

## 1 Introduction

State of the art techniques in object detection and pose estimation are powerful and general but usually run at a rate less than 1 Hz. This makes it difficult to employ such techniques in real-time human-computer interaction.

Pitch the grocery video.

Our overall pipeline can be described as:

1. Collect RGB-D data for objects.
2. (Automatically) Train BoW model and kNN classifiers for objects.
3. Use the classifiers and additional logic to provide 3D detections pose estimates of objects.

Related work.

## 2 Coordinating AI with Computer Vision

MDPs, OO-MDPs, and POMDBs. How to create a perceptual system that plays well with planning.

## 3 Teaching the System

This is teaching not training because it is an interaction used to collect data not a script used to optimize a function.

**Manual Teaching** Teaching the system about an object involves showing it many different views of the object in a controlled environment. Once a session is initiated, the following process should be performed:

1. Repeat k times:
  - (a) Adjust the object to expose a novel viewpoint and record pose data.
  - (b) Remove extraneous objects in the scene to ensure a unique blue box is present.
  - (c) Collect the view, which saves RGB-D data and the background data.

Where k might be around 100. Now the collected data can be used to train object class and pose classifiers.

## Semi-Automatic Teaching

1. Repeat k times:
  - (a) The object is placed in a robot's manipulator in a known grasp.
  - (b) A base pose for the grasp is provided.
  - (c) The robot collects view from many different precisely known poses, together with models for self and background filtering.

Where k might be around 3. Eventually we would like to have fully automatic training, where the robot grabs objects and coordinates base poses itself.

## 4 Work Forecast

**Existing Software** Manual training, robust pose estimation under good conditions. Objectness Fast Keypoints SIFT descriptors KMeans BoW Color Histogram Depth Histogram kNN MDP

Green Boxes Blue Boxes Red Boxes

**Current Directions** Semi-automatic training Automatic training More geometric work

**Broader Impact and Future Work** working MDP's into the red box exploration and data collection so that we can interact with large scale planners for tasks.

## 5 Attendance Statement

I have been paying attention to AI, Machine Learning, and Computer Vision since 2004. Regarding Computer Vision, I saw the progress of Neural Nets in the 90's swept under the rug by SIFT, HoG, and SVMs in the mid 2000's, only for neural nets to reclaim the throne in the 2010's. At one time it was said that AI was "vision hard" and that solving Vision would effectively solve AI. While that belief sweeps a bit under the rug, it is certainly true that in the past Computer Vision has been a strong bottleneck in the development of AI and Robotics.

Recent advances in object detection on large data sets suggest that we are ready to move beyond attacking vision in an isolated setting and begin integrating it in a larger framework for planning in an interactive environment. I have training in state of the art Computer Vision techniques and have been tracking the literature for a few years now. Although I have attended CVPR twice, I have not attended any conferences in AI or Robotics. I recently started to focus on Real Time Vision systems, and attending AAAI will help me rapidly learn about the community and hit the ground running. As my concentration shifts and I begin working in AI and Robotics, my assimilation of the literature will be enhanced by having attended AAAI.

One of my goals is to make a real time vision system with a capacity of 50 objects. It should be capable of giving accurate 3D pose estimates that enable the objects to be identified and manipulated by robots. It should be able to learn a new object in less than a minute, and should be simple enough that a non-expert can easily train the system. Yet it should remain versatile enough that state of the art detectors running on special hardware can be swapped in by experts.

I have made good progress towards this goal so far. By attending AAAI, I will be able to better understand the motivations, needs, and desires of AI and Robotics concentrators with regards to Computer Vision, which will enable me to complete my dissertation in a way that aligns with these communities' values.

## 6 Curriculum Vitae

### *Education*

BS in Math, Florida State University, 2003-2006

MA in Math, UC Berkeley, 2006-2008

PhD program in Computer Science at U Chicago, 2010-2011

PhD program in Computer Science at Brown University, 2011-Present

### *Employment*

Developer Support Engineer, Havok, 2008-2009

### *Conference Papers*

S. Naderi Parizi, J. Oberlin, P. Felzenszwalb.

*Reconfigurable Models for Scene Recognition.*

IEEE Conference on Computer Vision and Pattern Recognition (CVPR), 2012

P. Felzenszwalb, J. Oberlin.

*Multiscale Fields of Patterns.*

To Appear, 2014

### *Conferences Attended*

CVPR 2011

CVPR 2012

### *Teaching Experience*

Being a TA in the UCB Math Department can be close to a full time teaching position, including quiz design, office hours, and grading in addition to the intense recitation sections (which more closely resembled lectures).

Calculus 1 TA

UC Berkeley, 2006-2007

Two sections in the Fall, three sections in the Spring, 30 students in each section, each section met with me two or three times a week for a total of about three hours a week.

Linear Algebra and ODE TA

UC Berkeley, 2007-2008

Same configuration as calculus.

Algorithms Grad TA  
Brown University, 2012-Present

I am currently the Grad TA for the Algorithms class at Brown for the fourth semester. During this time the class has been between 45 and 100 students each iteration. I have been responsible for administering oral exams, holding office hours, lots of grading (most of our problems are proof based), and managing a group of at least 6 Undergraduate TA's each semester.

### ***Departmental Service***

Graduate Student Orientation Leader  
Brown CS Department, Fall 2012

Computer Vision Reading Group Coordinator  
Brown CS Department, 2012

Department Tea Organizer  
Brown CS Department, 2012-Present

### ***Misc Research***

Master's Thesis in Mathematics  
UC Berkeley, Written 2006-2008

Research Experience for Undergraduates in Mathematics  
Oregon State University, Summer 2005

Undergraduate Research Program in Physics  
Florida State University, Summer 2004

Research Assistant in Molecular Biology  
Florida State University, Summer 2003

### ***Hobbies***

Gardening  
Ballroom Dance  
Martial Arts  
Blacksmithing  
3D Printing

## 7 Letter From Supervisor