Joint Institute of Engineering

SUN YAT-SEN UNIVERSITY

Carnegie Mellon University

16-720J
Computer Vision

Course Website URL : TBA

Mobile Robotics & Computer Vision Laboratory

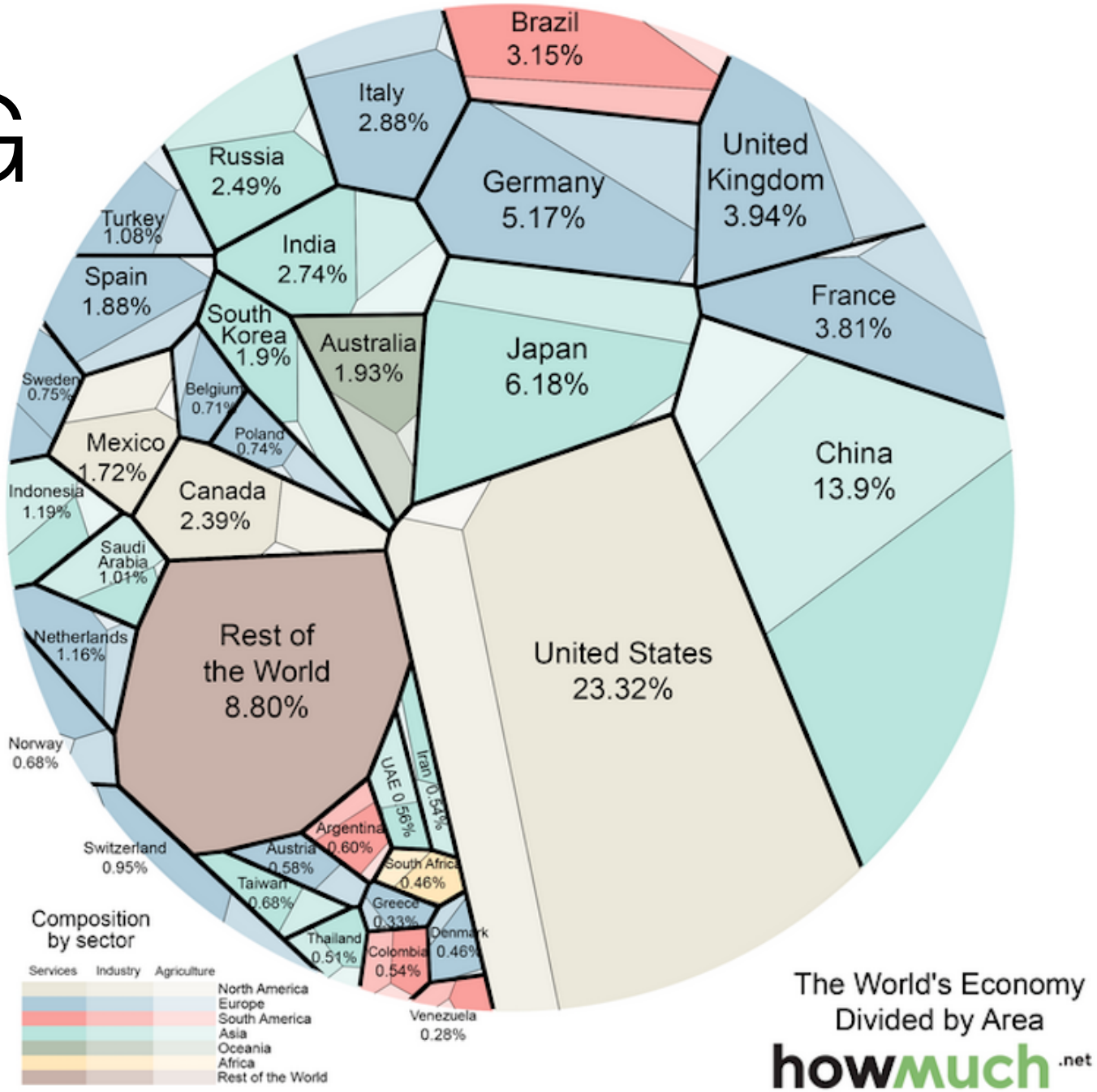
Dr. Gary Overett

Why do a Masters or PhD?

Why do a Masters or PhD at JIE?

Why do a Masters or PhD…
studying Mobile Robotics
or Computer Vision?

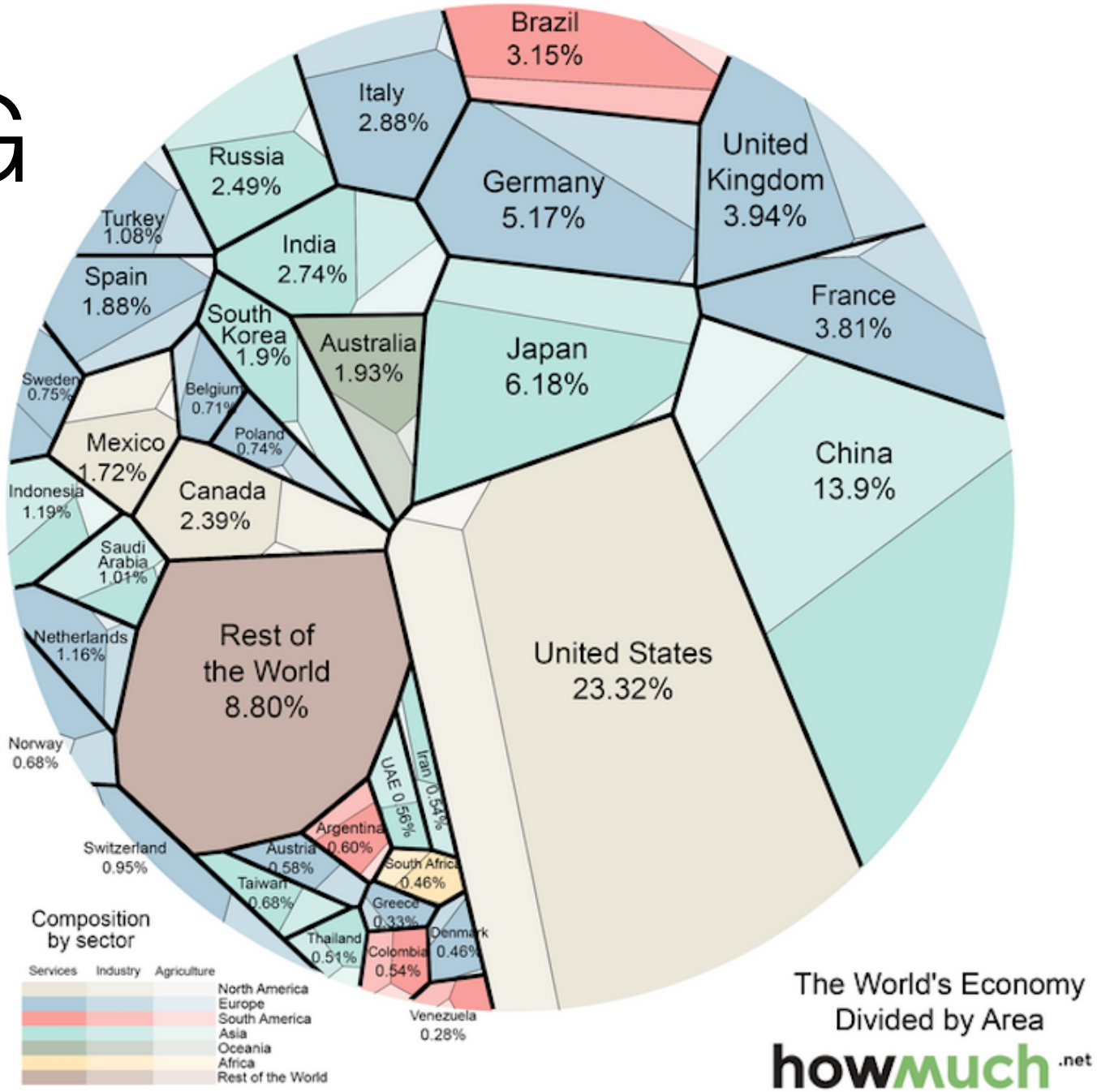
The BIG Picture



The BIG Picture

US Economic Growth has increased recently due to 2 main factors:

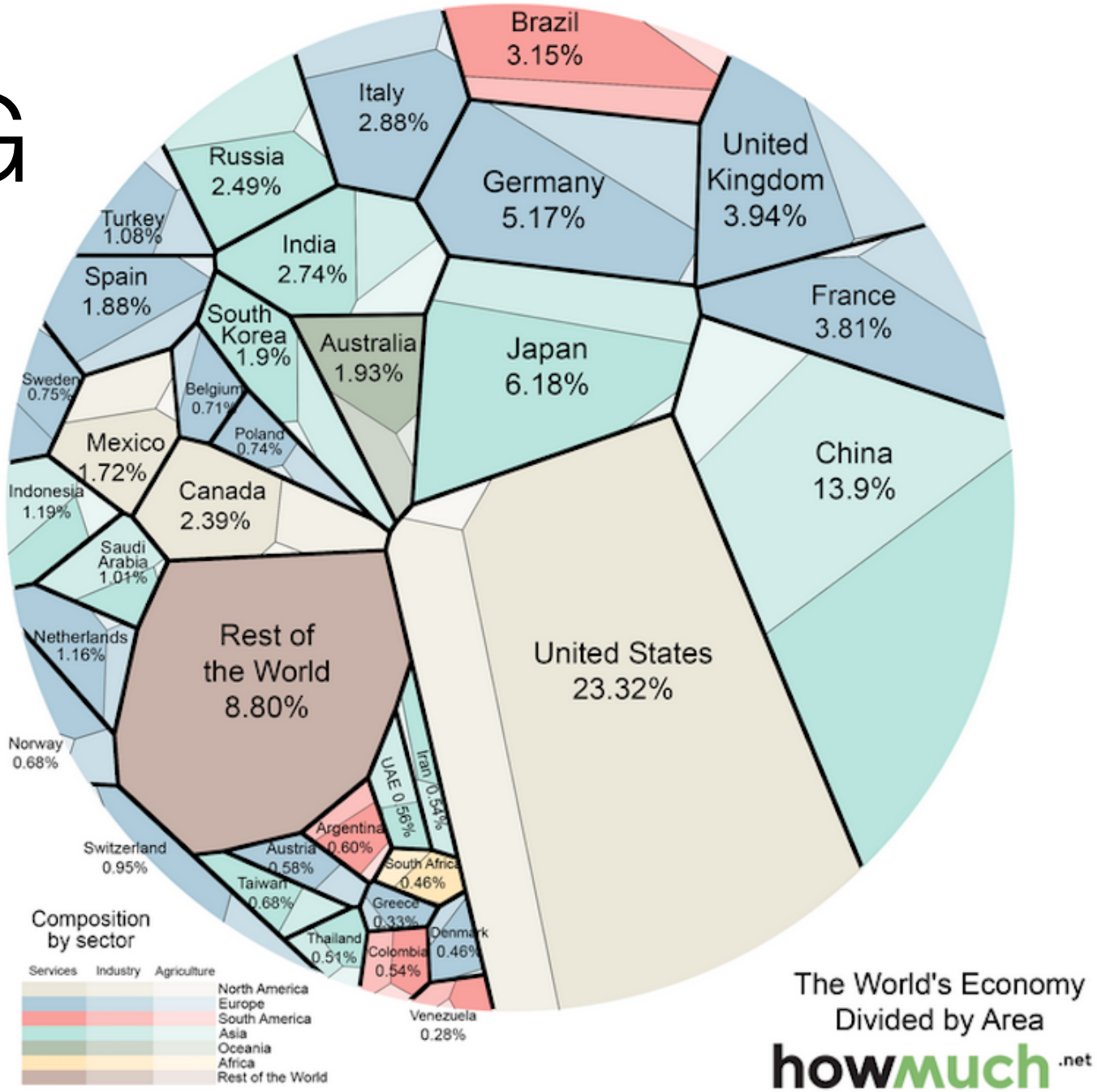
1. The Energy Sector
2. ?????



The BIG Picture

US Economic Growth has increased recently due to 2 main factors:

1. The Energy Sector
2. The DIGITAL ECONOMY



The Digital Economy

AI, Robotics, Automation, Vision

Story of 2 Factories

While the many robots in auto factories typically perform only one function, in the new Tesla factory in Fremont, Calif., a robot might do up to four: welding, riveting, bonding and installing a component. Paul Sakuma/Associated Press

The Foxconn plant in Shenzhen, China. Ym Yik/European Pressphoto Agency

Story of 2 Factories

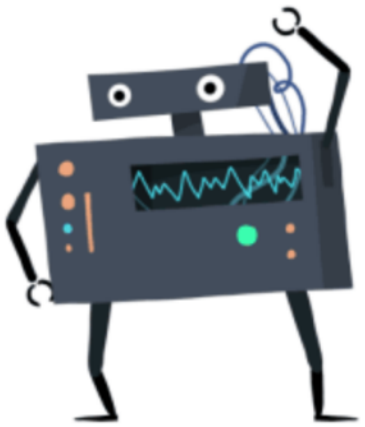
While the many robots in auto factories typically perform only one function, in the new Tesla factory in Fremont, Calif., a robot might do up to four: welding, riveting, bonding and installing a component. Paul Sakuma/Associated Press

"For 30 years the American worker has worried about their job going to China, now it might go to a robot!"

The Foxconn plant in Shenzhen, China. Ym Yik/European Pressphoto Agency

http://www.npr.org/sections/money/2015/05/21/408234543/will-your-job-be-done-by-a-machine

Production | Electrical and Electronic Equipment Assemblers



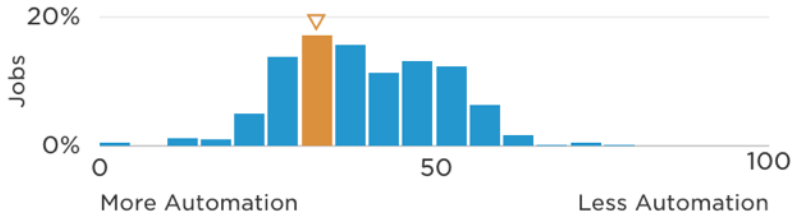
Electrical and Electronic Equipment Assemblers have a

95.1%

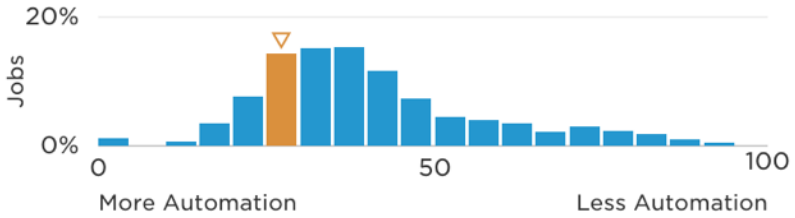
chance of being automated.

How do we know this? Some aspects of a job are easier to automate than others. It all depends on the tasks. Look at the orange bars to see how Electrical and Electronic Equipment Assemblers compare with other professions...

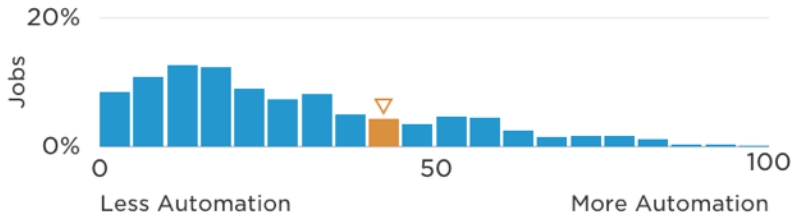
Do you need to come up with clever solutions?



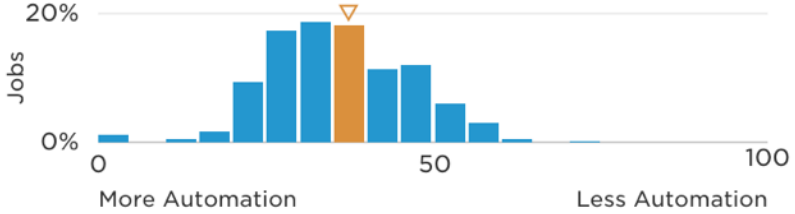
Are you required to personally help others?



Does your job require you to squeeze into small spaces?



Does your job require negotiation?



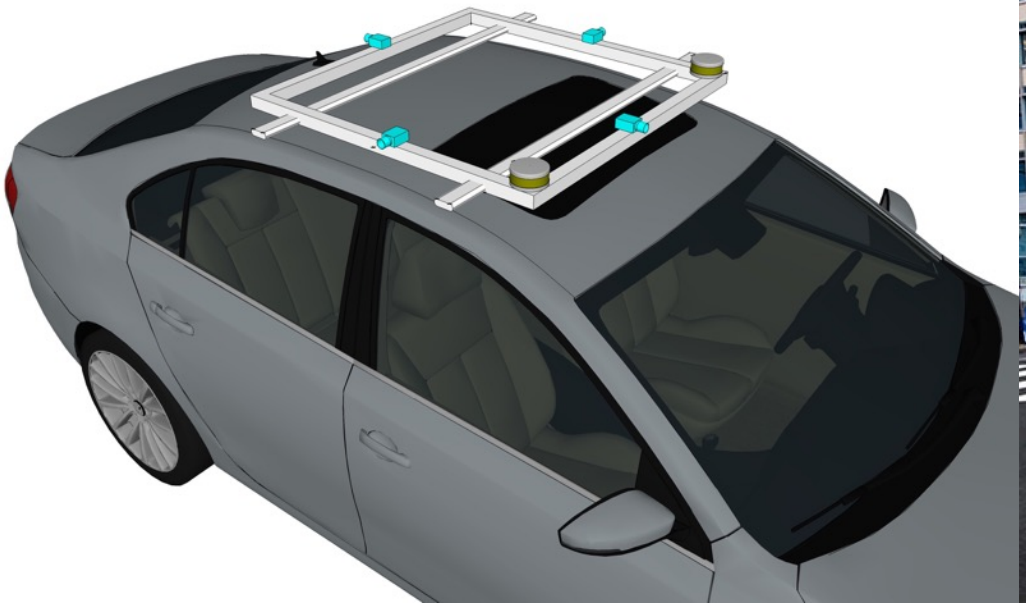
How will you ride the wave?

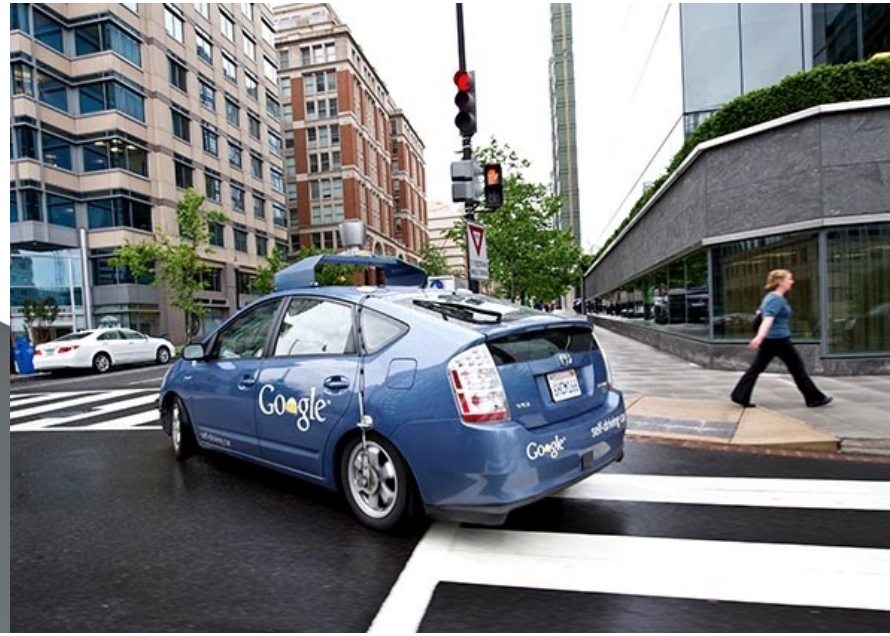
Why Mobile Robotics or Computer Vision?

- We have the coolest problems!

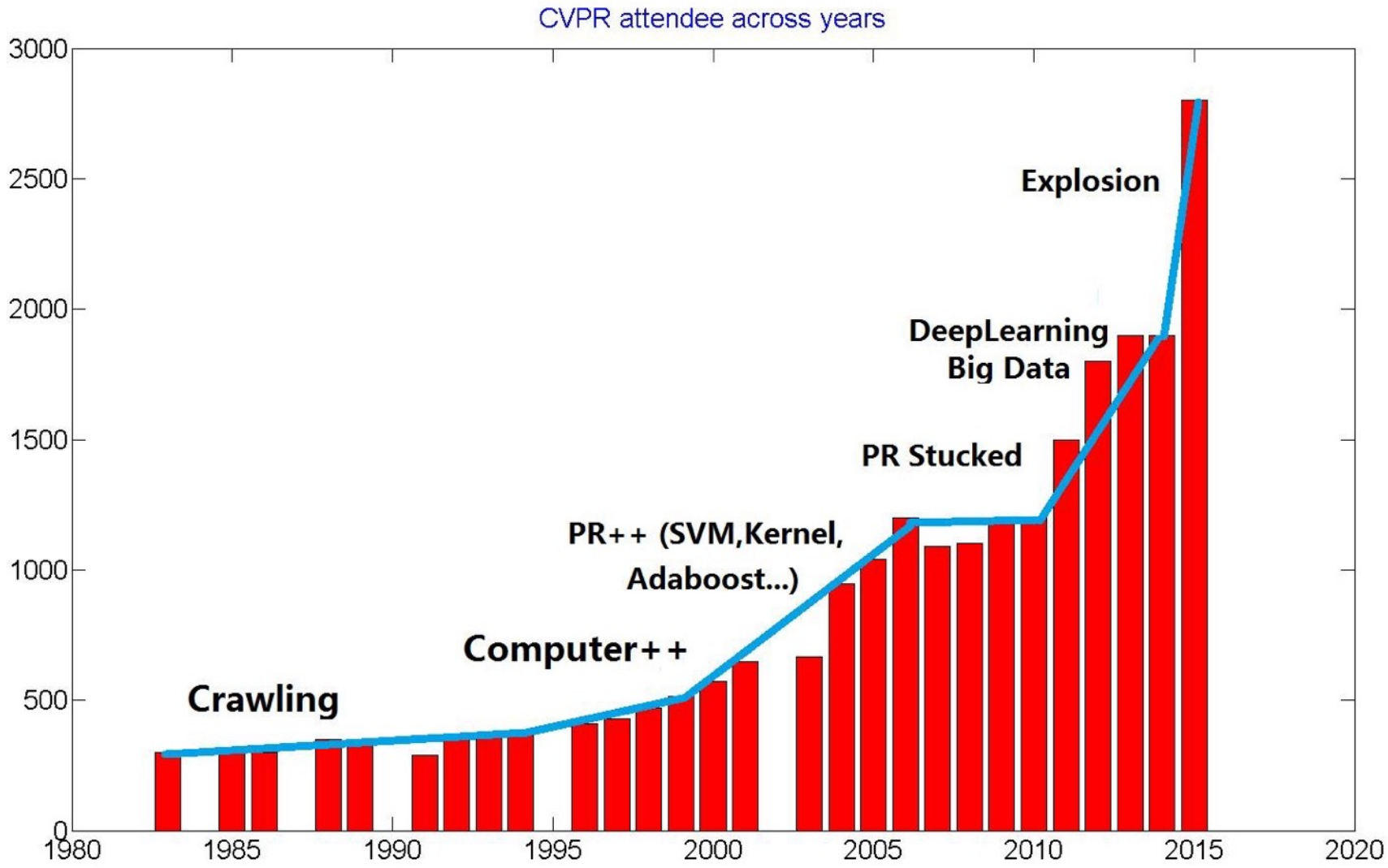
Why Mobile Robotics or Computer Vision?

- We have the coolest problems!
- Robotics and Computer Vision are major growth areas for the future economy.
- Great work with a great future!



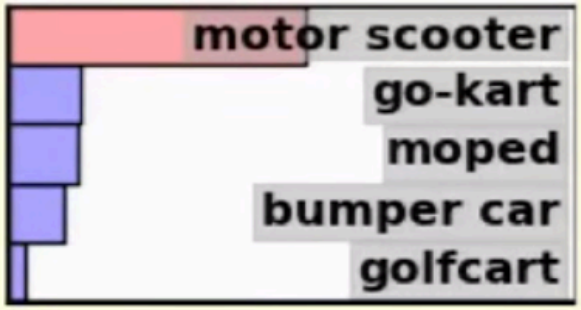


High Growth - High Opportunity

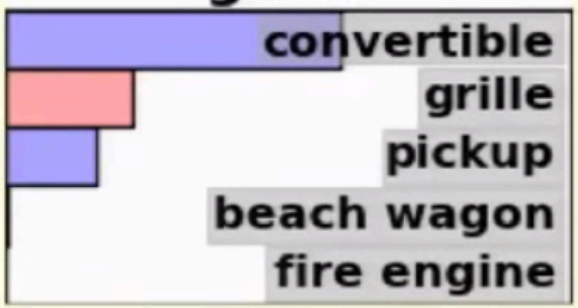


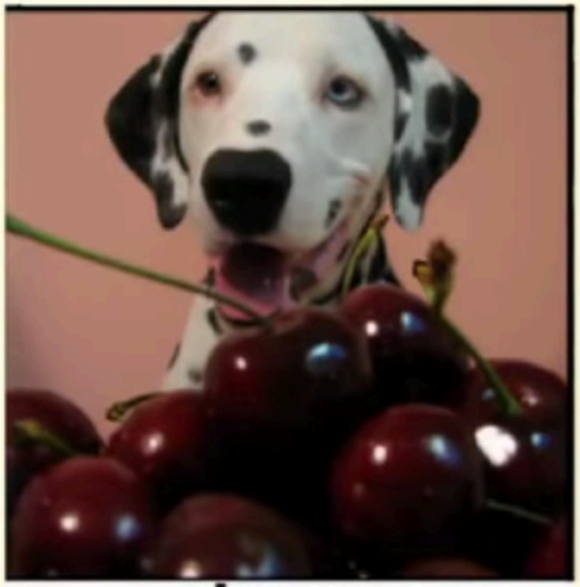
What might you study?

motor scooter

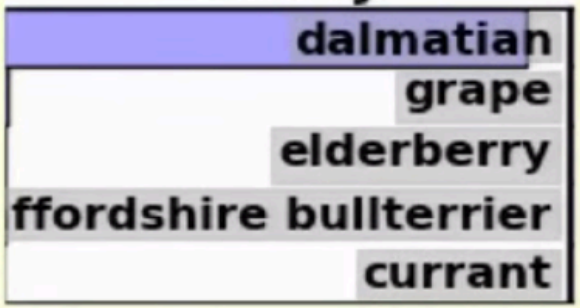


grille





cherry



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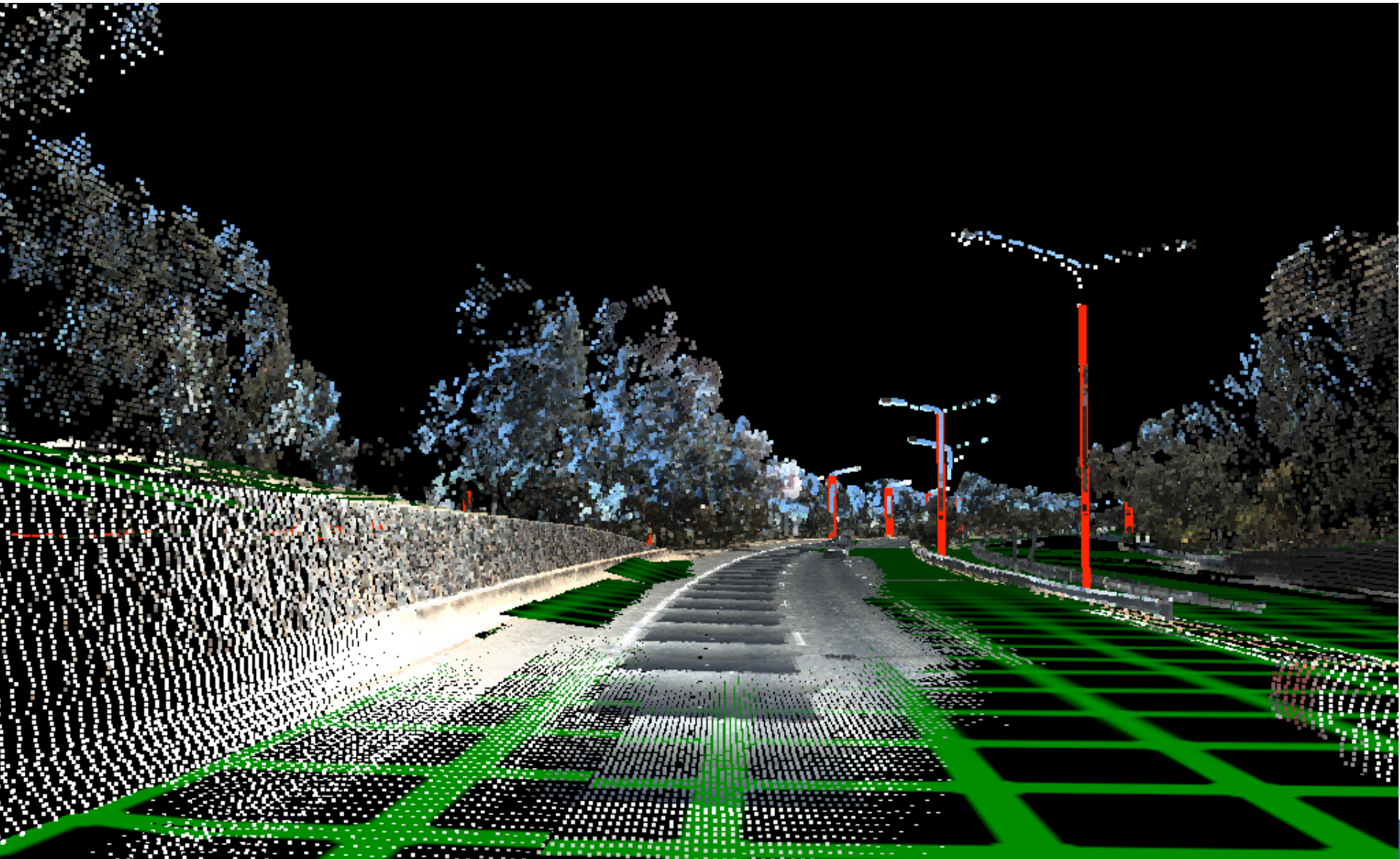

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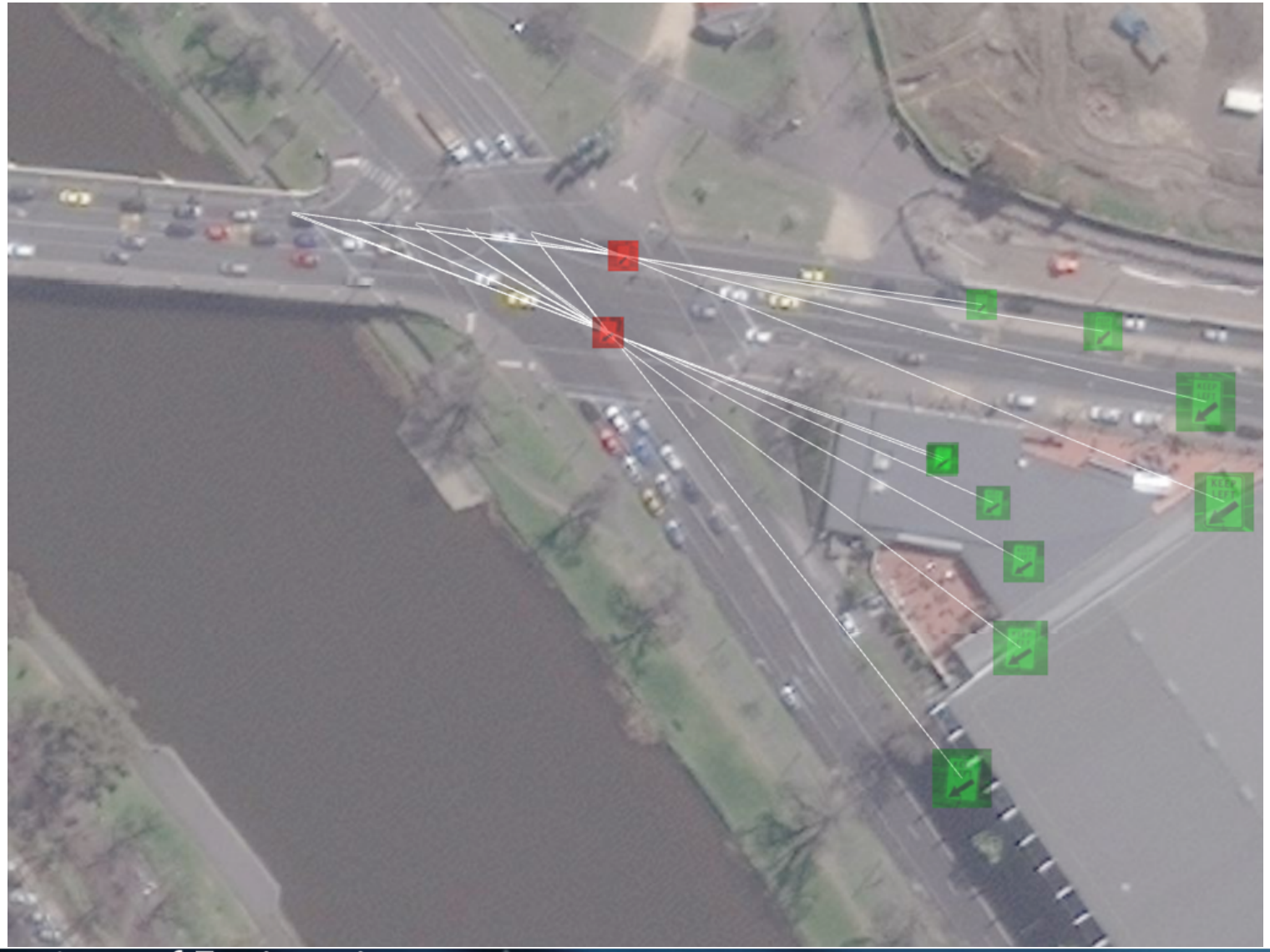


- Instructor: Gary Overett, Office:JIE 217C, Office Hours:

  TBA, Email: overett@mail.sysu.edu.cn

- **Teaching Assistants**
  - Yang Gao. Office: JIE 217. Office Hours: TBA

    Email: Yolandac_Gao@163.com

Considering a Master Project in our Lab

Please see the information at

- http://gary.overett.org/prospective-students/
- http://gary.overett.org/prospective-students/masters-project-students/
- I have details there about how to show your interest in a project.

Course Background

- CMU's 16-720 Computer Vision course is a capstone graduate level course. It is considered one of their most challenging offerings.
- With hard work YOU can do this course but take note:
- Students at CMU spent 20-40 hours completing homework that was required every 2 weeks!
- I will be reducing the homeworks but students will need to begin each assignment early and work efficiently to complete them.
- Warnings : Programming in **Matlab**, **Linear Algebra**, and general **Mathematics** are used heavily. We release a primer for these this week. Take a look. If it all looks very foreign - you may want to do some preparation and try this course later.

Reference Material

- "Text":
  - Computer Vision – A Modern Approach
    - Forsyth & Ponce
    - www.cs.berkeley.edu /~daf
  - Computer Vision: Algorithms and Applications
    - Richard Szeliski
    - http://szeliski.org/Book/

Reference Material

- Others:
  - Introductory Techniques for 3-D Computer Vision, E. Trucco & A. Verri
  - Vision Science, R. Palmer
  - Multiple View Geometry, Hartley & Zisserman
  - The Geometry of Multiple Images, Faugeras
- Linear algebra:
  - Introduction to Linear Algebra, Fourth Edition, Gilbert Strang
  - http://ocw.mit.edu/courses/mathematics/18-06-linear-algebra-spring-2010/video-lectures/
- Compendium of vision:
  - www.dai.ed.ac.uk/CVonline/
- IEEE Publications (on CMU machines):
  - www.ieeexplore.org

Date	Day	Class Activity	
Sept			
1	Tues	Introduction and Image Formation	Assignment 0
3	Thur	Calibration	
8	Tues	Filtering/image features	Assignment 1 Distributed
10	Thur	Photometry	
15	Tues	Introduction to ML for Vision	
17	Thur	Filtering/image features	
22	Tues	Filtering/image features	Assignment 1 Due / 2 Distributed
24	Thur	Filtering/image features	
29	Tues	Filtering/image features	
Oct			
1	Thur	Recognition	
6	Tues	Recognition	Assignment 2 Due / 3 Distributed
8	Thur	Recognition	
13	Tues	Recognition	
15	Thur	Neural Networks	
20	Tues	Neural Networks	
22	Thurs	Segmentation	Assignment 3 Due / 4 Distributed
27	Tues	Optical Flow, Tracking and Motion Segmentation	
29	Thurs	Optical Flow, Tracking and Motion Segmentation	
Nov			
3	Thur	Optical Flow, Tracking and Motion Segmentation	
5	Tues	Multiple-view Geometry	
10	Thur	Structure from Motion and Multiview Stereo	Assignment 4 Due / 5 Distributed
12	Tues	Structure from Motion and Multiview Stereo	
17	Thur	Structure from Motion and Multiview Stereo	
19	Tues	Features and Recognition	
24	Thurs	**Spotlight Presentations**	
26	Tues	THANKSGIVING	
Dec			
1	Tues	SPECIAL TOPIC - TBA	
3	Thur	SPECIAL TOPIC - TBA	5 Due

- Homeworks
  - 2-week period
  - MATLAB implementation + problems
- Final Project
  - Literature search + Implementation
- Review Sessions
  - **Tuesdays 10:30pm –** 12**:00pm** (announced via e-mail and blackboard)
- MATLAB
  - Mandatory
  - Intro lecture coming up → **TBA**
  - Intro document online (MATLAB primer)
  - Homework 0
- Math
  - Basic math tools (See "*Math Primer*" online)
    - Linear Algebra
    - Basic optimization/calculus
  - Probability (see link to Andrew Moore's tutorials)
    - Basic probability (first part only)
    - Densities/estimation
    - Gaussian distributions
- Handouts
  - Posted before class

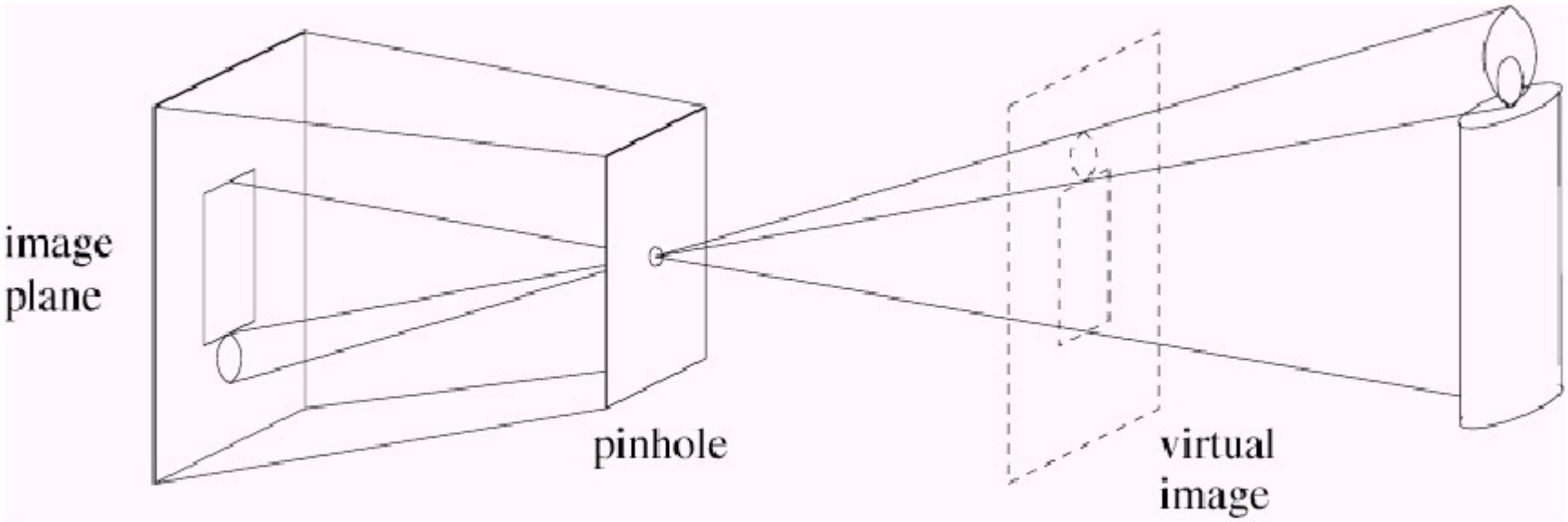
Communication

- All notes, homework, discussion, through "blackboard"
- www.cmu.edu/blackboard

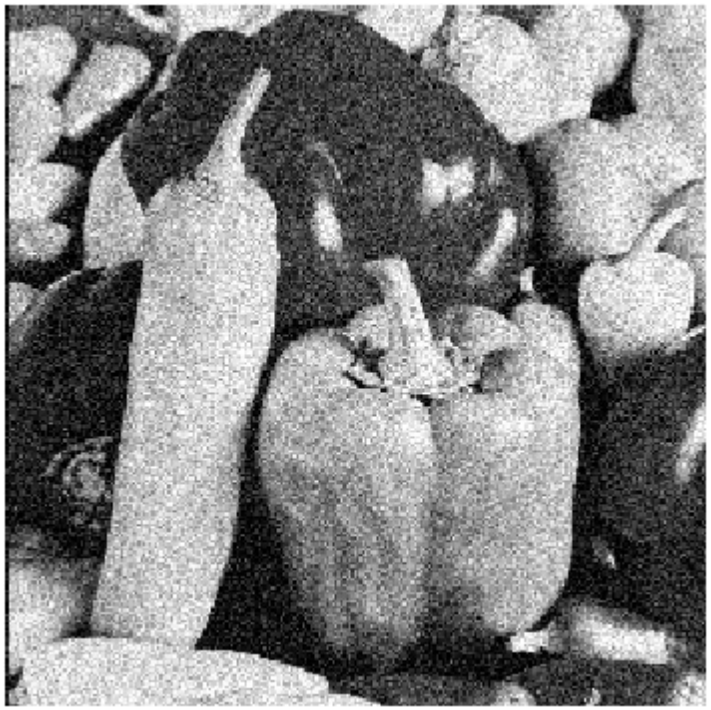
- Homework due on time:
  - You will be allowed 3 total late days without penalty for the entire semester. For instance, you may be late by 1 day on three different homeworks or late by 3 days on one homework. Each late day corresponds to 24 hours or part thereof. Once those days are used, you will be penalized according to the policy below:
    - Homework is worth full credit at the beginning of class on the due date.
    - It is worth half credit for the next 48 hours.
    - It is worth zero credit after that.
- Example of bad excuses:
    - I am busy with the Machine Learning class
    - I have a massive DARPA demo tomorrow when it's due (and I did not know until today)

Example from
Scott Satkin

Image Formation



Filtering



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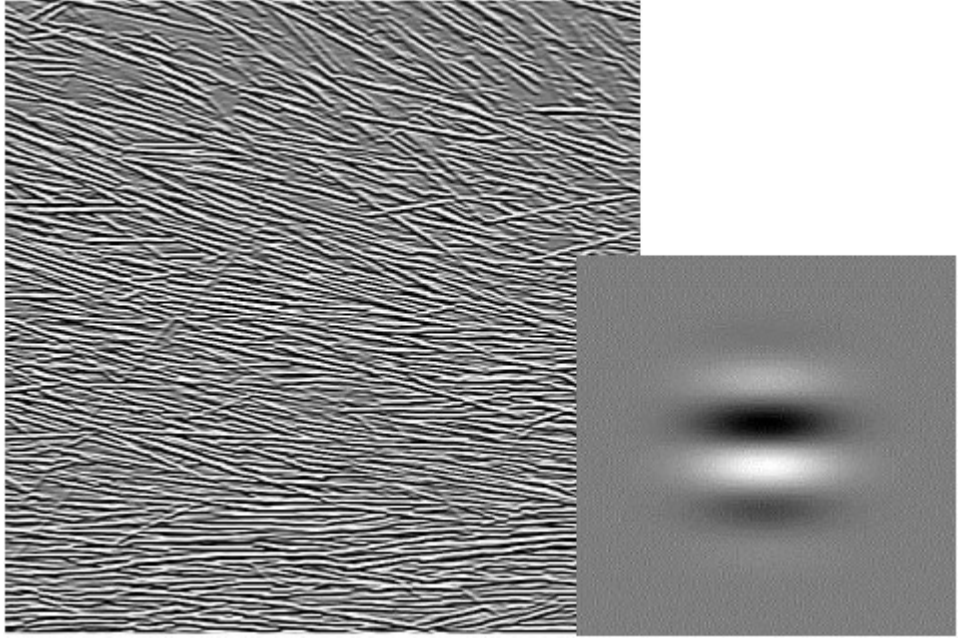
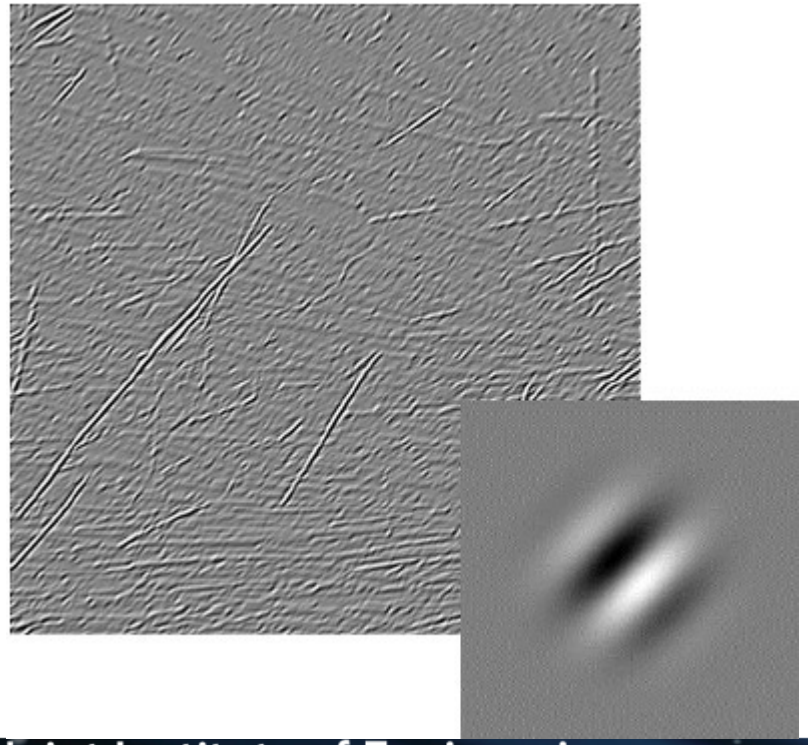
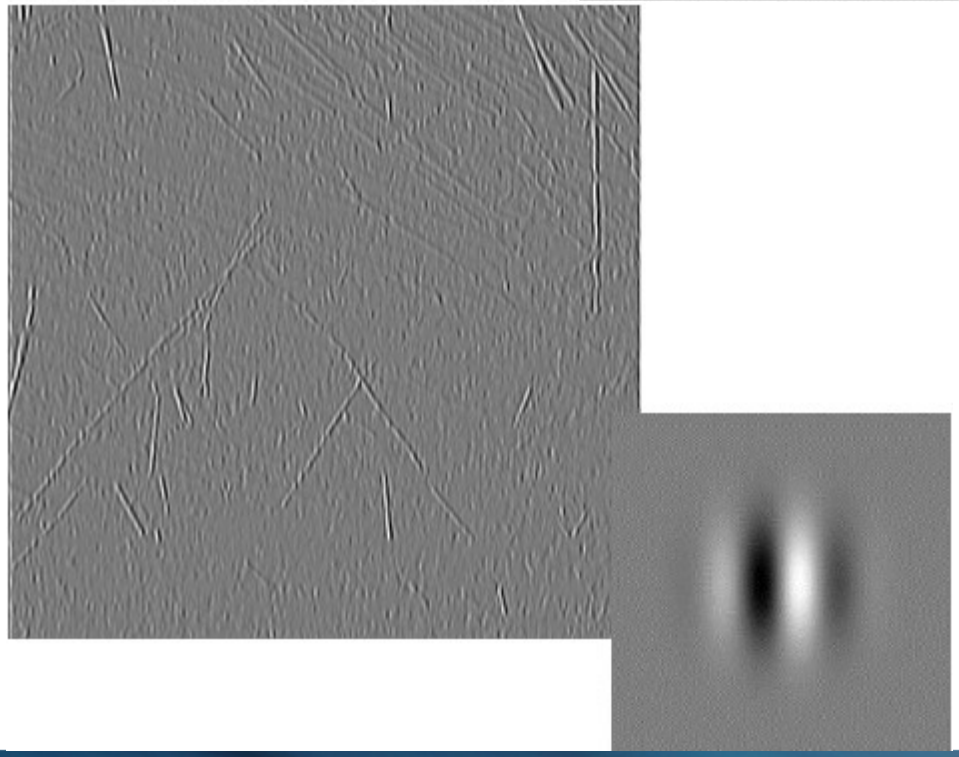
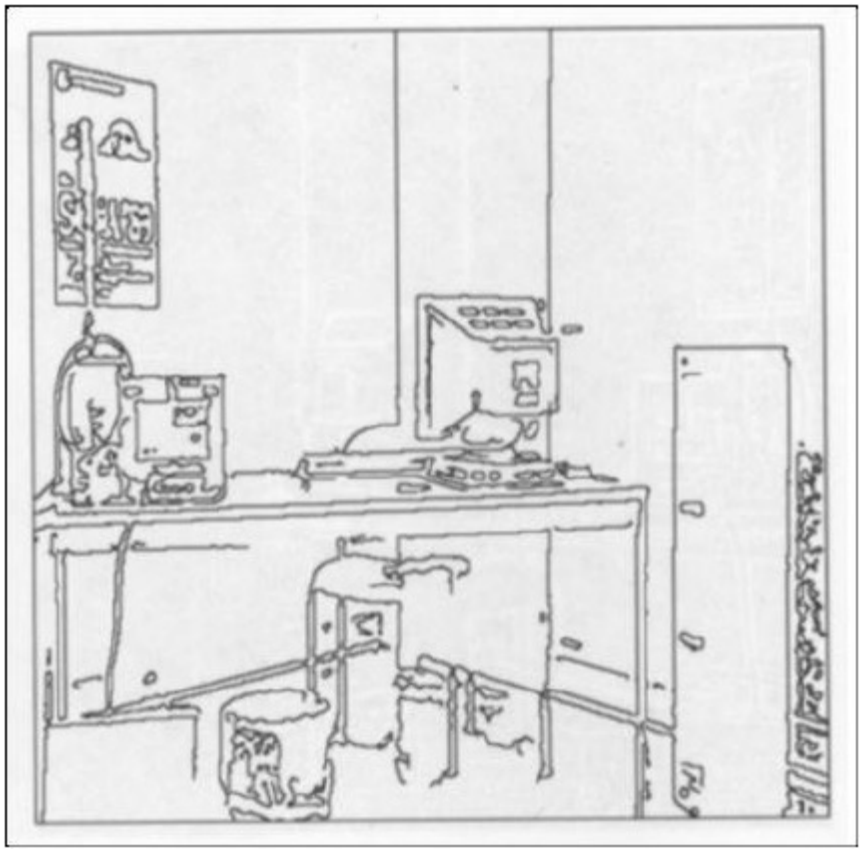




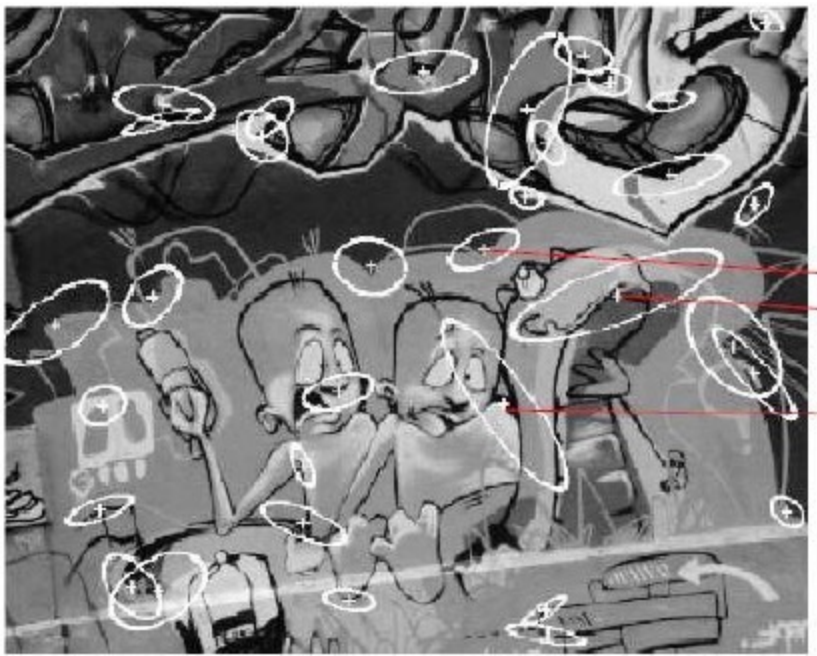


Edge Detection

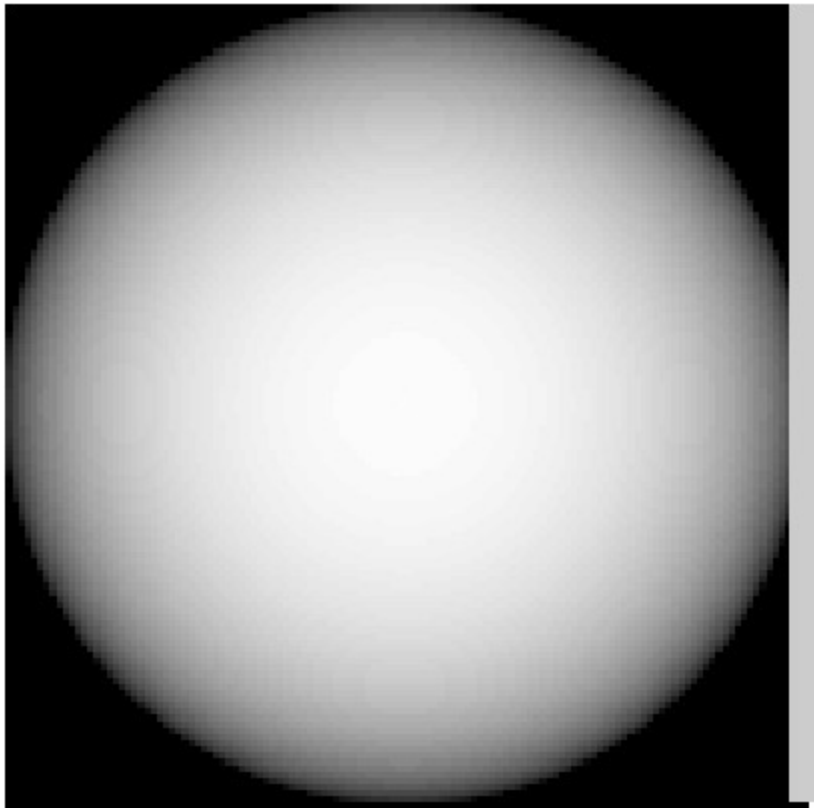
Edge Detection

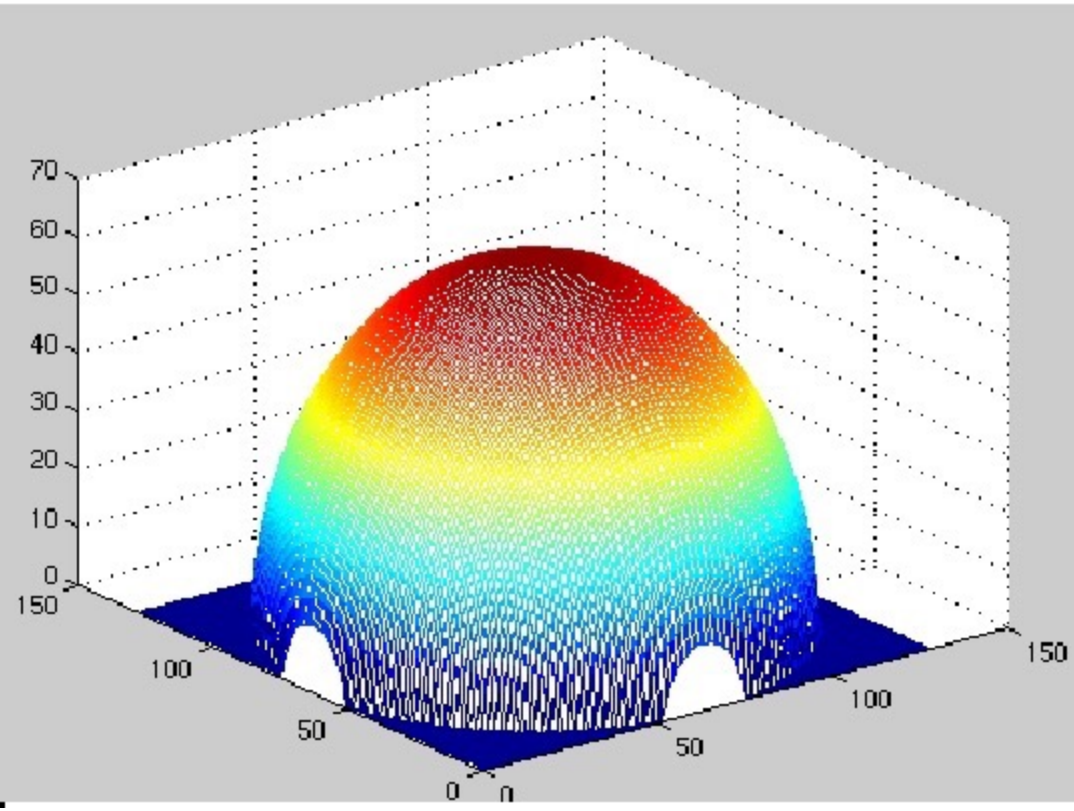


Interest points and descriptors (SIFT,..)

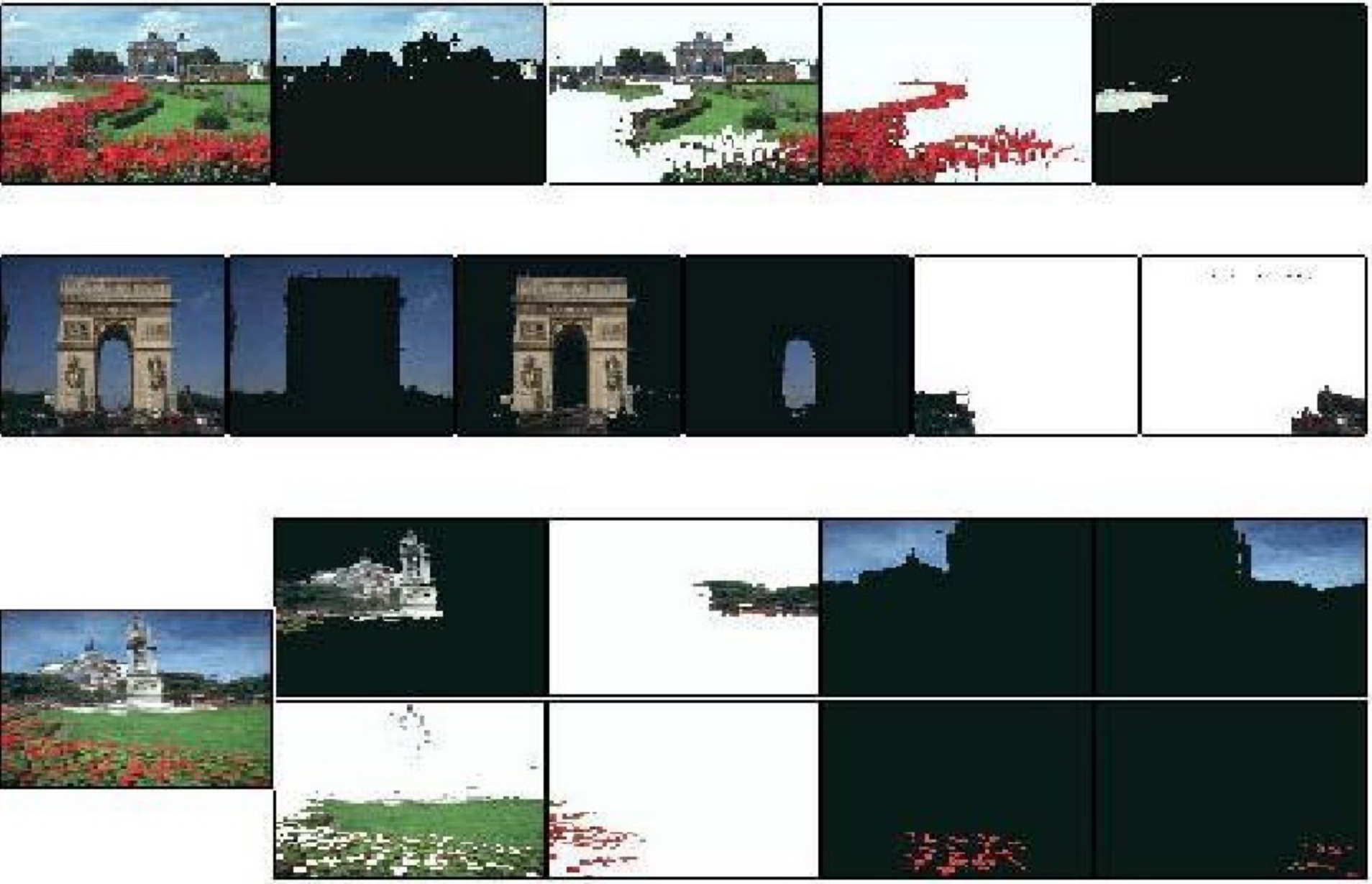


Radiometry/Shading





Segmentation



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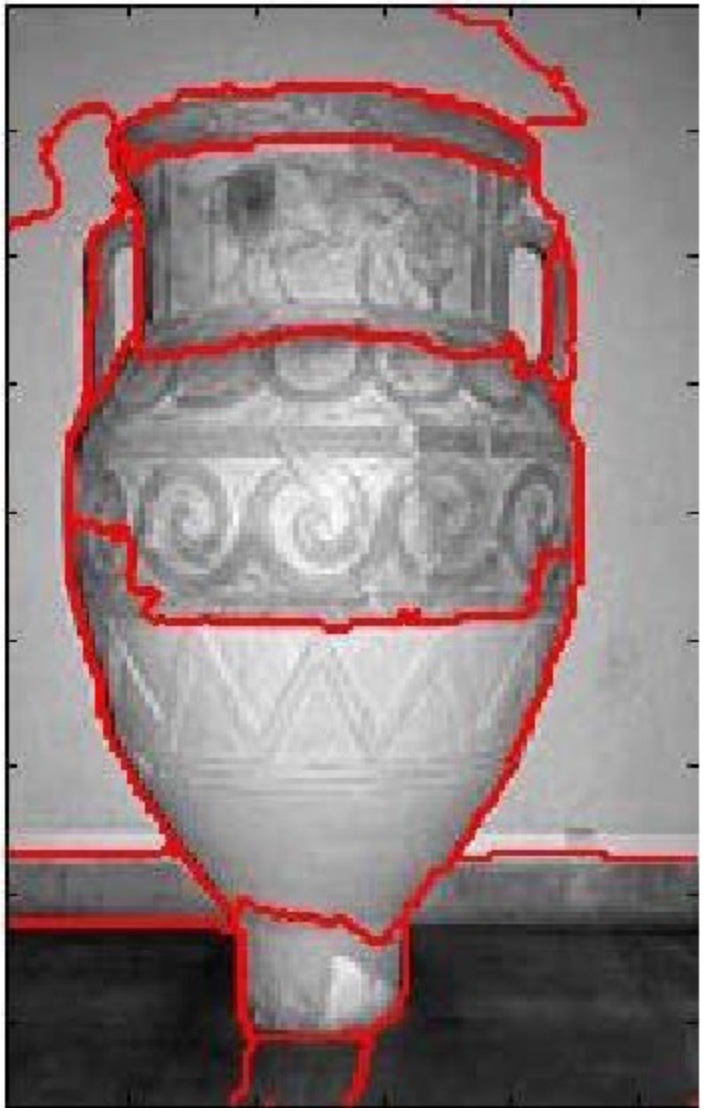
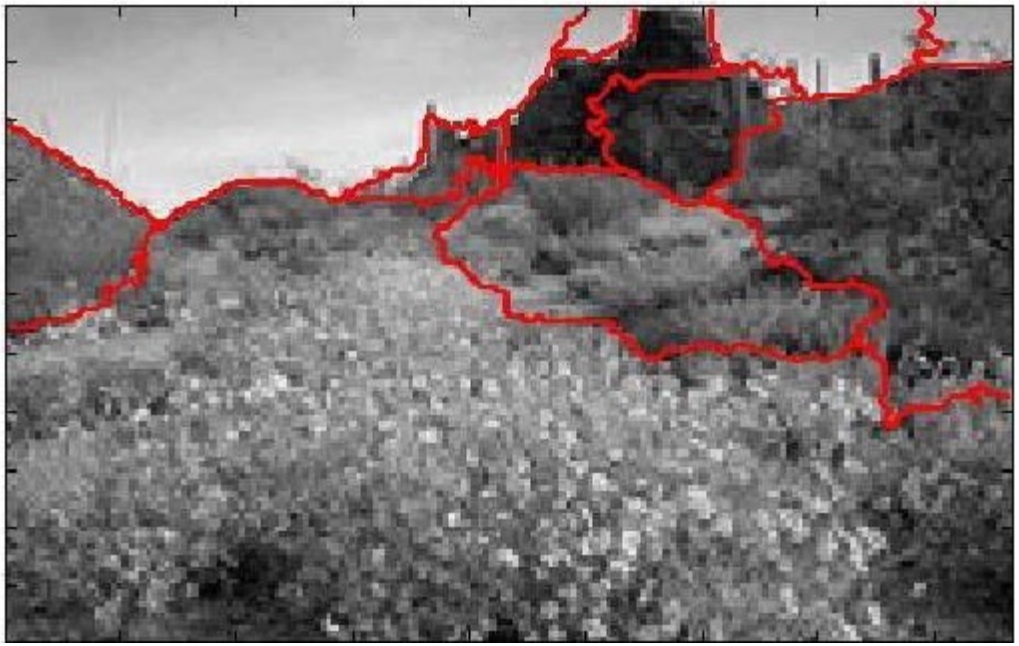
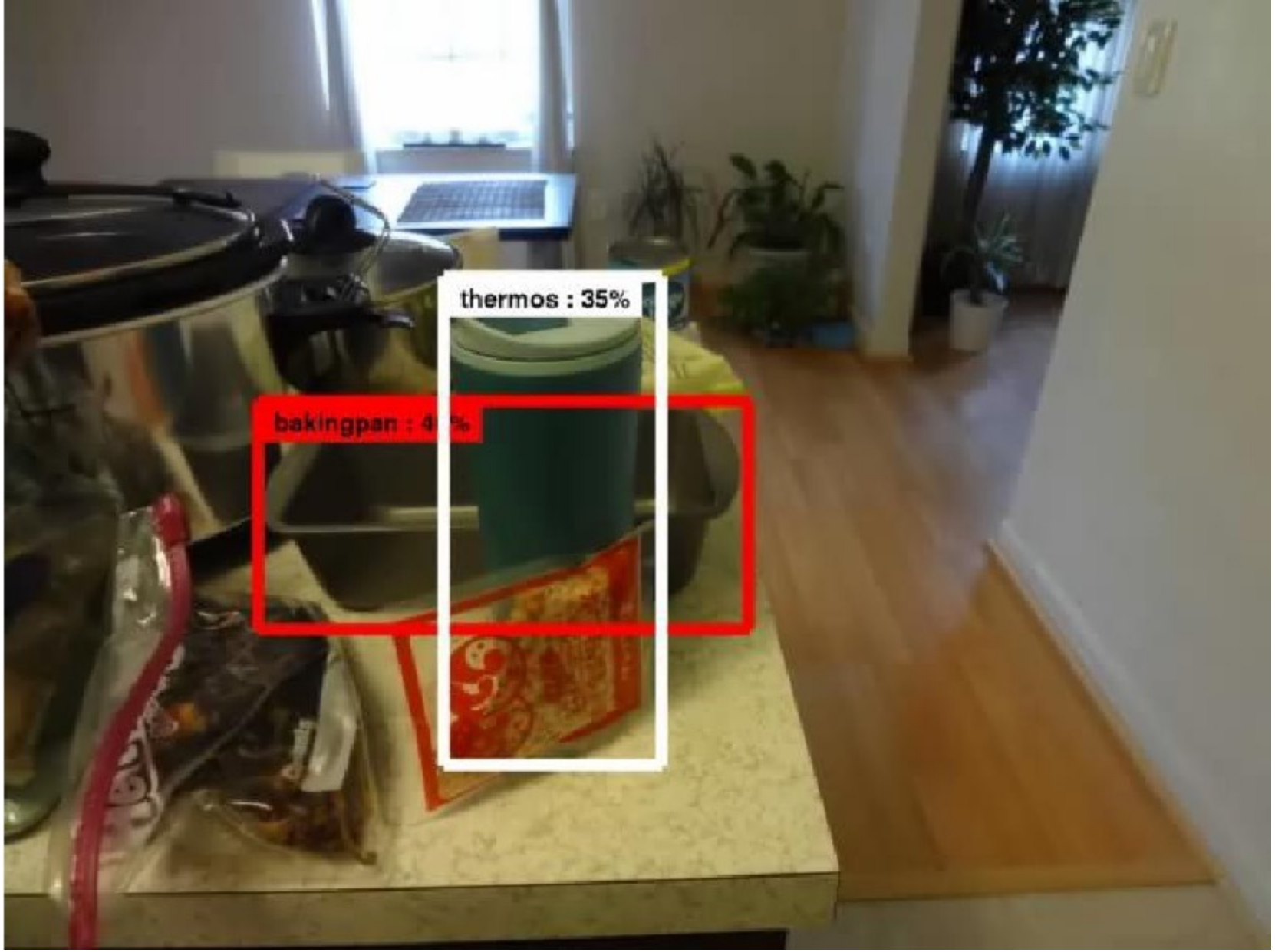


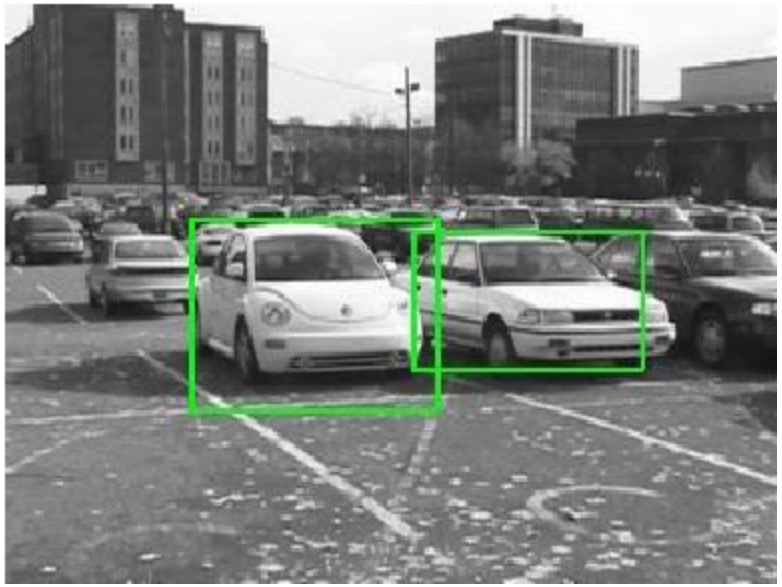


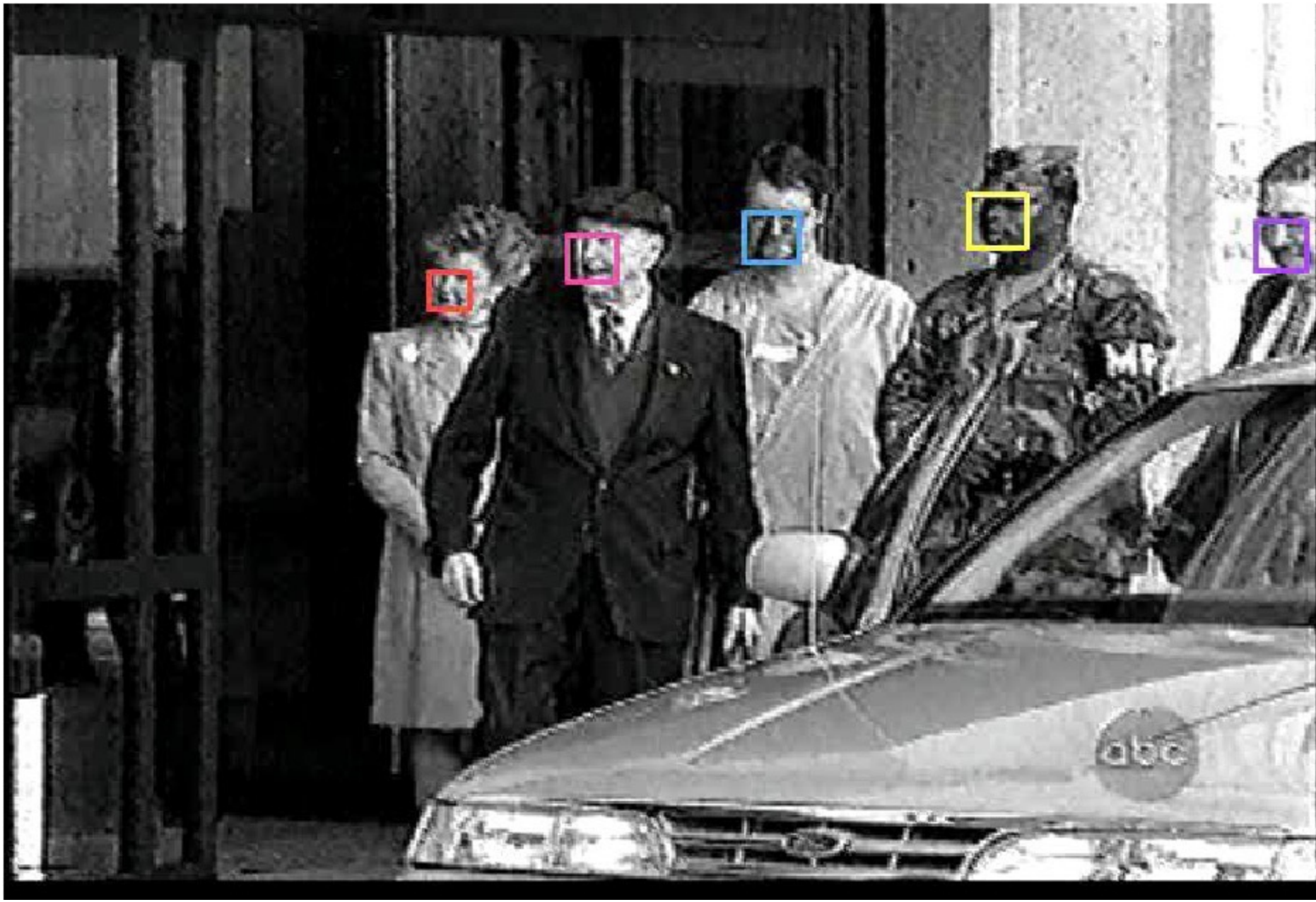
Recognizing objects and understanding scenes


thermos : 35%
bakingpan :

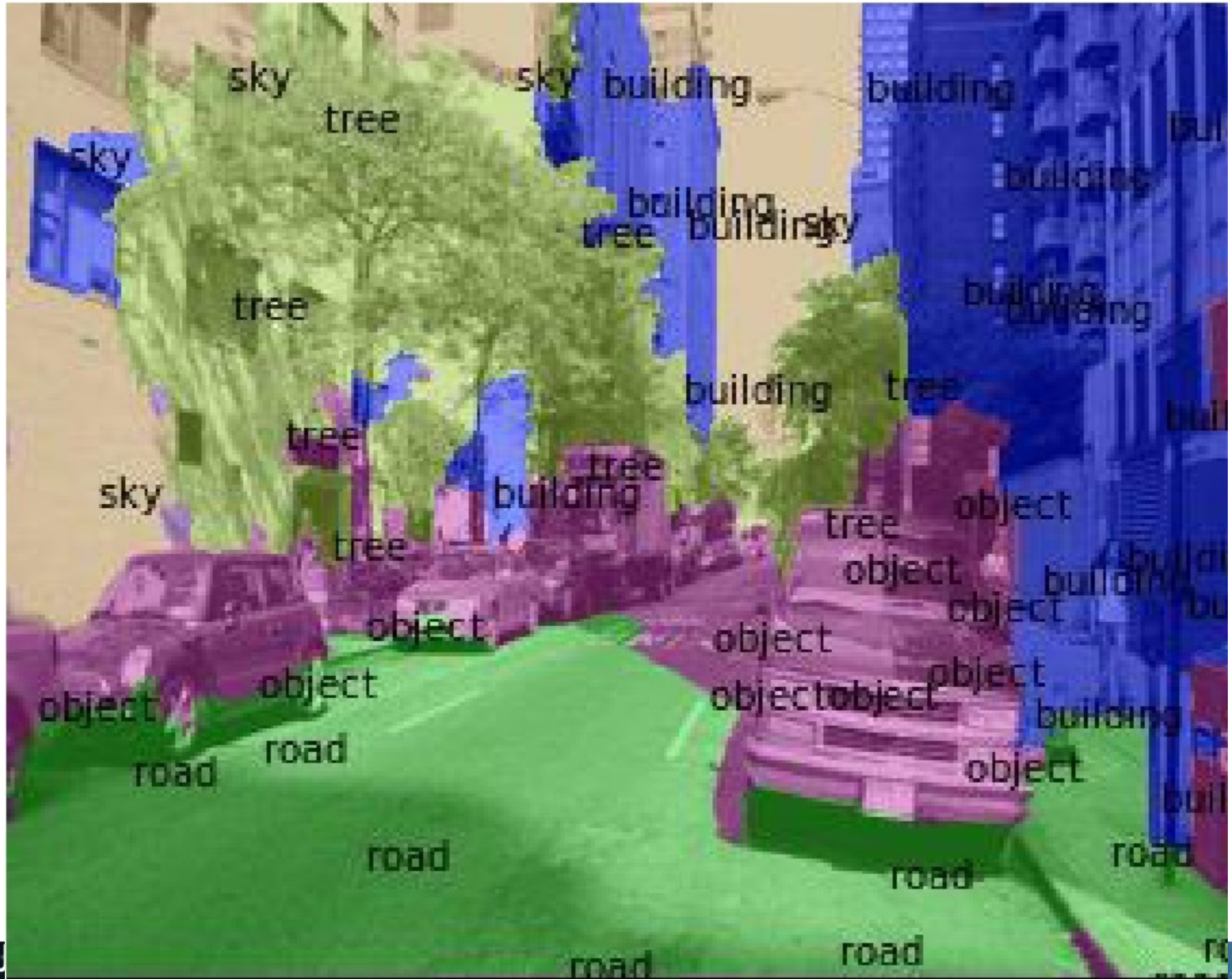
Recognition







abc

Tracking & Estimating motion


sky
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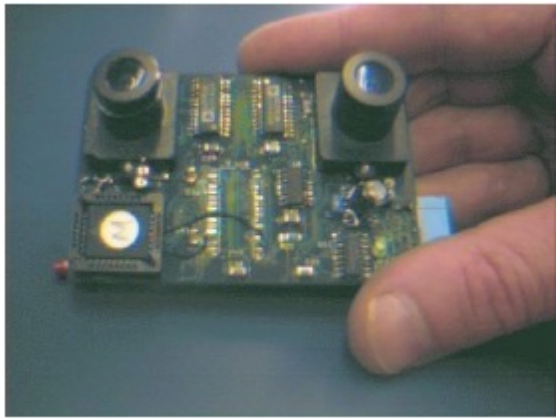
road

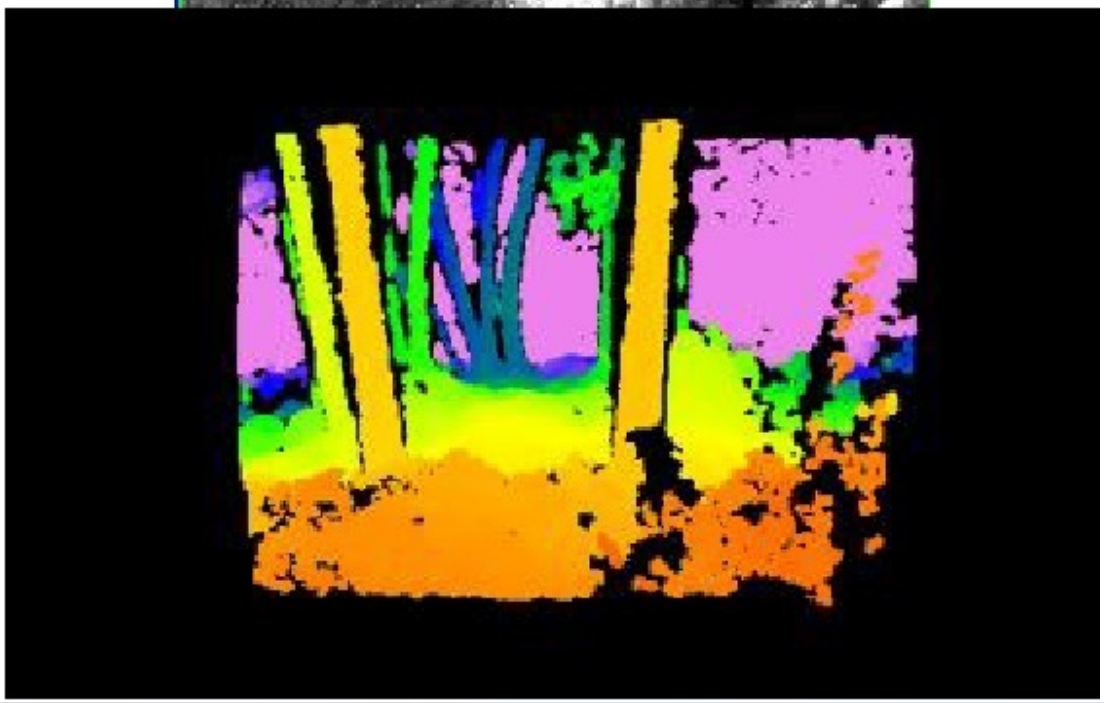
Motion

Reconstructing 3D

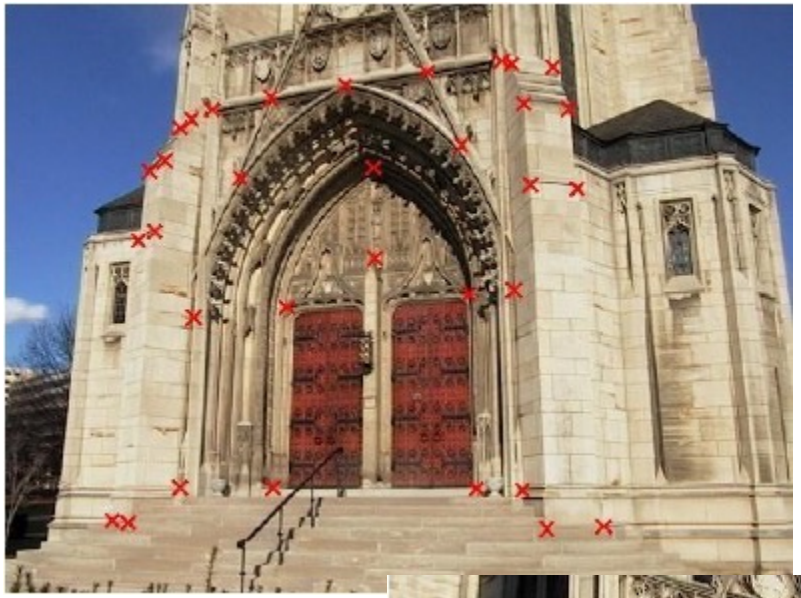
Multi-Camera Geometry: Stereo



Multi-Camera Geometry: Stereo



Multi-Camera Geometry





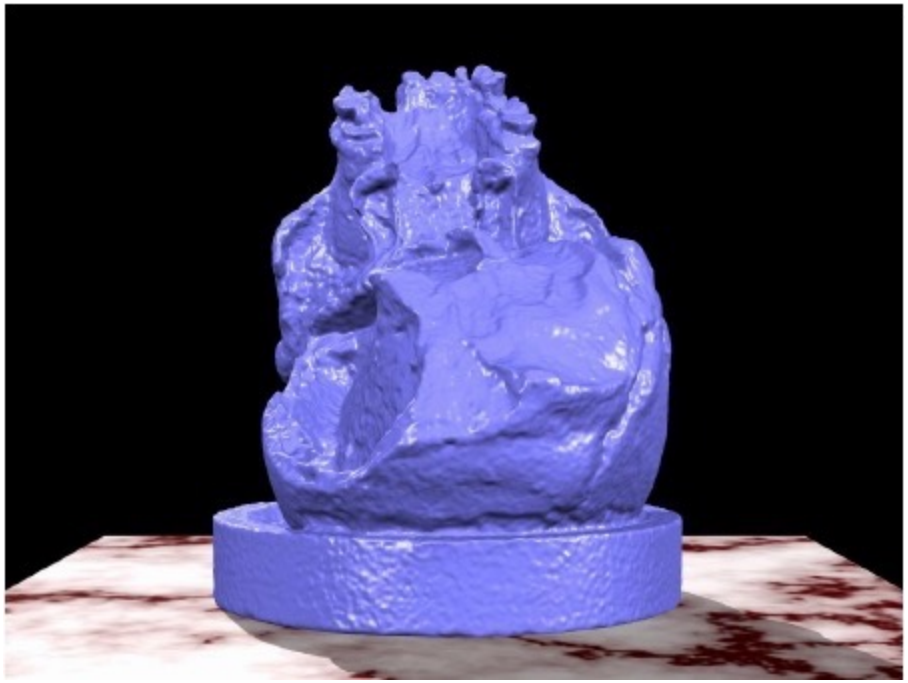


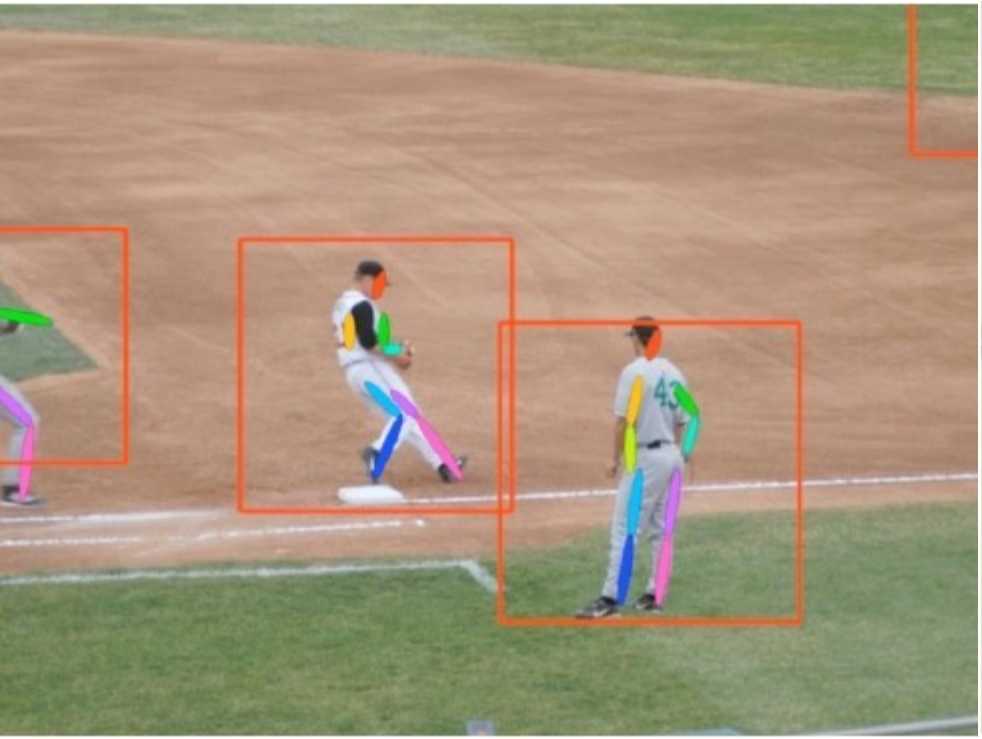






Understanding videos



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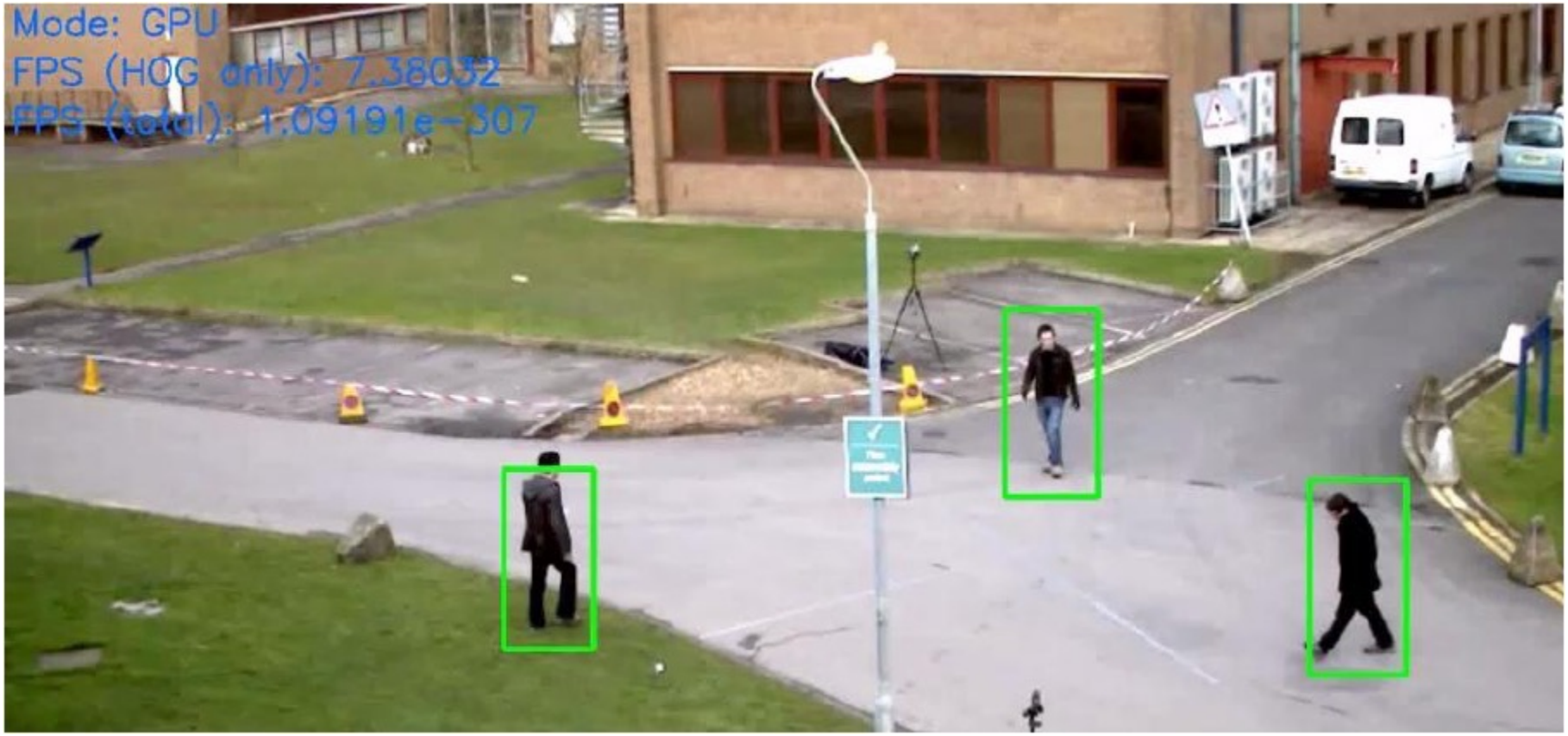
Mode: GPU
FPS (HOG only): 7.38032
FPS (total): 1.09191e-307

- Interested about applications? See:
  - http://www.cs.ubc.ca/spider/lowe/vision.html

If you stick with this class: Other "specialized"classes at CMU

- Physics-based methods
- Geometry-based methods
- High-level vision (Recognition, scene understanding…)
- Mid-level vision (Contours, grouping, segmentation)
- Pixels to Percepts: Human Visual Perception
- Vision Sensors
- Human motion modeling and analysis