CS231A Project Discussion

Philip Lee

Winter 2015

Overview

- Project Logistics
- Class Coverage and Ideas
  › Geometry
  › Recognition
- Example Projects
- Helpful Resources

CS231A Project Logistics

Philip Lee

Winter 2015

Project Logistics

- Teams of 1 – 4
  - Number of people is taken into account when grading project
- Suggestions for project direction
  - Replicate an interesting paper
  - Compare different methods to a benchmark
  - Use a new approach to an existing problem
  - Implement an interesting system
  - Original research

Sharing Project with Another Class

- Sharing projects is generally allowed
- Must be approved by both our staff and the other class' staff
- Project must be big enough that you can clarify which parts of the project were done for which class
  - Each part must be substantial enough to hold as a single project
- Will need 2 separate write ups

Using your Research as a Project

- If your research is vision related, this is usually okay

- Must be approved by our staff

- In your write up, explicitly explain what you got from CS231A and how it helped

Project Grading

- Course Project is 38% of your final grade
  - › Project Proposal - Required
  - › Midterm Progress Report– 5%
  - › Presentation – 8%
  - › Final Report – 25%

Project Proposal

- Due on 2/2
- Maximum of 4 pages
- Must include:
  - › Title and authors
  - › Introduction to your project
    - What's the problem
    - Why is it interesting
  - › Technical approach
  - › Milestones
  - › References
- You will be assigned a project mentor

Stanford University

Project Midterm Progress Report

- Due on 2/20
- Maximum of 4 pages
- Halfway between proposal and final report
- Must include:
  › Title and authors
  › Introduction to your project
    - What's the problem
    - Why is it interesting
  › Technical approach
  › Milestones
    - Achieved
    - Remaining (dates and goals)
  › References

Stanford University

Project Presentation

- Presentation dates on 3/9, 3/10, and 3/11
- 4 Minutes Total
  - 3 Minutes Talk
  - 1 Min Q & A
- Include at least:
  - Problem Motivation/Description
  - Technical Approach
  - Results
- Quick "elevator pitch"
- Audience participation

Final Project Report

- Due on 3/18
- Maximum 10 pages
- Submit code + report
  - Can request to not make project public

Project Report Contents

- Title and Authors
- Abstract
- Introduction
  - › Introduce the problem you want to solve, explain why it is important to solve it
- Literature Review
  - › Review of previous work
  - › Describe why your method is better than previous work.
- Technical Approach
  - › Summary of the technical solution.
  - › Details of the technical solution.
- Experiments
  - › Show numerical/quantitative and qualitative results
- Conclusions
- References.

CS231A Course Coverage - Geometry

Philip Lee

Winter 2015

Class Coverage - Geometry

- Camera Models / Calibration
  - Single camera and how we model it
- Single View Metrology
  - Estimating geometry from a single view
- Epipolar Geometry (Stereo Vision)
  - Estimating geometry from two viewpoints
- Structure from Motion
  - Using motion / several viewpoints to estimate structure
- Volumetric Stereo
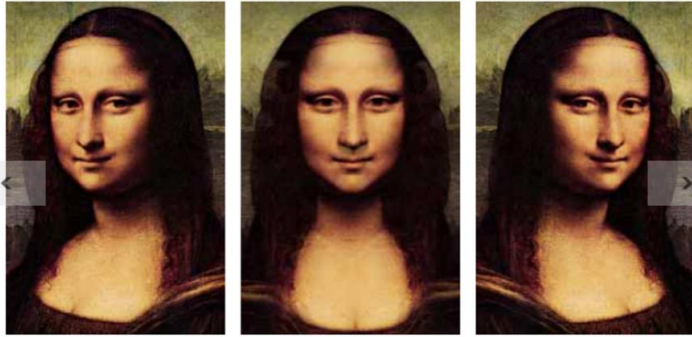 - Using multiple views to map 3d points

Geometry Project Ideas

Philip Lee

Winter 2015

Geometry Idea - Morphed View
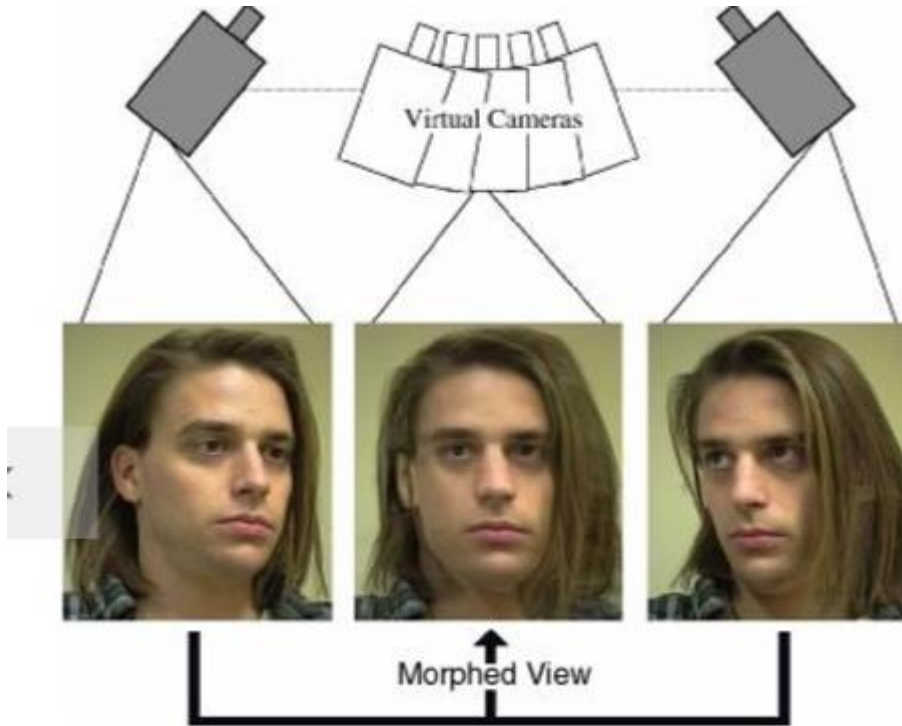
S. M. Seitz and C. R. Dyer Proc. SIGGRAPH 96, 1996, 21-30

Stanford University

Geometry Idea - Morphed View

Geometry Idea – Single View Geometry

D. Hoiem, A.A. Efros, and M. Hebert, "Automatic Photo Pop-up", ACM SIGGRAPH 2005

Geometry Idea – Scene Augmentation


The 'yellow line' in football games

THE VIRTUAL FIELD
The computer-generated map of the field
appears as a blue grid on the computers used.
It is manipulated to fit the cameras' views.

THE LOOK OF THE LINE
The size and appearance of the line can
be changed. It can look like paint on artificial
surfaces or like chalk on grass fields.

CAMERA POSITIONS
Three cameras are used in the process.
One is at the 50-yard line, and the others
are at about the 25-yard lines.

Geometry Idea – Scene Augmentation

- Identifying occlusions, surfaces, etc from image/video

Geometry – 3d Models
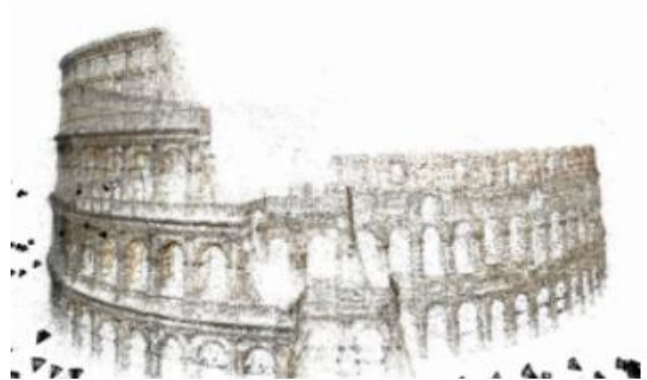
Geometry Idea – Hardware and Systems

Use multiple cameras

Depth Cameras

Calibrate

Etc…

Geometry Idea – Hardware and Systems

CS231A Course Coverage - Recognition

Philip Lee

Winter 2015

Class Coverage - Recognition

- Fitting and Matching
- Detectors and Descriptors
- Object Classification
- 2D / 3D Object Detection
- 2D / 3D Scene Understanding

Recognition Project Ideas

Philip Lee

Winter 2015

Recognition Idea – Matching
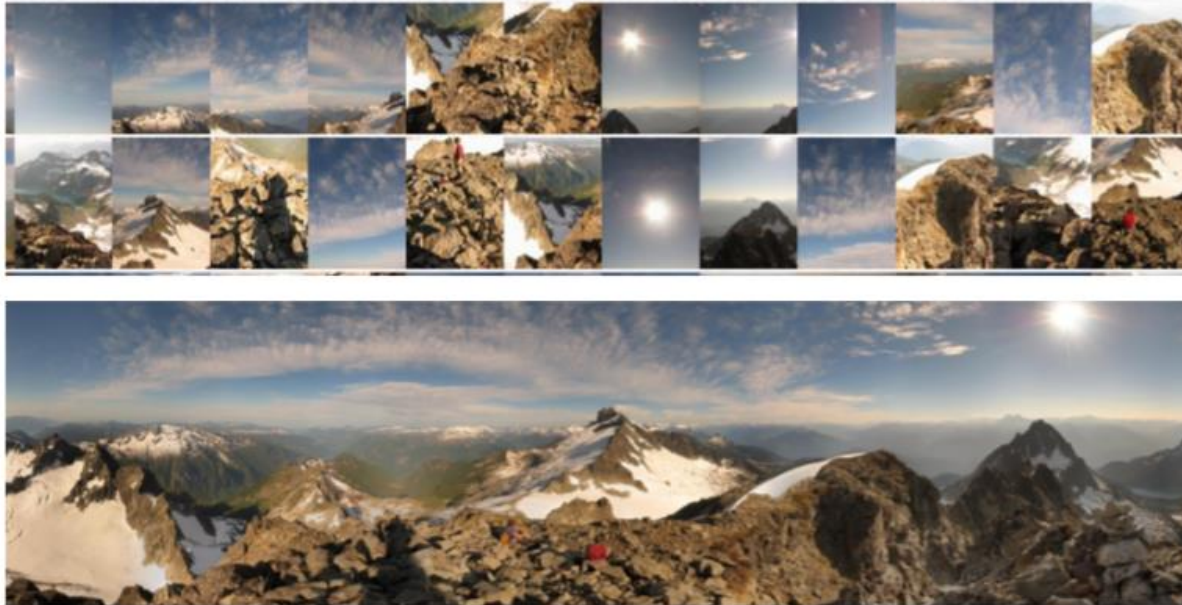
M. Brown and D. G. Lowe, Recognizing Panoramas, ICCV 2003

Recognition Idea – Mid Level Segmentation

• Image segmentation

Recognition Idea – Image Completion

"James Hays, Alexei A. Efros. Scene Completion Using Millions of Photographs. ACM Transactions on Graphics (SIGGRAPH 2007). August 2007, vol. 26, No. 3

Recognition Idea – Object Recognition
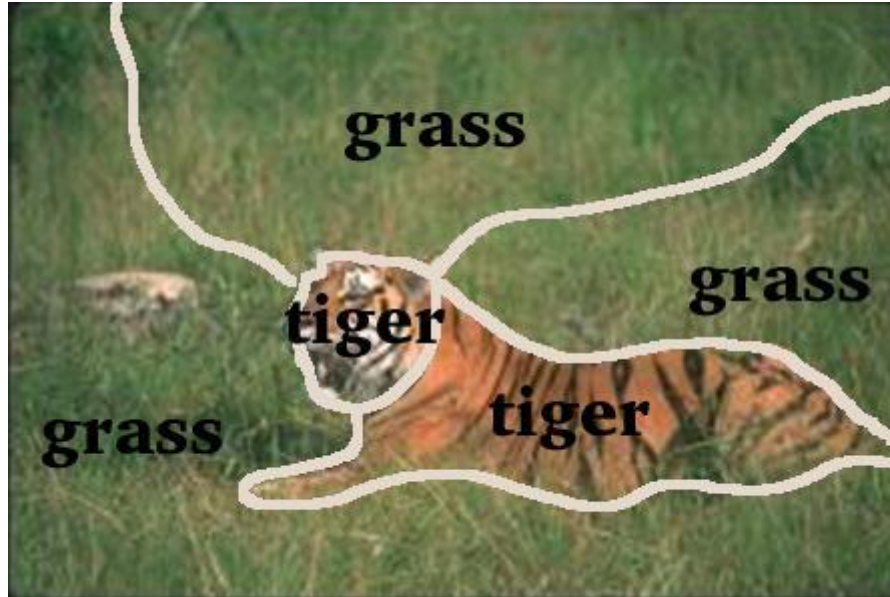
Recognition Idea – Face Recognition
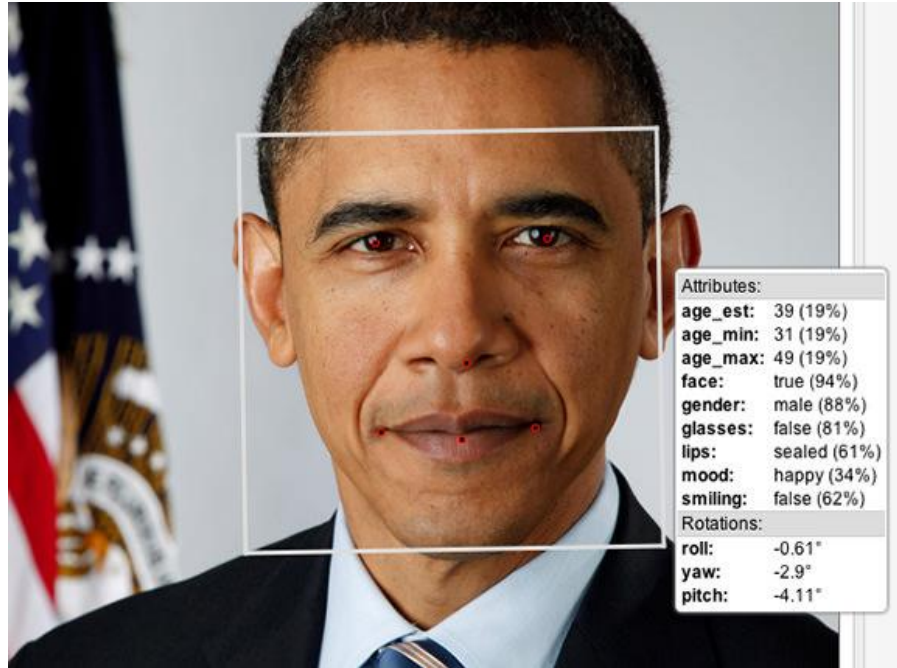
Recognition Idea - Classification

Recognition Idea – Pose Estimation
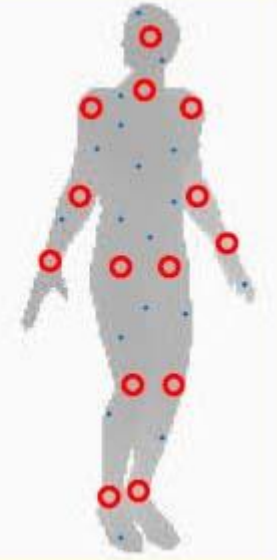
(a)   (b)

Recognition Idea –Gesture Recognition

Recognition Idea – Action Recognition
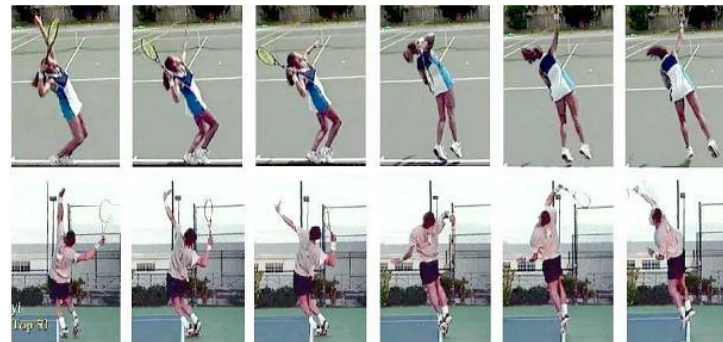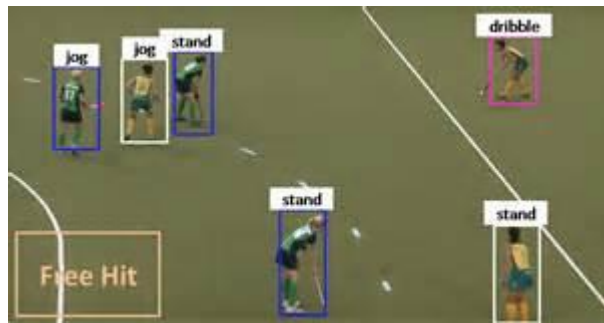
Recognition Idea – Scene Understanding

Original Image

Examples from Training Set
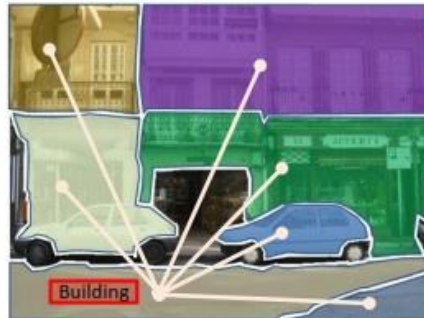
Fully Connected Network
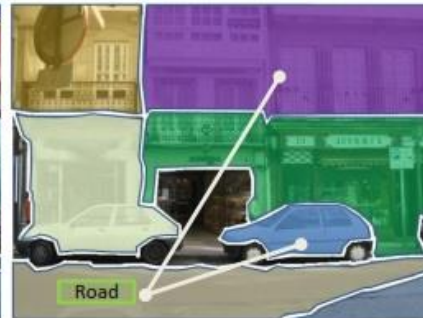
Our Learned Network

CS231A Helpful Resources

Philip Lee

Winter 2015

Where to get Project Ideas

- Project suggestions provided by us – posted on website / Piazza
- Interesting vision papers in Journals
  - CVPR, ECCV, ICCV
- Computer vision research groups at Stanford
  - Email professors or their grad students
    - Silvio Savarese *
    - Fei-Fei Li
    - Sebastian Thrun
    - Daphne Koller
- **Look at last year's projects**
  - › http://cvgl.stanford.edu/teaching/cs231a_winter1415/projects.html
- Come up with your own ideas

Data Sets Available

- Caltech – Object classification
- Face datasets
- Pedestrians
- Youtube videos
- Stanford Dogs Dataset
- Gesture
- Video surveilance
- Light field
- Sports
- Image Stitching

- Medical
- Buildings
- Plants
- 3d Photography
- RGBD scenes
- Traffic
- Head tracking
- Eye tracking
- Segmented images
- SO MANY MORE …

Quick Links to Dataset Aggregators

- http://www.cvpapers.com/datasets.html
- http://riemenschneider.hayko.at/vision/dataset/
- http://clickdamage.com/sourcecode/cv_datasets.php

Useful Things

- OpenCV
  - Industry standard
  - Support for lots of programming languages
- Matlab
  - Image Processing/Computer Vision toolboxes
- Various camera / sensors
  - Depth sensors
    - Kinect
    - Leap motion
  - Tablet
    - NVIDIA
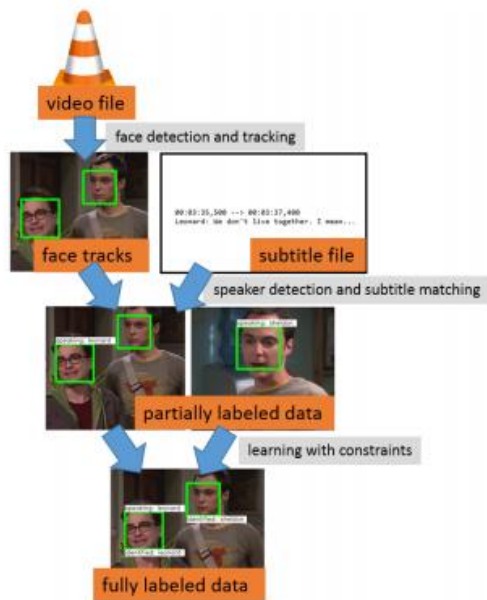   - Amazon fire

CS231A Example Projects

Philip Lee

Winter 2015

Face Recognition

Example Project - Mustachify

Example Project - Mustachify
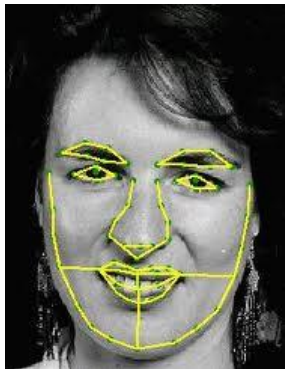
Character Recognition in TV Show

Facial Verification using Fisher Vectors and Deep Nets

Action Recognition

Hand Gesture Recognition

Figure 2. Rectangular hand shape is used to select part of the scene to be cropped out.
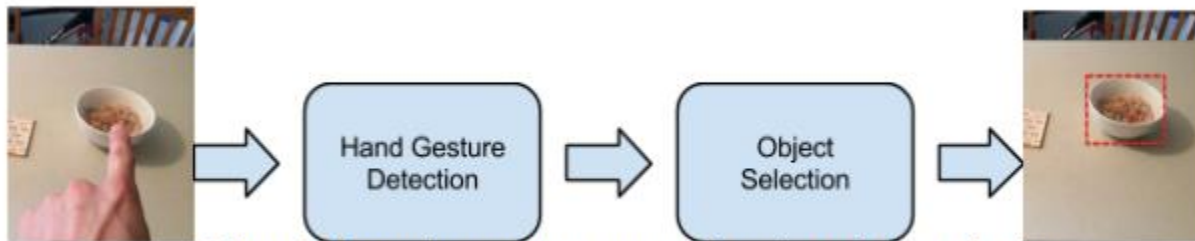
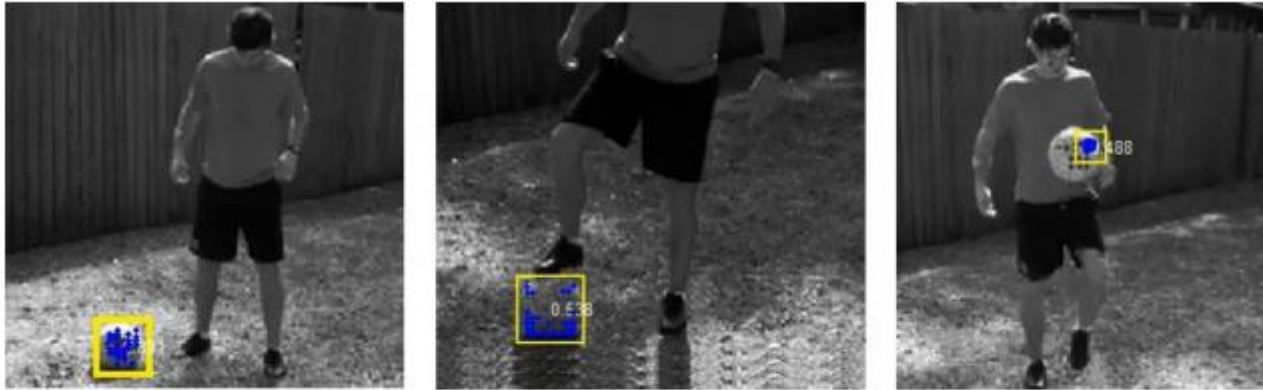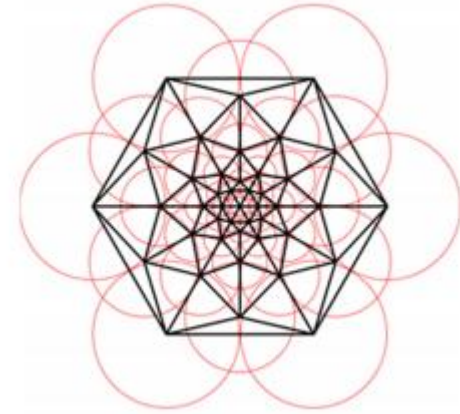**Figure 3.** Two main components: gesture detection and object selection
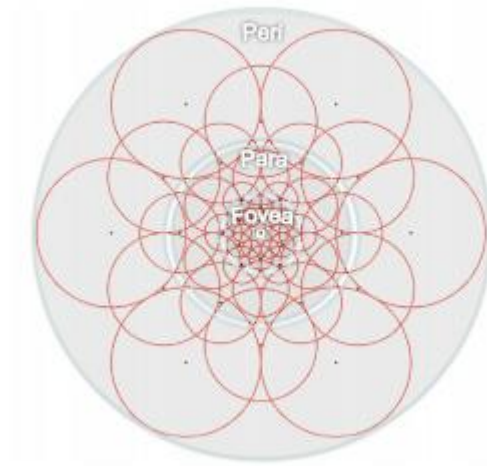
Tracking Objects in Youtube Videos

Figure 4. Snapshots from Soccer Video showing tracking under multiple view points

Research Oriented

Keypoint Descriptor Inspired by Retinal Computation

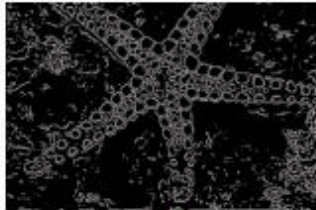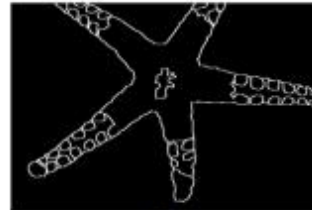# Comparative Study of Color Edge Detectors
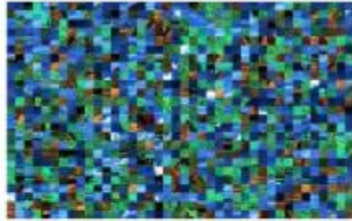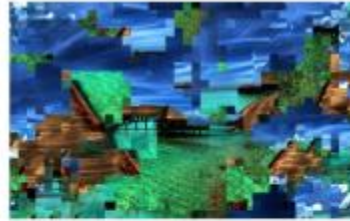

(a) (b) (c) (d) (e) (f)

(a) (b) (c) (d)

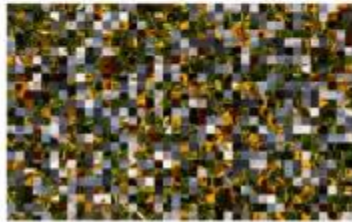# Genetic Algorithm for Jigsaw Puzzle Solver

Scrambled · Generation 1 · Generation 100
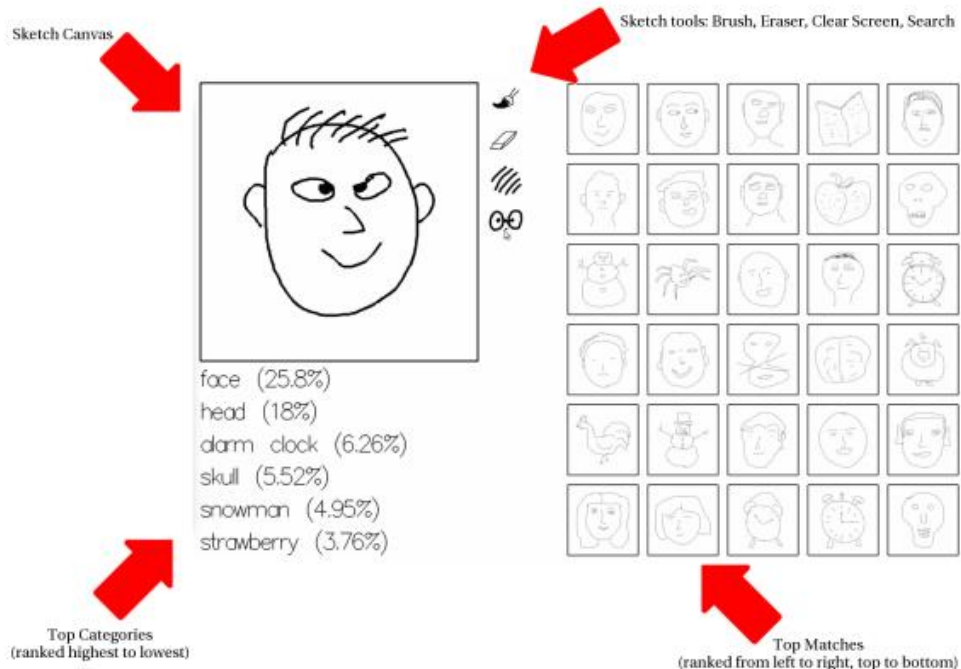
Scrambled · Generation 1 · Generation 100

General Classification

Beer Label Recognition Engine

Figure 2: Bottle Photos w/ Varying Angles and Illumination

Sketch Based Object Recognition

Sketch Canvas

Sketch tools: Brush, Eraser, Clear Screen, Search

face (25.8%)
head (18%)
alarm clock (6.26%)
skull (5.52%)
snowman (4.95%)
strawberry (3.76%)

Top Categories
(ranked highest to lowest)

Top Matches
(ranked from left to right, top to bottom)
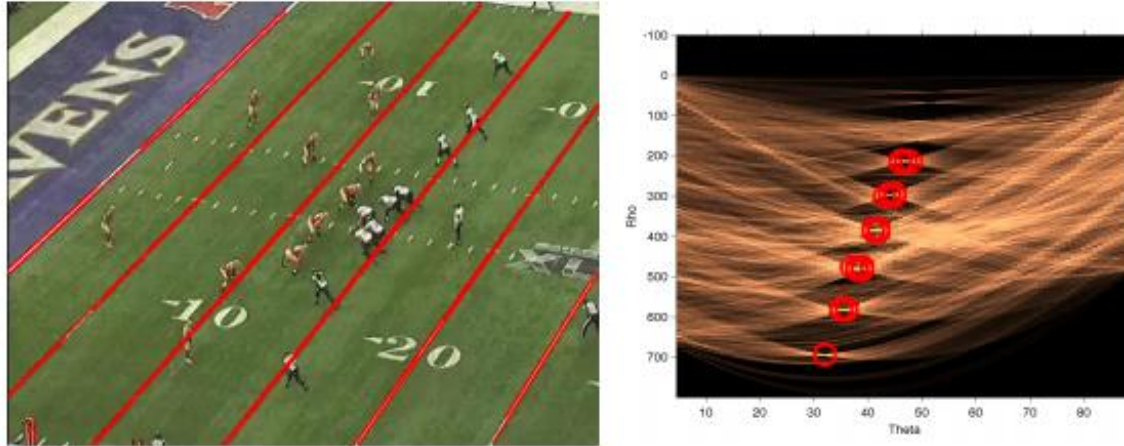
# Geometry

Analyzing All-22 NFL Film

Figure 2: Automatic detection of yardlines on a football field (left) using the Hough transform (right).

Analyzing All-22 NFL Film (cont.)

Figure 4: *Automatic recognition of Baltimore players, with bounding box overlaid on play image (left) and on the underlying processed image (right) that exposes the unique color features of the Baltimore players: black pants.*

Chess Analysis
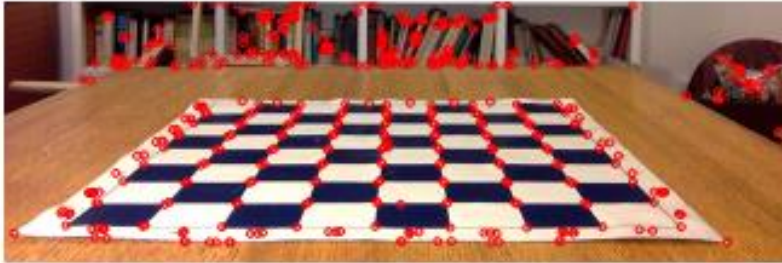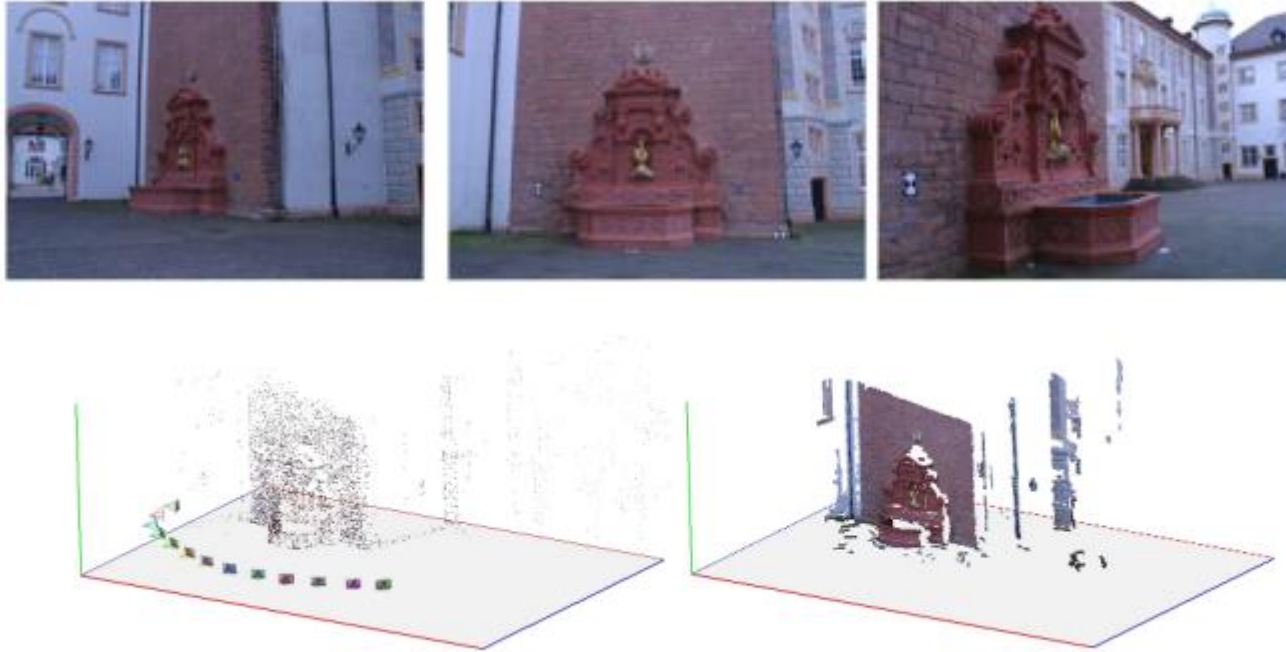
3D Reconstruction from Multiple Images

Figure 4: Sparse and Dense 3D models for the Fountain dataset

Stanford University

Computer Vision for Augmented Reality

Final Notes - Advice

- Choose your team well
- Make sure the scope of you project fits a quarter
  - A good plan may be to have a minimum goal, goal, and moonshot
- Constrain your problem smartly
- See what data is available if you're doing a recognition project
- You may need to plan ahead / learn outside material
- Use software when available
  - OpenCV
  - Matlab
- Come ask questions – we're happy to talk
- Have fun!