NYU NEUROSCIENCE

A GPU accelerated 3D kinematic modeling platform for behavioral neuroscience

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Introduction

Computer vision techniques for 3D reconstruction and kinematic modeling are positioned to bring about a major advance in the field of behavioral neuroscience. Integrating GPUs into the software pipeline has qualitatively improved our ability to fit, inspect, and refine complex kinematic models. Our custom markerless motion capture system, in conjunction with our use of high-density silicon neural implants (≥ 100 channels), provides an unprecedented glimpse into the relationship between the brain, memory, and behavior.

From Corazza et al. 2006

Environment Construction

Multiple Camera Synchronization

Lines to cameras

Line to Amplipex system

Camera Calibration

3D to 2D perspective transformation

Complete Distortion Model

2D error: mean (blue), std (red)

Svoboda et al. 2005

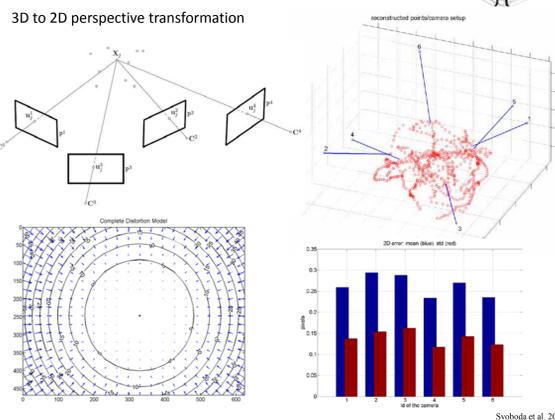## Image Segmentation

Camera 1   Camera 2   Camera 3

Camera 4   Camera 5   Camera 6

Total Frame 1
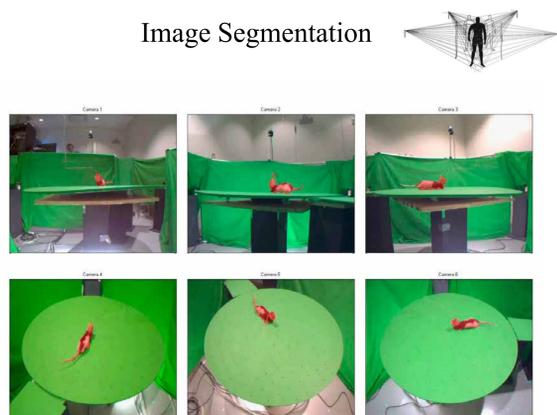
Visual Hull Construction
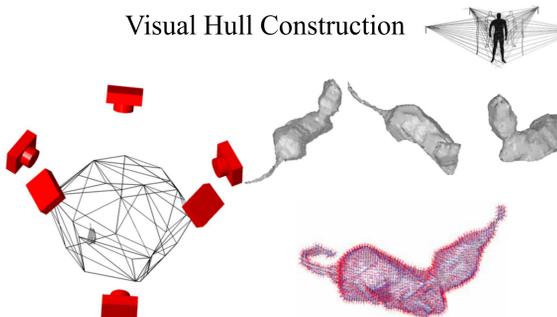
Kinematic Model Design

Insert Joint   Joint Mesh
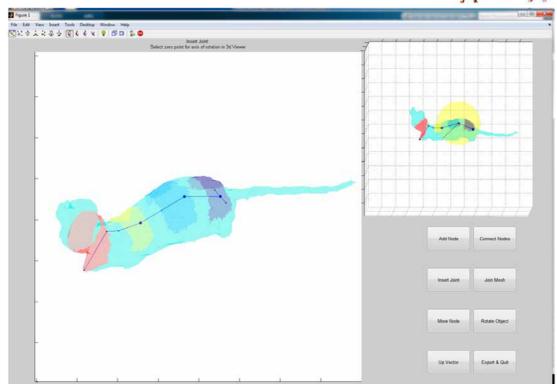
Kinematic Model Manipulation

Cap housing implant

Base of skull

Hips

Nose

Murray et al. 1994
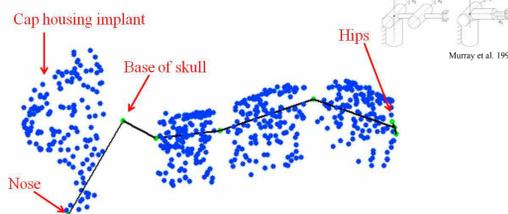
Kinematic Model Fitting

Generate Candidate Poses → Score Each Pose

Update Posterior Estimate ← Compute Cost Components

$$d_{ij} = ||M_i - D_j||^2$$
$$\alpha_{ij} = dot(n_i, n_j)$$

Environment Rendering

Camera 4   Camera 5   Camera 6

Blue = Ideal Model Fit   Red = Image Features   Green = Projected Final Model Points
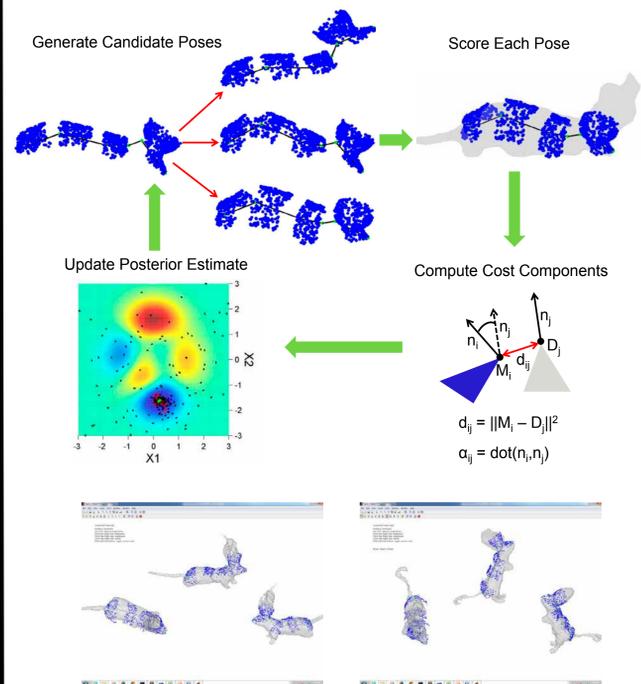
Environment Rendering: 3 Views
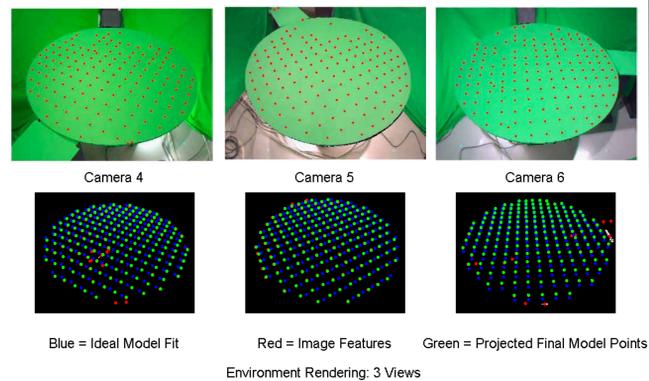
Relating Neurophysiology to Behavior
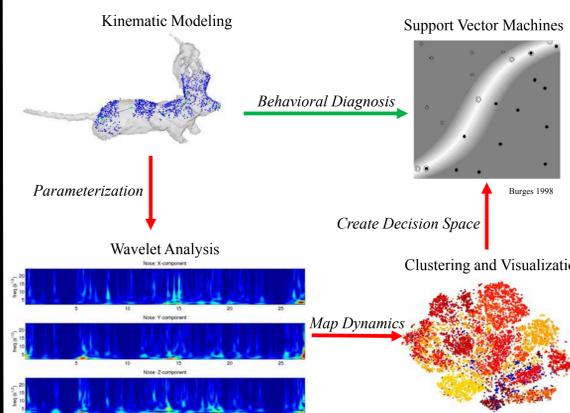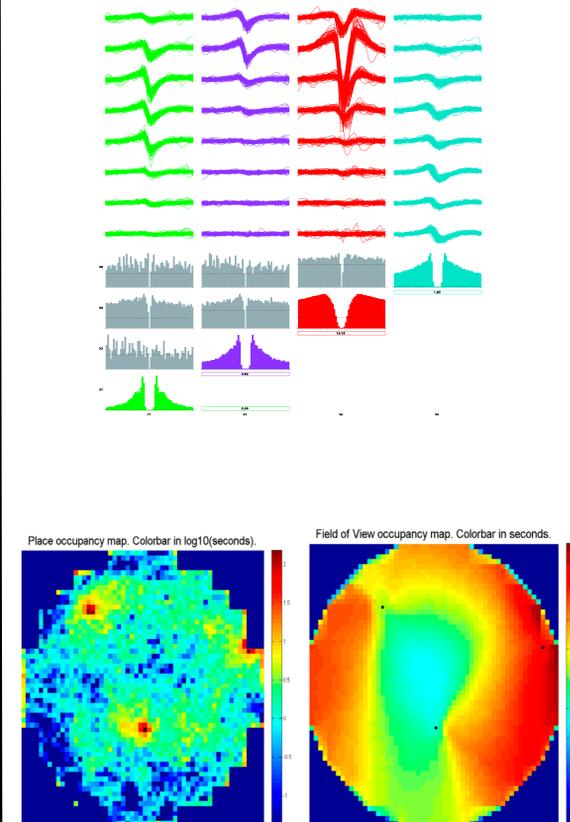
Place occupancy map. Colorbar in log10(seconds).   Field of View occupancy map. Colorbar in seconds.

Kinematic Modeling → *Behavioral Diagnosis* → Support Vector Machines

Burges 1998

Parameterization ↓   *Create Decision Space*

Wavelet Analysis   Clustering and Visualization

Map Dynamics

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