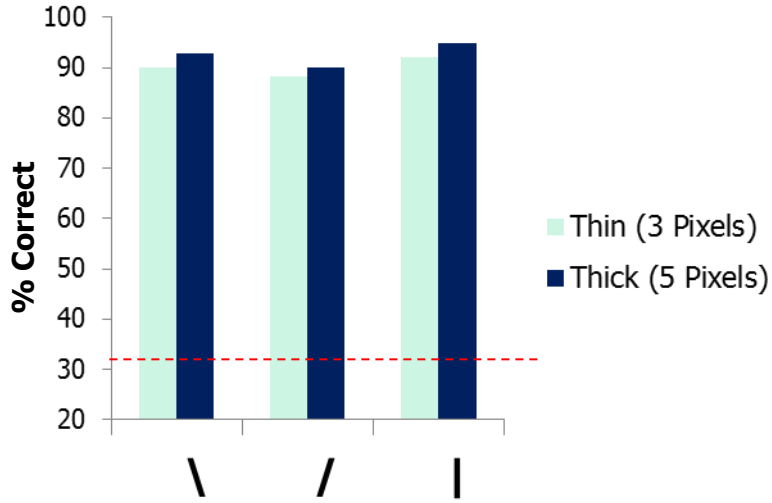
Sampling results of highlighting objects in a closed range

Sampling results using motion parallax simulation

EARLY TESTS USING BRAINPORT

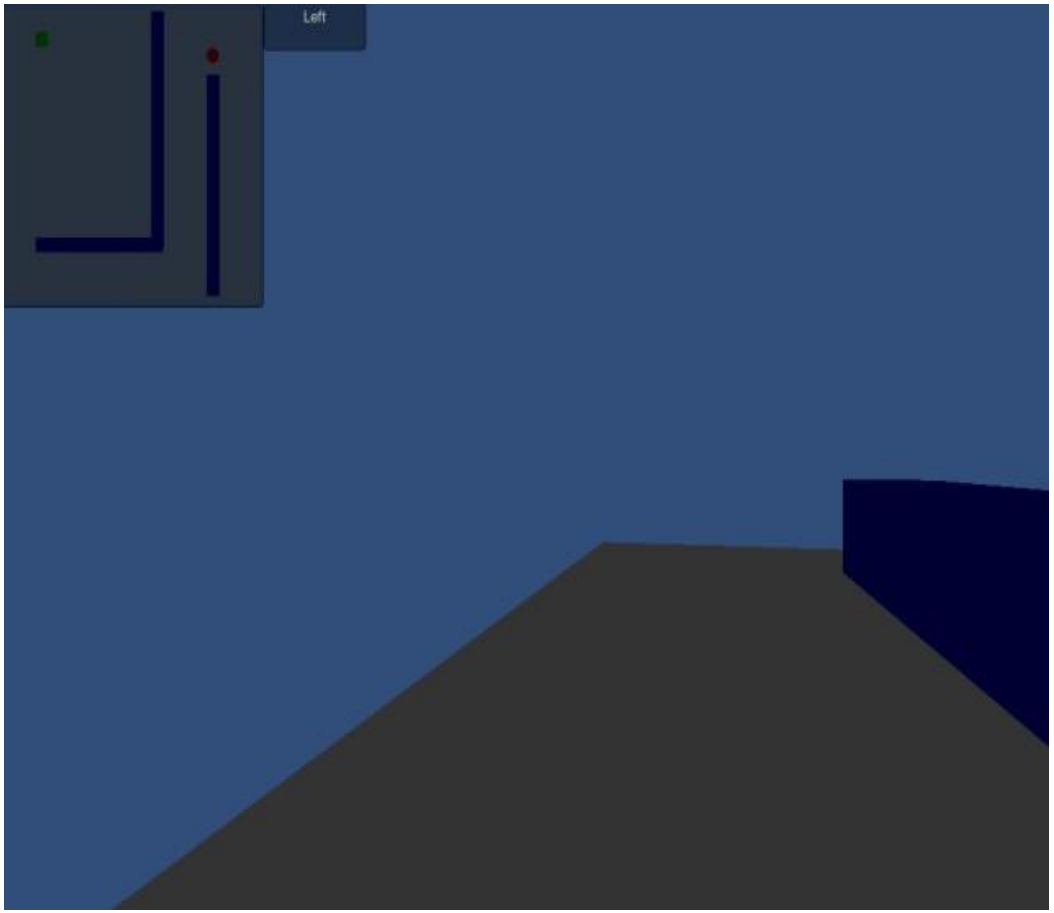
- Line Orientation
  3 pixel & 5 pixel widths / 45° diagonal

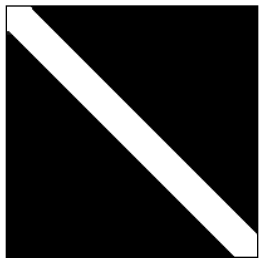




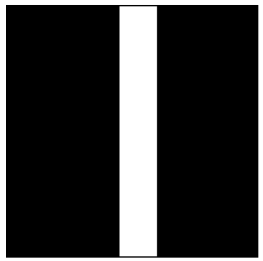
EARLY TESTS USING BRAINPORT

- Navigation using line orientation

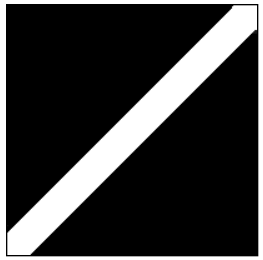




Turn Left



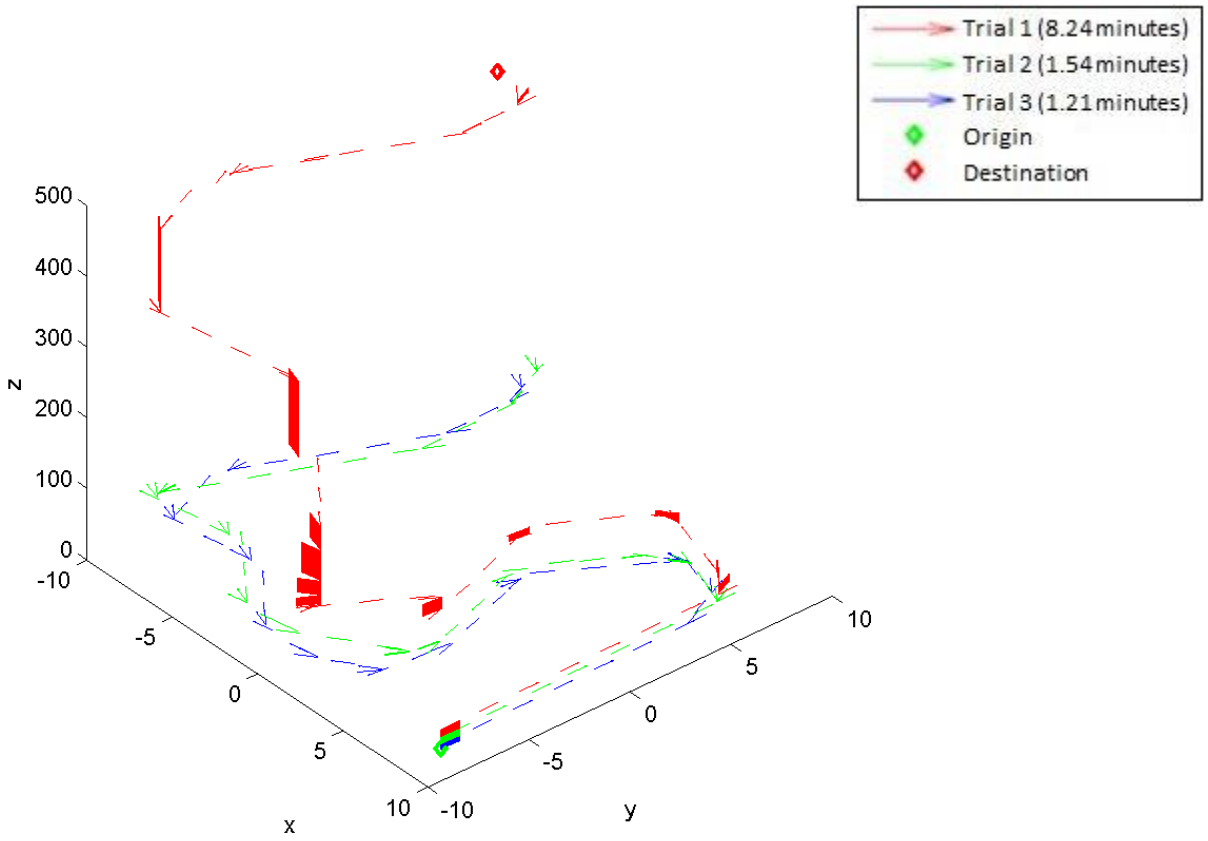
Go Straight

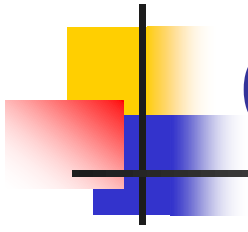


Turn Right

EARLY TESTS USING BRAINPORT

- Trajectories





Conclusions

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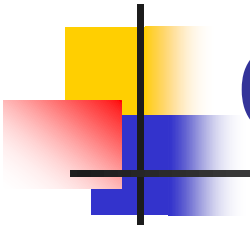
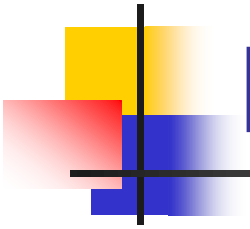


Conclusions

- Transduce image and 3D scenes
  - RGB-D image acquisition and segmentation
  - Smart sampling
  - Different rendering methods
- Early tests on Brainport
  - Line orientation
  - Navigation using line orientation



Future work

- Continue current experiments on Brainport
  - Active exploration for object recognition
  - Navigation using line orientation
- Use Brainport with RGB-D sensor
  - Object localization/manipulation

Acknowledgments

- US National Science Foundation
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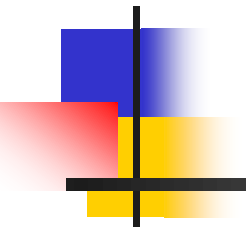
- PSC-CUNY Research Award
  - Grant Round 44



Thank you!
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Questions?