Introduction to Computer Vision

1. Introduction

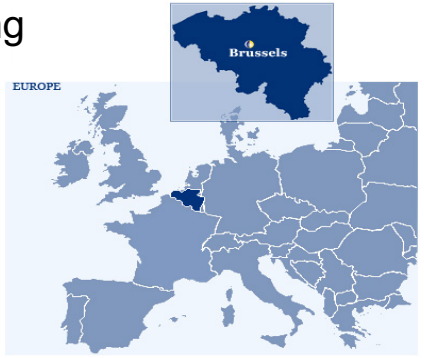
UCLA – CS 188.2 – Fall 2019
Profs. Fabien Scalzo, Stefano Soatto, Achuta Kadambi

Brief Bio

2008 - Ph.D. in Machine Learning – Computer Vision (Belgium)
2013 - Post-doc (UCLA, Neurosurgery - Neurology)
2015 - Assistant Professor of Neurology at UCLA
Joint appointment in Computer Science - Electrical and Computer Engineering

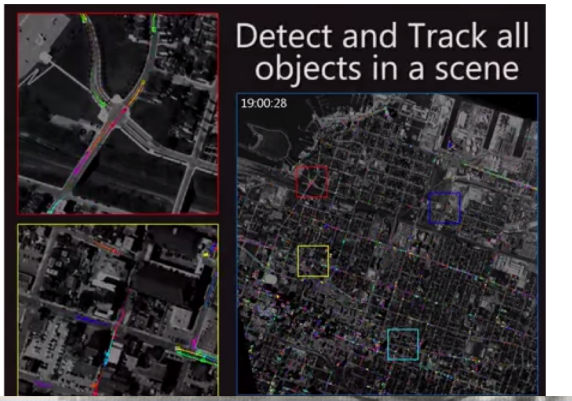


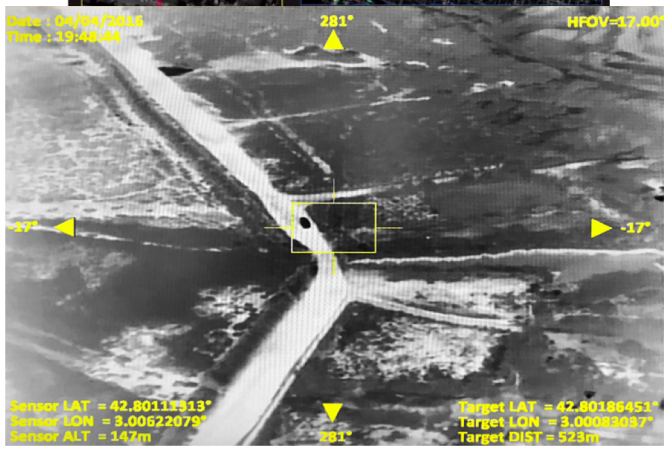






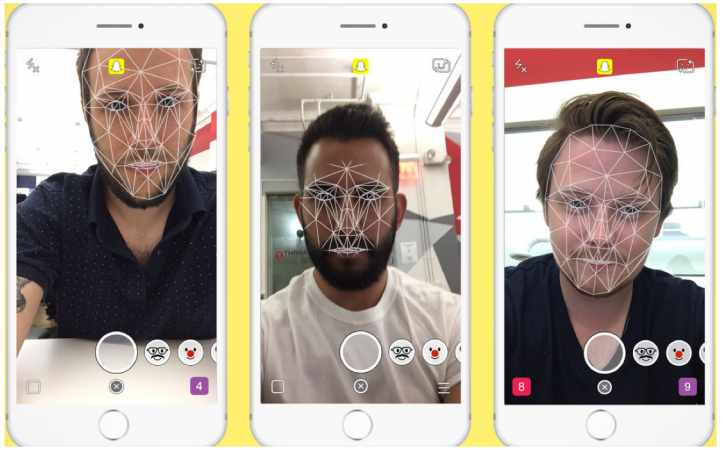

Computer Vision: Detect, Track, Reconstruct





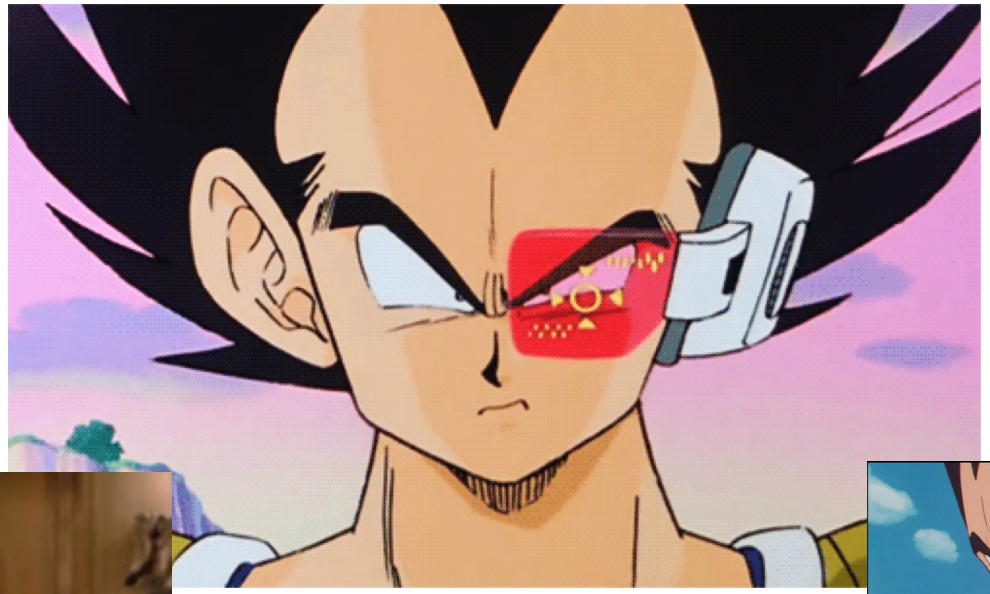

Normal - No Filter
Kelvin
Amaro
Rise
Hudson
X-pro II
Lomo-fi
Earlybird
Sutro
Toaster
Brannan
Inkwell
Walden
Hefe
Valencia
Nashville
1977
Instagram

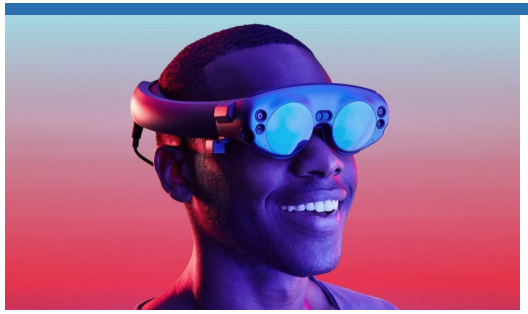
Aging

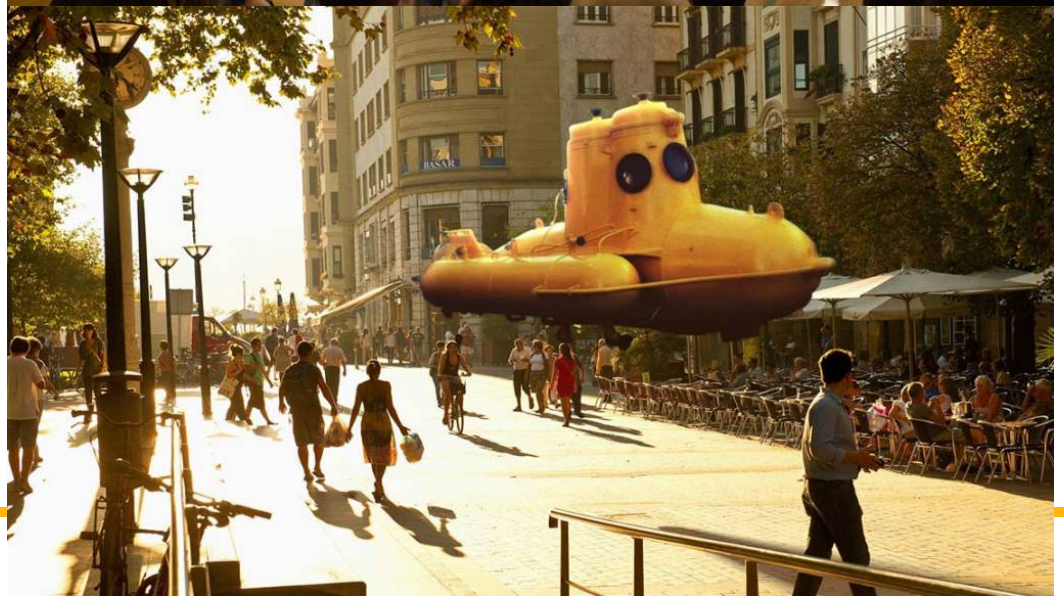


Sunface

The future is now

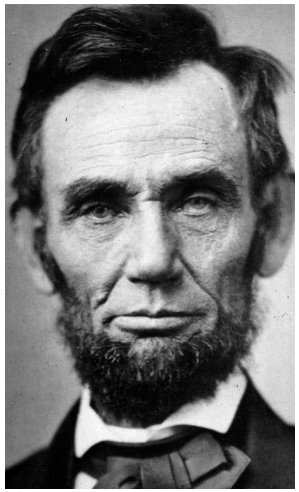


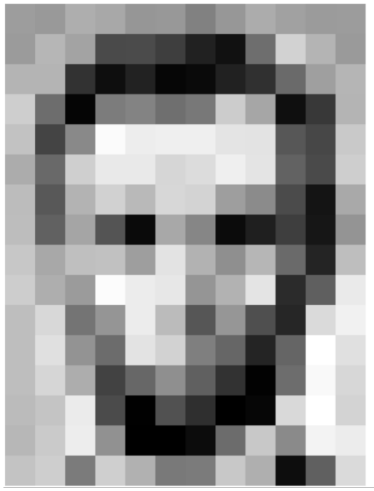





traffic light
traffic light
traffic light
traffic light
traffic light
bus
truck
car
car
truck
truck
car
person
handbag
person
person
person
person

Why is Computer Vision Hard?





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172	105	207	233	233	214	220	239	228	98	74	206
188	88	179	209	185	215	211	158	139	75	20	169
189	97	165	84	10	168	134	11	31	62	22	148
199	168	191	193	158	227	178	143	182	106	36	190
205	174	155	252	236	231	149	178	228	43	95	234
190	216	116	149	236	187	86	150	79	38	218	241
190	224	147	108	227	210	127	102	36	101	255	224
190	214	173	66	103	143	96	50	2	109	249	215
187	196	235	75	1	81	47	0	6	217	255	211
183	202	237	145	0	0	12	108	200	138	243	236
196	206	123	207	177	121	123	200	175	13	96	218

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155	182	163	74	75	62	33	17	110	210	180	154
180	180	50	14	34	6	10	33	48	106	159	181
206	109	5	124	131	111	120	204	166	15	56	180
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188	88	179	209	185	215	211	158	139	75	20	169
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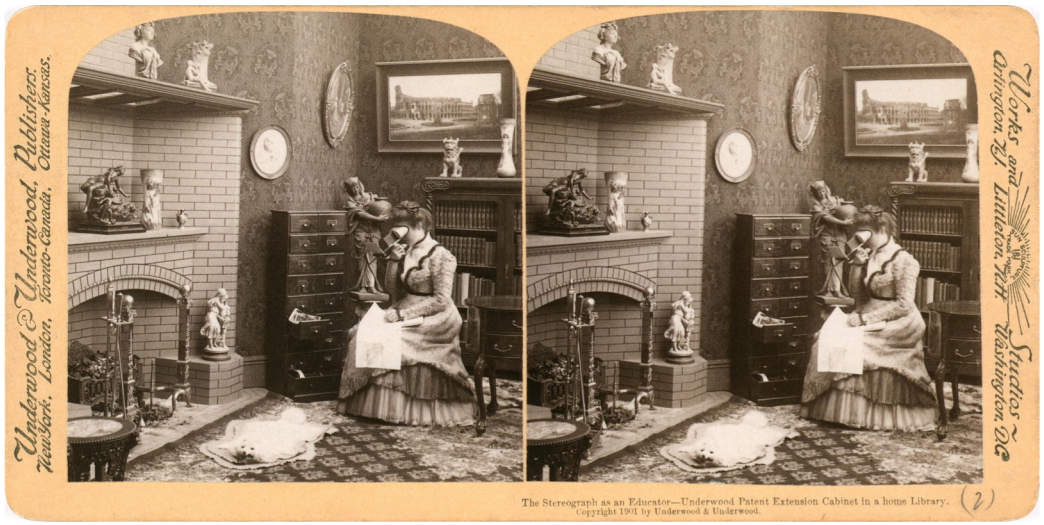
196	206	123	207	177	121	123	200	175	13	96	218

Brewster-type stereoscope, 1870

3D World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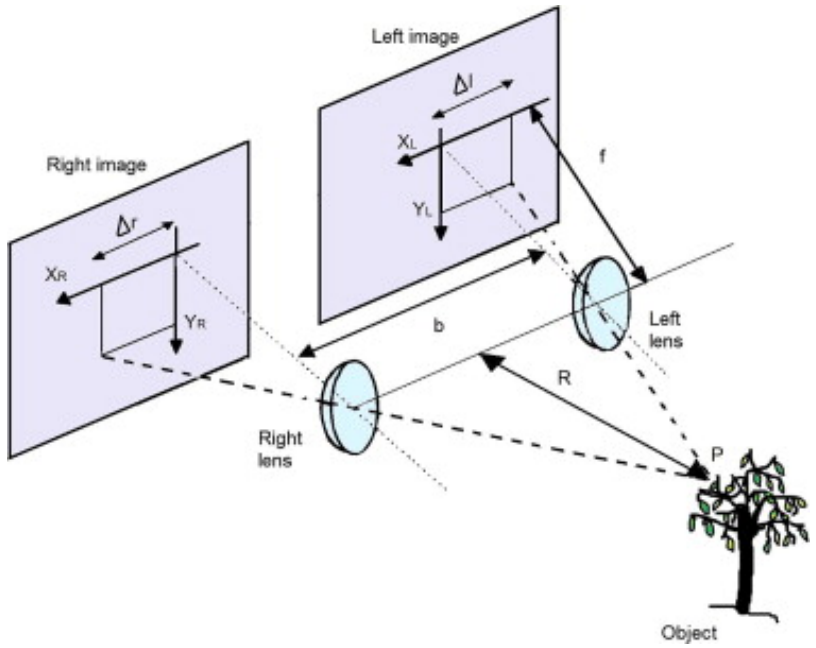
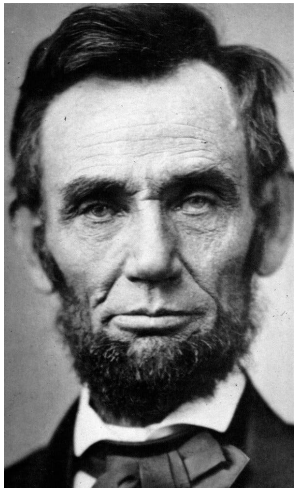
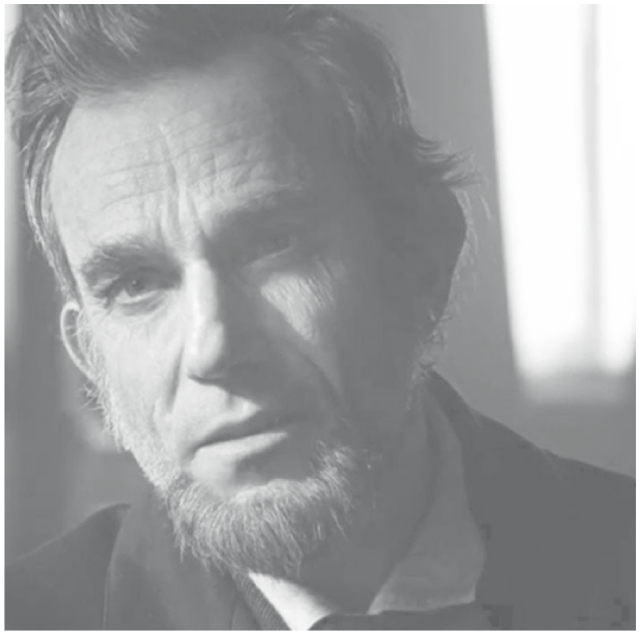

Left image
Δl
XL
YL
f
Right image
Δr
XR
YR
b
Left lens
R
Right lens
P
Object



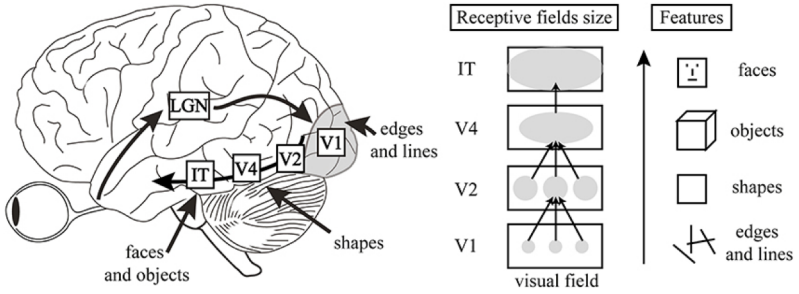

Jamie Foxx Ray Charles

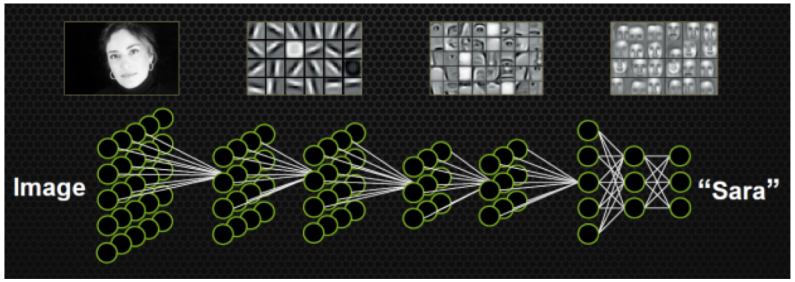

Downey Jr Charlie Chaplin


Stephen Hawking



Task-driven Visual Learner





Approach

- Focus on your Learning Experience
  - Build a knowledge foundation in Computer Vision
  - Get inspired
- Develop Problem Solving Skills
  - Acquire skills needed today in the real world
- Learn to work as a team and communicate

Schedule and Topics

- Signal Processing
- Physics Perspective
- Machine Learning
- Applications

Week 1			26-Sep	**Introduction**
Week 2	1-Oct	**Basic Image Processing**	3-Oct	**Feature Extraction and Classification**
Week 3	8-Oct	**Feature Tracking/Optical Flow**	10-Oct	**SVD, 2D camera model, projective plane**
Week 4	15-Oct	**2D Image transformations, RANSAC**	17-Oct	**Euclidean geometry, rigid body motion**
Week 5	22-Oct	**Epipolar Geometry**	24-Oct	**3D Cameras and processing**
Week 6	29-Oct	**Midterm**	31-Oct	**Statistical decision theory/Pattern Recognition**
Week 7	5-Nov	**Deep Learning**	7-Nov	**Deep Learning for Image Classification**
Week 8	12-Nov	**Object Detection**	14-Nov	**Generative models**
Week 9	19-Nov	**Medical Imaging**	21-Nov	**Autonomous Navigation**
Week 10	26-Nov	**Guest Lecture (Nikhil Naik)**	28-Nov	
Week 11	3-Dec	**Recursive 3D reconstruction and pose estimation**	5-Dec	**Recap**
Week 12	10-Dec		12-Dec	**Final**

Lecture 2: Basic Image processing: Convolution, filtering, smoothing, Gaussian and Laplacian pyramids, edge detection.

Lecture 3: Local features, scale-space, SIFT, introduction to basic classification.

Lecture 4: Feature tracking, optical flow.

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Lecture 5: Singular value decomposition, 2D cameras, pinhole camera and the projective plane.

Lecture 6: 2D image transformations, panoramas, RANSAC.

Lecture 7: Euclidean geometry, rigid body motion.

Lecture 8: Epipolar geometry, sparse 3D reconstruction.

Lecture 9: 3D cameras and processing - stereo and structured light. 3D Registration and ICP.

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Lecture 11: Basics of statistical decision theory and pattern recognition. Linear classification. Risk, loss, regularization

Lecture 12: Introduction to Deep Learning: Convolutional Neural Networks, auto-encoding, Stochastic Gradient Descent.

Lecture 13: Deep Learning continued, Large-scale Image Classification.

Lecture 14: Object Detection: SSD, Yolo. Semantic Segmentation.

Lecture 15: Generative models. Encoder-decoder architectures, GANs.

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Lecture 16: Applications I – Deep Learning for Medical Imaging.

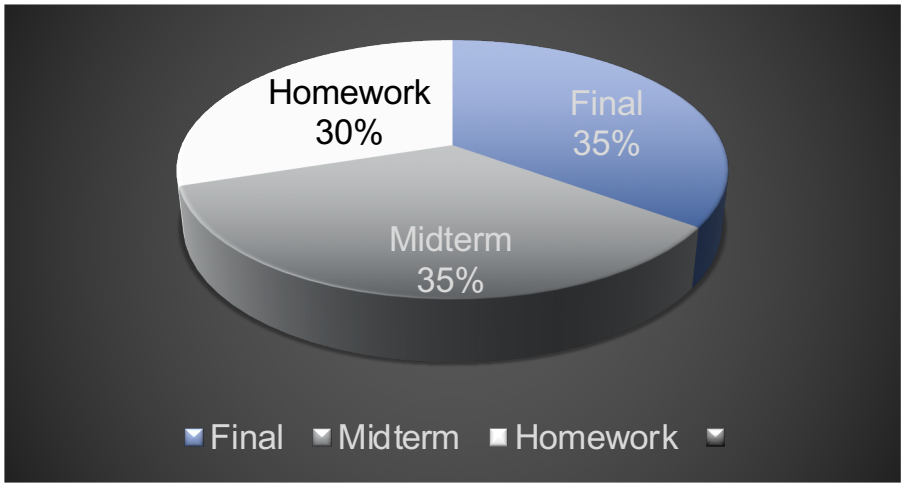
Lecture 17: Applications II – Autonomous Navigation (self-driving cars, mobile robots).

Lecture 18: Guest Lecture by Dr. Nikhil Naik.

Lecture 19: Recursive 3D reconstruction and pose estimation, AR/VR.

Grading

- ***Midterm****(35%)*
- ***Final*** *(35%)*
- ***Homework*** *(30%)*



Organization

- Assistants
  - Ali Hatamizadeh (ahatamiz@ucla.edu), Albert Zhao (azzhao@cs.ucla.edu), Nikita Sivakumar (nikita3096@g.ucla.edu), Alexandre Tiard (tiard@cs.ucla.edu)
- Questions
  - Homework, midterm, final, discussions: contact Assistants
  - Otherwise, contact us: fab@cs.ucla.edu
- Home page
  - https://ccle.ucla.edu/course/view/19F-COMSCI188-2
- PTE
  - Send request to assistant with current status and UID.

Knowledge of Python is recommended,
Linear algebra is required,

Thirst for knowledge is necessary.