Computer Vision

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Course: 911.908 / 911.909, Winter term 2017/2018

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Schedule for today's class

- **Logistics** (grading, resources, etc.)
- **What is computer vision?**
- **Questions?**

Logistics

A little bit about myself

Dipl.-Ing., University of Salzburg, 2007

Dr. techn., University of Salzburg, 2010

Post-Doc, University of Salzburg, 2010 - 2011

R&D Engineer, Kitware Inc., NC, USA, 2011 - 2013

Ass.-Prof., University of Salzburg, Nov. 2013 – Aug. 2017

Assoc.-Prof., University of Salzburg, Aug. 2017– now

Research Interests:

- Computer vision (mostly recognition topics)
- Machine learning
- Medical computer vision

Logistics

General information

- **E-Mail:** rkwitt [at] gmx [dot] at (or Roland.Kwitt [at] sbg [dot] ac [dot] at
- **Slides**: available online at http://rkwitt.org (→ Teaching)

Logistics

Grading (2 VO + 1 PS)

[VO] **1 final exam** at the end of the course (typically in the last lecture)

[PS] Small projects + Paper reading / discussion

Note: It's possible to work in **groups of 3**

Logistics

”Proseminar (PS)” – Some useful software packages

OpenCV (use the Python bindings)

http://opencv.org

scikits-learn (Python)

http://scikit-learn.org/stable/

scikit-image (Python)

http://scikit-image.org

PyTorch (Python)

http://pytorch.org

Logistics

Reading material

I will, in general, provide references for all topics but

R. Szeliski**, "Computer Vision: Algorithms and Applications",**
Springer 2010 (online at: http://szeliski.org/Book)

is one of the standard (possibly slightly outdated) textbooks in the field.
I'll refer to this book as "Szeliski's book" in most of my slides.

Logistics

Acknowledgements

Many slides/figures are originally from

- James Hayes (http://cs.brown.edu/people/hays/),
- Derek Hoeim (http://web.engr.illinois.edu/~dhoiem/),
- Antonio Torralba (http://web.mit.edu/torralba/www/),
- Kristen Grauman (http://www.cs.utexas.edu/~grauman/),
- and others (listed on slides)!

What is computer vision?

… and why is it such a difficult problem ?

Courtesy of Szeliski

(Luiz Gomez Photos)

The **human visual system (HVS)** is remarkably good at so many tasks, e.g.,

- detecting people & object's,
- perceiving translucency, shape, color (see Fig. on the left),
- counting people & vehicles,
- recognizing scenes, etc.

A substantial fraction of the macaque's total cortical area is devoted to vision (approx. 15% according to [Hubel, "Eye, Brain and Vision"])

What is computer vision?

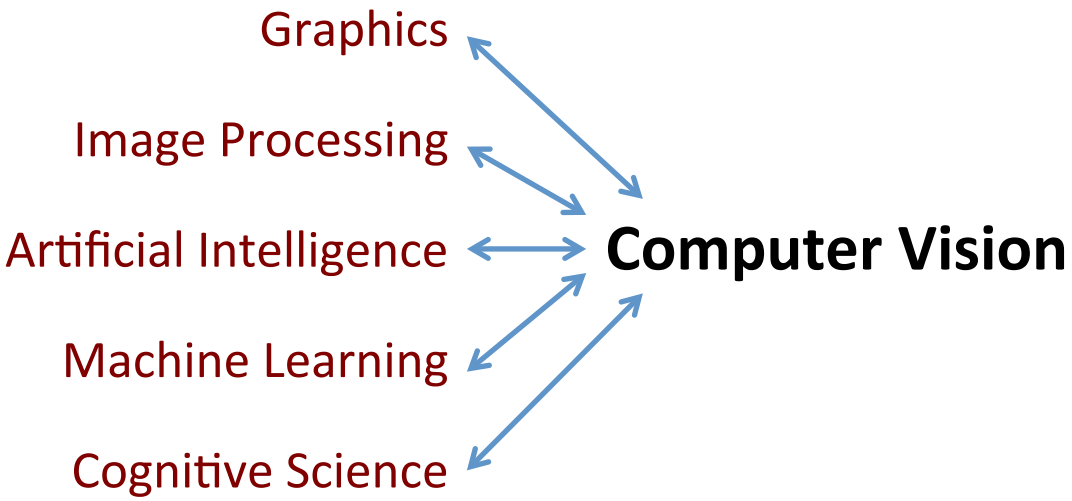
… and why is it such a difficult problem ?

We want to build systems for **automatic understanding of images and videos**. This includes, but is not limited to,

1) inferring properties of the 3D world **(measurement)**

2) enabling recognition of objects, people, scenes, etc. **(perception)**

3) mining, searching and interacting with visual data **(search / organization)**

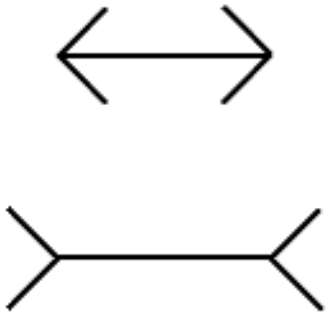


Slide adapted from Kristen Grauman, "Introduction to Computer Vision"

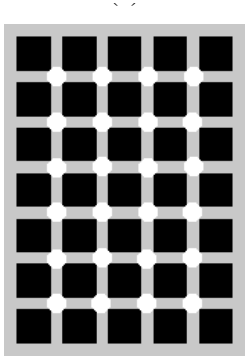
What is computer vision?

Dealing with inverse problems

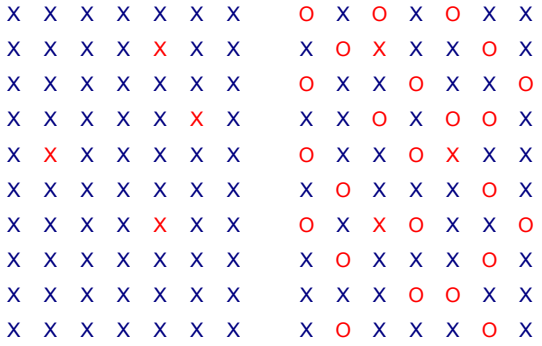
We still don't fully understand how the HVS works! Optical illusions are used to tease apart some of its principles …



Mueller-Leyr illusion



Hermann grid illusion
(courtesy of Hany Farid)

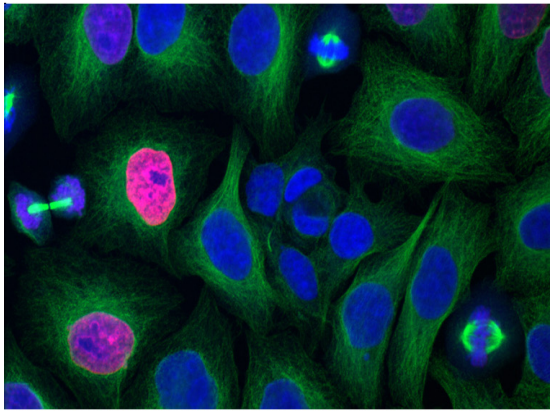


Pop-out effect

In computer vision, we try to recover unknowns from insufficient information → these are **inherently inverse** problems!

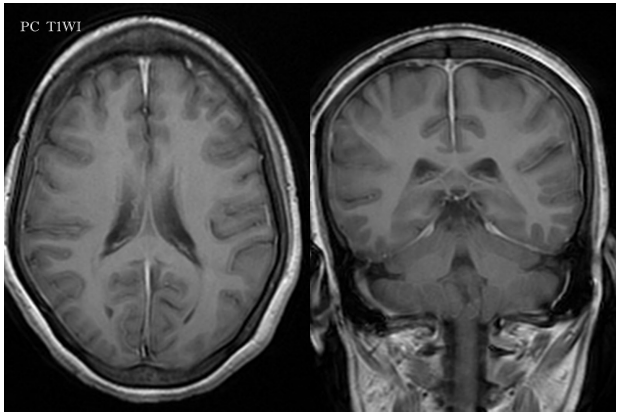
Why computer vision matters?

Bio-Imaging



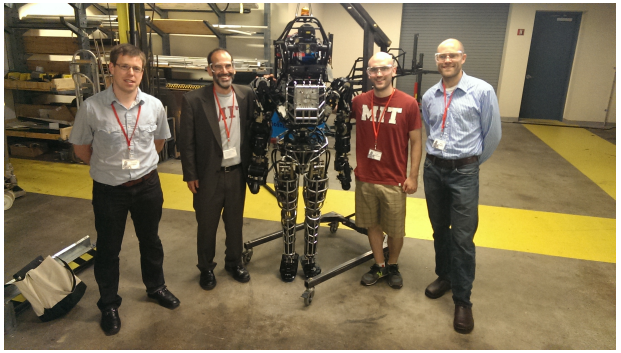
Surveillance

Medical Imaging



Autonomous Cars

Mapping



Robotics

Picasa™ flickr™

Social Media

What is computer vision?

Overview of the field: important conferences & journals

Conferences

Computer Vision

- Computer Vision and Pattern Recognition (CVPR)
- International Conference on Computer Vision (ICCV)
- European Conference on Computer Vision (ECCV)
- British Machine Vision Conference (BMVC)

Machine learning

- Neural Information Processing Systems (NIPS)
- International Conference on Machine Learning (ICML)

Journals

- IEEE Pattern Analysis and Machine Intelligence (PAMI)
- International Journal on Computer Vision (IJCV)
- IEEE Transactions on Image Processing (TIP)

Relevance of Computer Vision

	Publication	h5-index	h5-median
1.	Advanced Materials	201	301
2.	Nano Letters	192	270
3.	Energy & Environmental Science	184	254
4.	ACS Nano	180	243
5.	Nature Materials	171	285
6.	Nature Nanotechnology	154	244
7.	Journal of Materials Chemistry	141	176
8.	**IEEE Conference on Computer Vision and Pattern Recognition, CVPR**	**140**	**214**
9.	Nature Photonics	138	231
10.	Advanced Functional Materials	125	183
11.	Renewable and Sustainable Energy Reviews	124	175
12.	The Journal of Physical Chemistry C	124	157
13.	Nanoscale	120	171
14.	**IEEE Transactions on Pattern Analysis and Machine Intelligence**	**114**	**200**
15.	Chemistry of Materials	113	160
16.	Bioresource Technology	113	146
17.	IEEE Transactions on Industrial Electronics	111	176
18.	Journal of Power Sources	107	144
19.	IEEE Transactions on Power Electronics	107	135
20.	Advanced Energy Materials	106	158

This is a snapshot (as of Oct. 2016) taken from Google Scholar in ALL of Computer Science & Engineering!

Some interesting resources …

- Browse D. H. Hubel's online book (Nobel prize winner, 1981)
  http://hubel.med.harvard.edu/book/bcontex.htm
- Read one of his and Torsten Wiesel's seminal papers:

D. H. Hubel and T. N. Wiesel, *Receptive Fields and Functional Architecture of Monkey Striate Cortex*, J. Physiol., 1968
(Online: http://www.ncbi.nlm.nih.gov/pubmed/4966457)