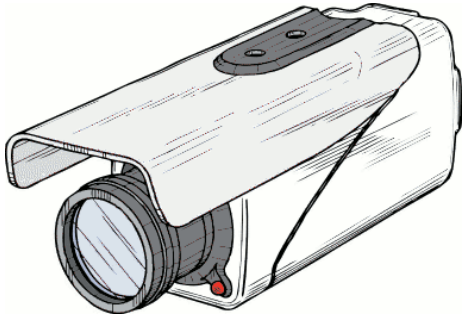
Univerza v Ljubljani

ViCOS visual cognitive systems lab

Machine perception
Introduction



Matej Kristan

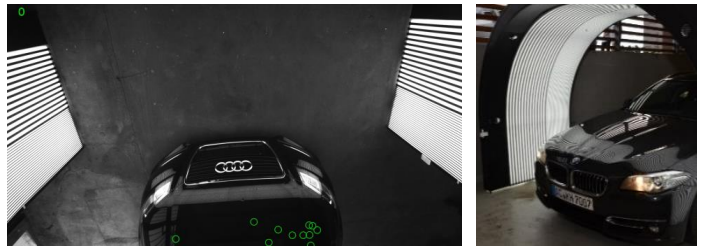
Laboratorij za Umetne Vizualne Spoznavne Sisteme,
Fakulteta za računalništvo in informatiko,
Univerza v Ljubljani

About the lecturer

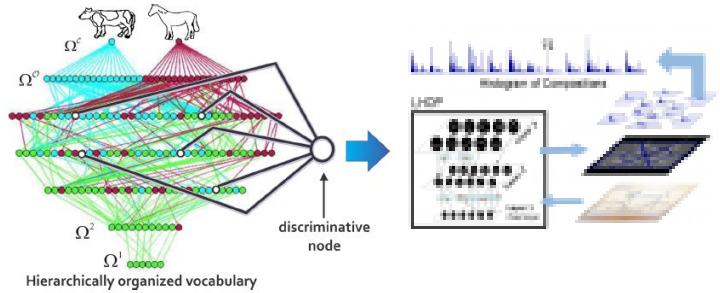
- Name: Matej Kristan
- Where to find me: 2nd floor, ViCoS
  (not in office, in the lab most of time)

- Online contacts and resources:
  - www.vicos.fri.uni-lj.si/matejk
  - ResearchGate
  - Google Scholar
  - eclassroom (https://ucilnica.fri.uni-lj.si/)
  - mail:matej.kristan@fri.uni-lj.si

1. Industrial vision

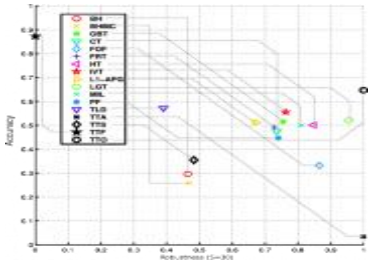


2. Deep structured models



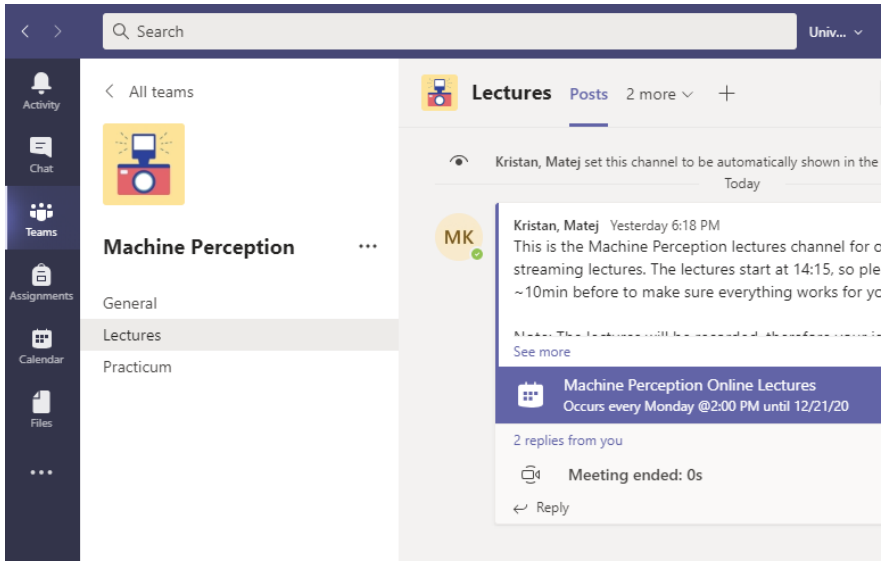
3. Robotic vision

4. Visual object tracking



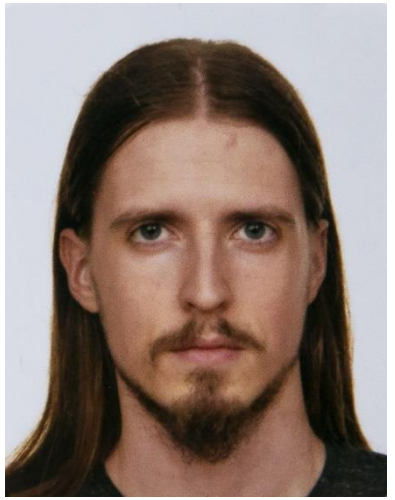
Lectures regime

- Lectures will be in-person in class
- If we go fully online, the lectures will be streamed via MS Teams (Machine Perception channel)
- I've added you to the Teams – Machine Perception channel.
- If you feel unwell, don't attend the physical lecture. Last years recordings will be available on Streams (not exact copy of this year's).
  - Will be made available upon request



Practicum (2-week long guided projects)

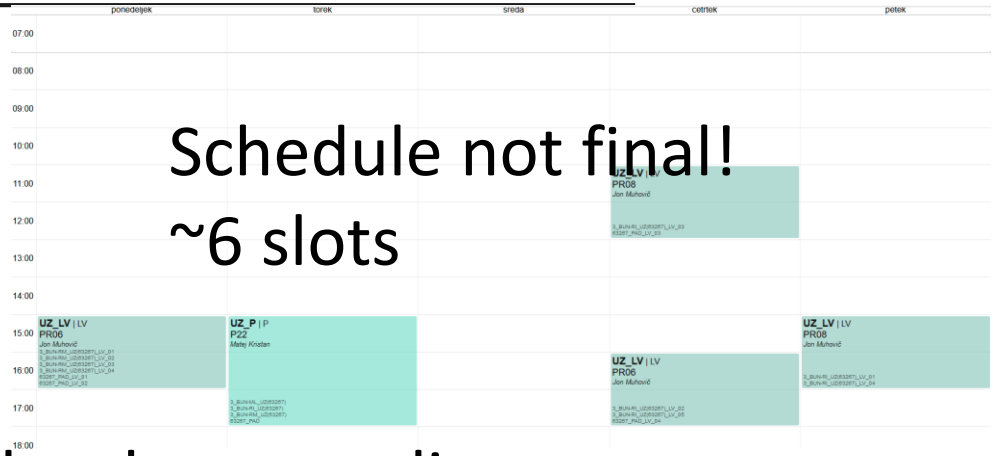
- Guided by:
  - mag. Jon Natanel Muhovič *(jon.muhovic@fri.uni-lj.si)*
  - *Marko Rus*
- Practice the theory covered in lectures
- Mostly implementation-oriented
  - *Result is a working source code (Python)*
- Two-week assignments:
  - 1 week consultation (bug the assistants!!)
  - 1 week defense (have to defend in your assigned slot!)
- Practicum starts in the week 11.10. - 15.10.



Start planned:
2nd week Details at the lab.

Lab regime

- The lab will take place in person & online



Schedule not final!
~6 slots

- To cater to those who would like to attend the assignments online, we will set some of the slots to online.

- At break: go to the e-classroom and fill out the pole about online/in-person preferences

Written exam info in case the exam is online: *[exam date: tba]*

- Installation guideline and exam protocol (read carefully!)
- The current exam Key *(available ~30min before the exam ; CAUTION -- write it down on a piece of paper, and do not leave exam.net upon entering the key)*: tba
- Zoom link for the exam (open in your smart phone): tba

Announcements

Questionaire about online/physical attendance of assignments

Requirements of the course

1. Practicum (programming assignments) > 50% each assignment evaluated during the semester (deadlines!)

2. Written exam > 50%

   Cannot access the written exam without passing the lab.

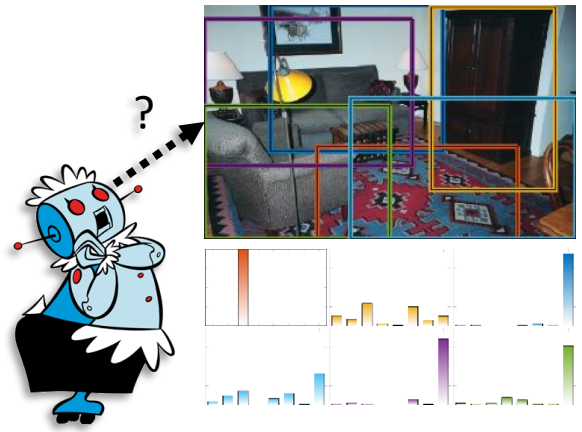
   Content: lab assignments + lectures

3. Oral exam:

   Not necessary if written >X%

   (Will depend on class attendance and progress at assignments)

Machine perception examples – fast-forward



Place category recognition for service robots

Uršič, Mandeljc, Skočaj, Leonardis, Kristan, IJRR 2017;
Uršič, Leonardis, Skočaj, Kristan, ICRA 2016 ;
Uršič, Mandeljc, Leonardis, Kristan, ICRA 2016;
Uršič, Tabernik, Boben, Skočaj, Leonardis, Kristan, IJRAS 2013

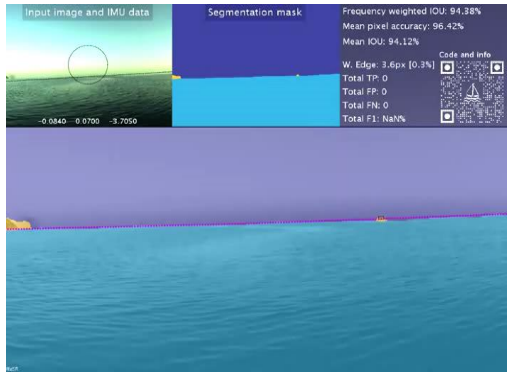
Drones

Lukežič, Muhovič, Strgar, Čehovin, Kristan 2015

Moving cameras

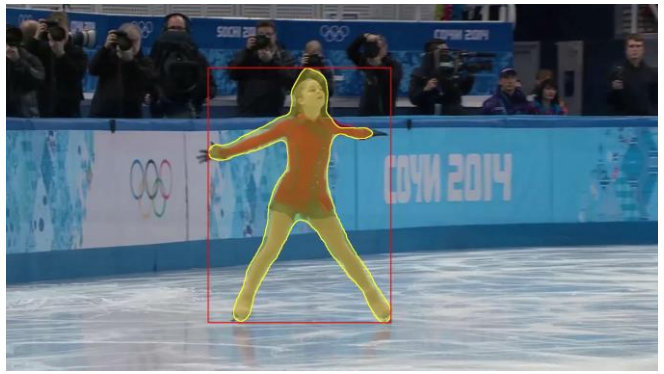
Čehovin, Leonardis, Kristan WACV 2016, PAMI2013

Boats



Bovcon et al., ICRA2020

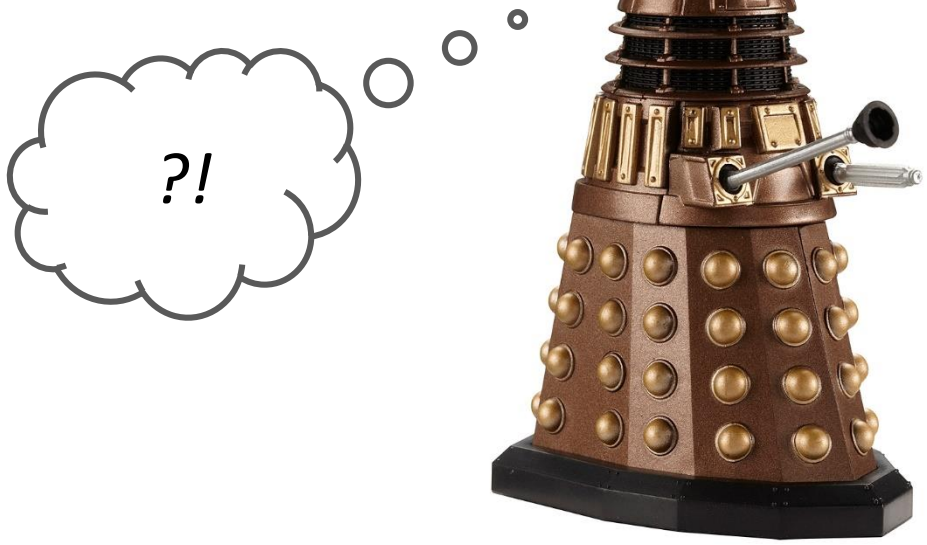
General purpose tracking

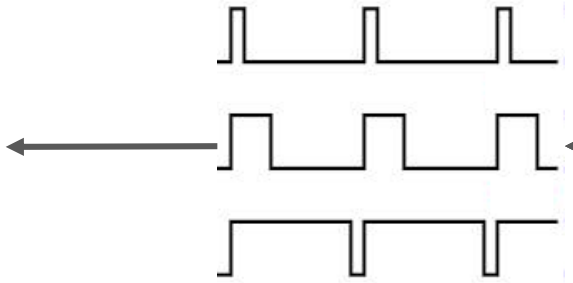


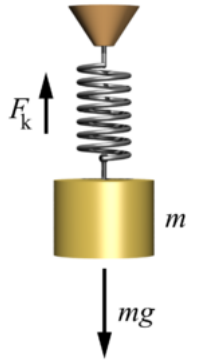
Lukežič, Matas, Kristan, CVPR2020

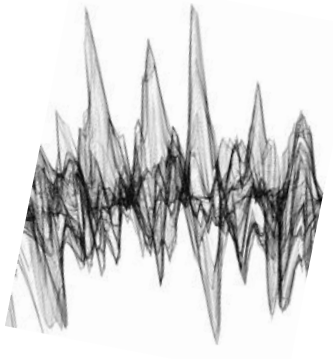
What is machine perception about?

- Building machines that perceive their environment
- Digitalize environment through sensors
- Image of light, ultrasound, force field, etc.
- Perception through images: Computer vision









Development of Computer Vision

- Origins: 1950-1965 as side project at MIT:

  "...building perceiving machines would take about a decade..."

- Development paced by hardware development (numerical maths)

First multipurpose comps
(UNIVAC ~1951)

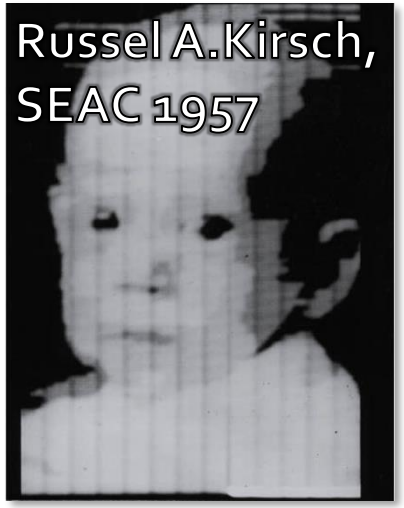


Image digitization

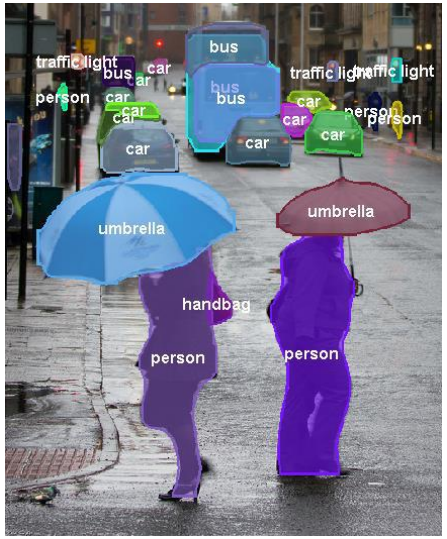
~50 years

Embedded computers
(ARM ~2001)

Face detection

~15 years

Graphic processing units
(GPU ~2016)

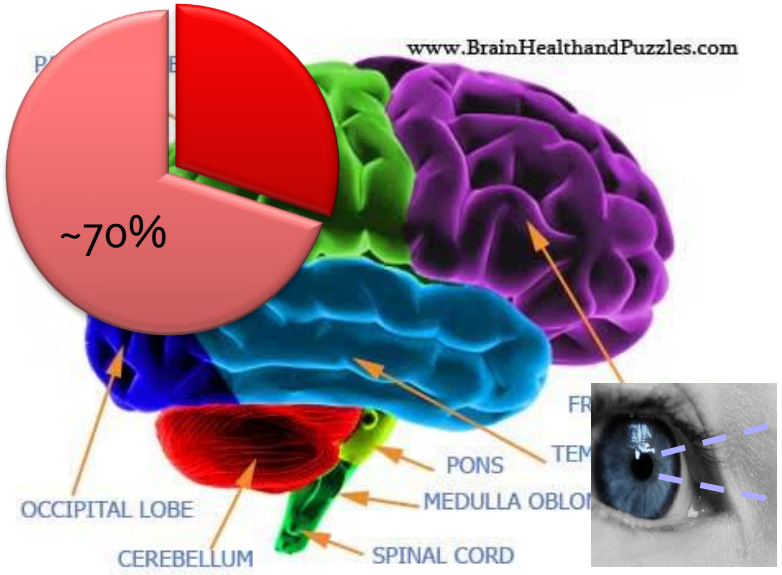


Instance segmentation

Human vs. Computer vision

- Much harder than it looks…
- Neuroscience: >50% brain dedicated to vision*

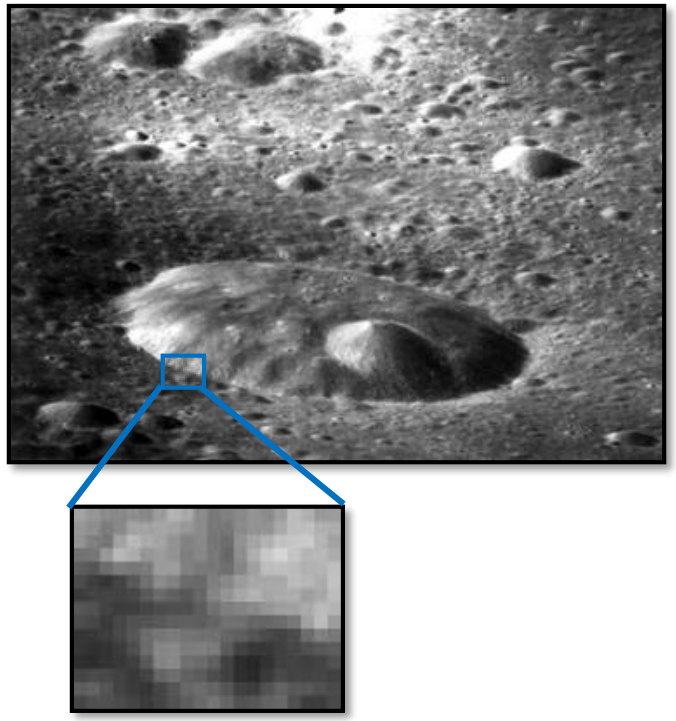
*Prof. Cornelia Fermueller ,University of Maryland in College Park



Human vs. Computer vision

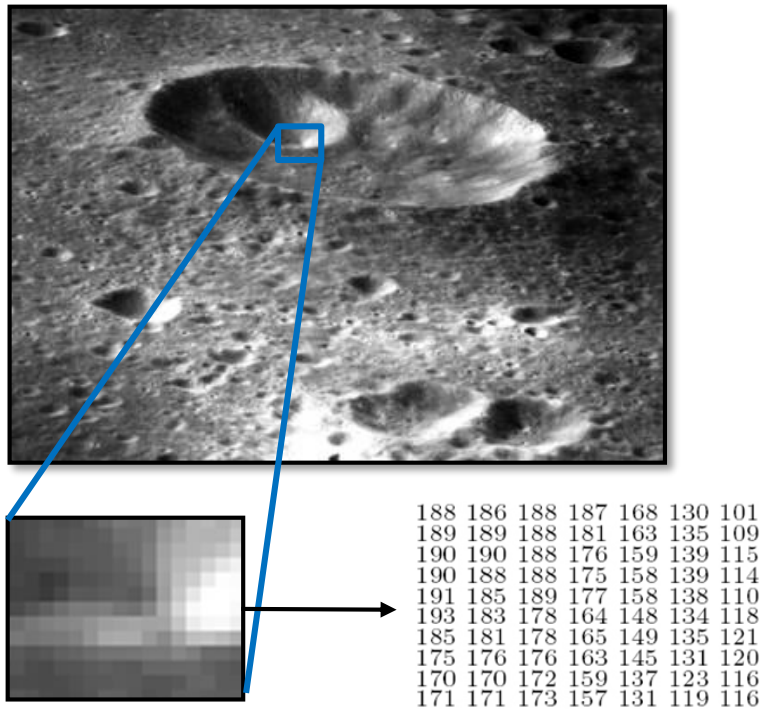
- Much harder than it looks…
- Neuroscience: >50% brain dedicated to vision
- Humans apply experience (prior knowledge)

What do you see?



The CV “tools”:
Algebra, Analysis
Statistics
Signal processing
Machine learning
Algorithms
…

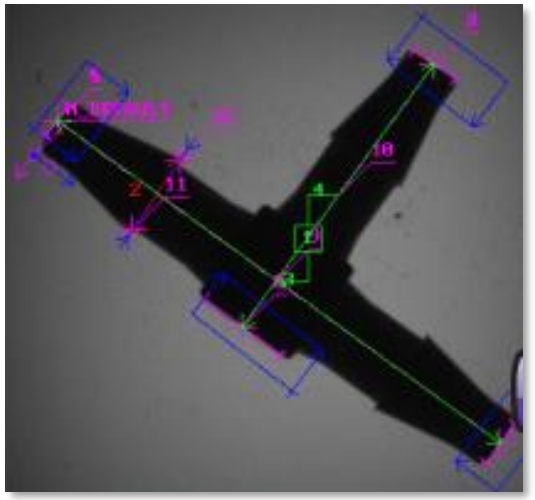
What do you see?



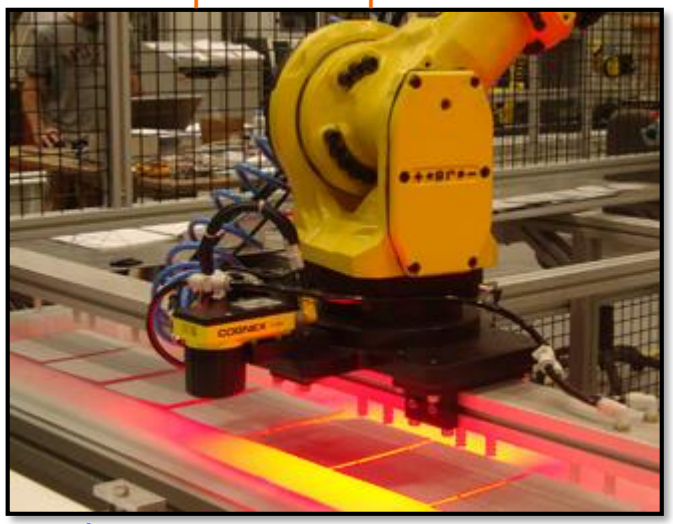
Modern industrial applications

Industrial applications CONTROL THE SETUP.

Smart cameras http://www.matrox.com



Solar panel inspection



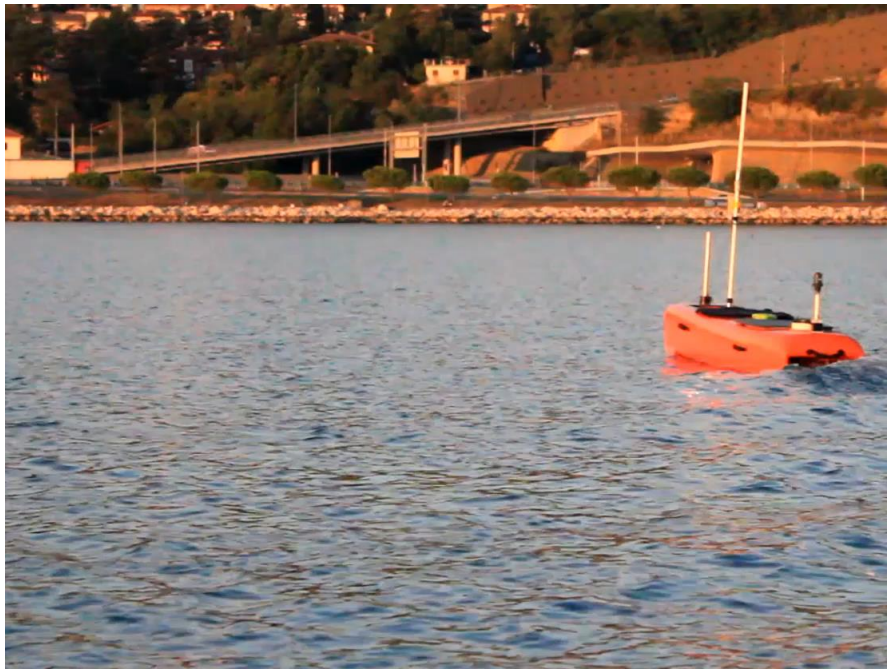
http://www.cognex.com

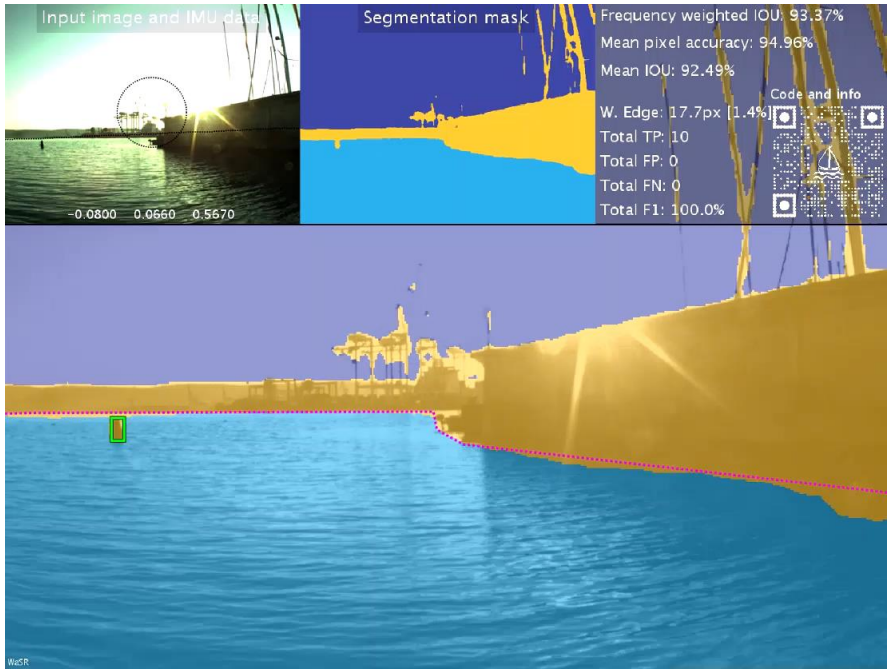
Car damage inspection

Vicos (http://www.vicos.si)

Modern autonomous vehicles applications

Boats:
(www.vicos.si/Projects/Viamaro)



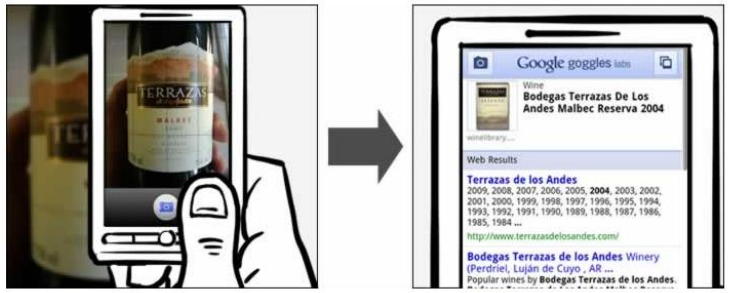


Cars: (https://youtu.be/rPj4T1__gZ4; https://youtu.be/VG68SKoG7vE)

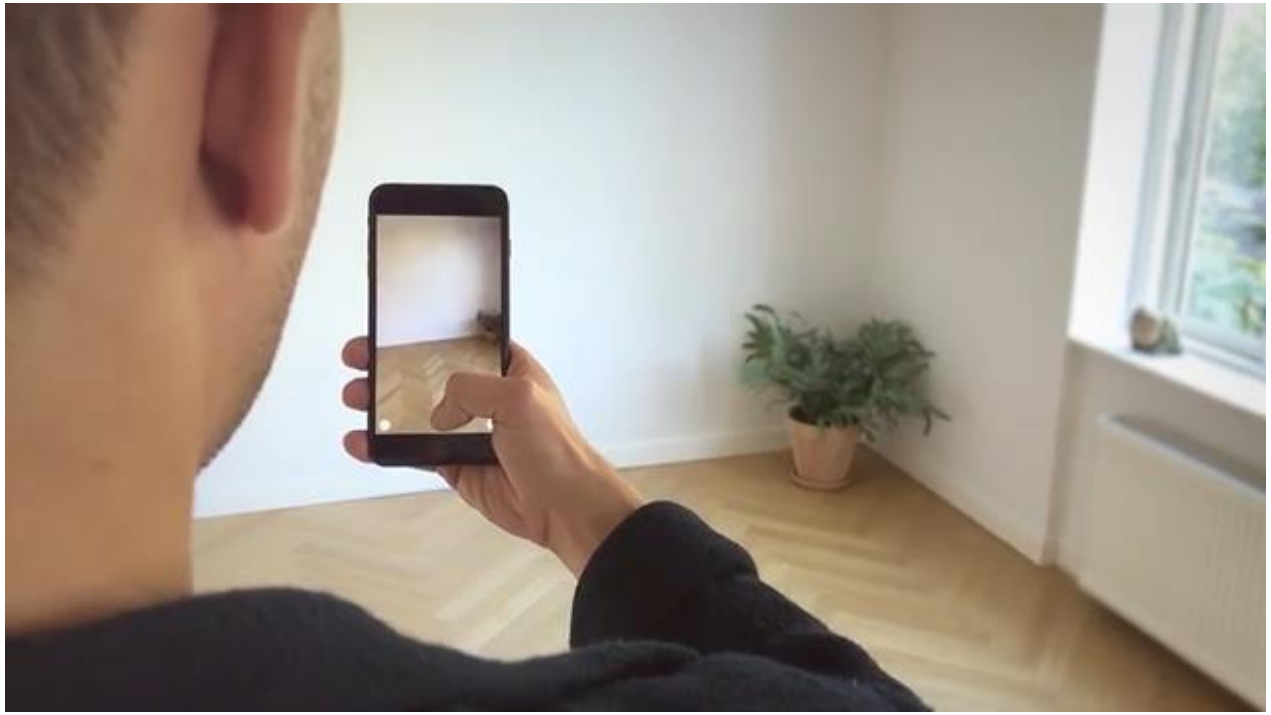
Modern visual query / AR applications

MS Hololens https://youtu.be/ihKUoZxNClA

Google goggles labs



IKEA AR



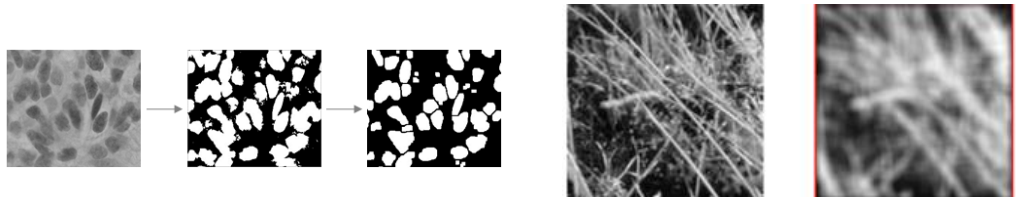
https://youtu.be/ZDWRl9A1p6s

Topics covered in this course

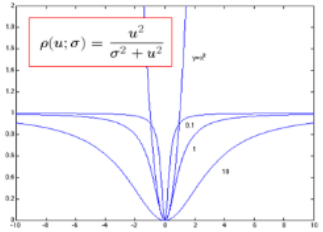
Might change a bit…

1. Image processing 1
2. Image processing 2
3. Edge detection
4. Fitting parametric models
5. Local features
6. Camera geometry
7. Multiple-view geometry
8. Recognition & Detection

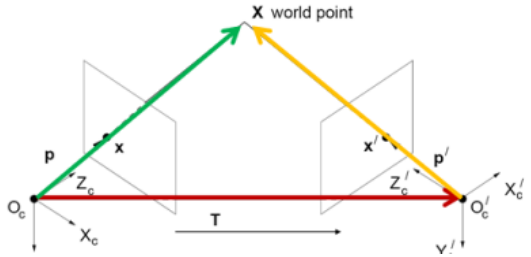
Basic image processing

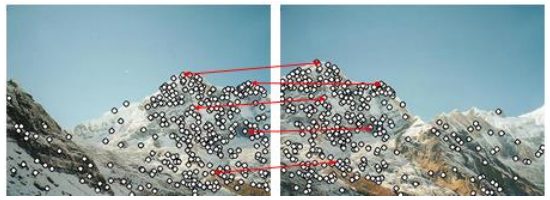


Necessary LS tools

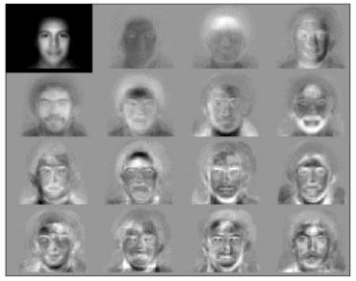


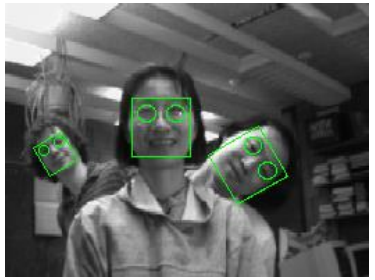
Cameras





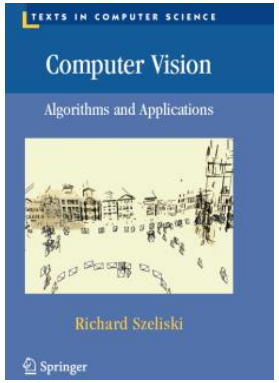
Detection and beyond





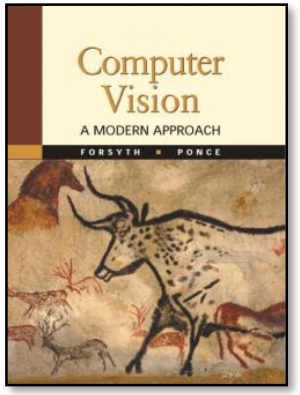
Literature

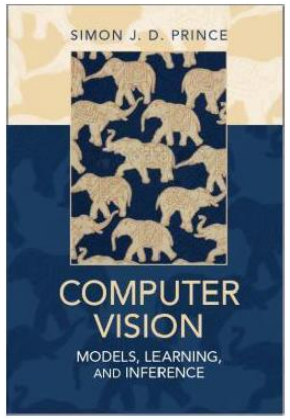
- The topics covered in lectures can be found in the following textbooks:



R. Szeliski, Computer Vision: Algorithms and Applications, 2010
Available online:
http://szeliski.org/Book/

David A. Forsyth, Jean Ponce, Computer Vision: A Modern Approach (2nd Edition)
(first edition available online)





Simon J.D. Prince, Computer Vision: Models, Learning, and Inference, 2010
Available online:
http://www.computervisionmodels.com/

Considerable book collection:
http://homepages.inf.ed.ac.uk/rbf/CVonline/books.htm

Literature

- Use the books for studying and solving the practicum assignments
- Lecture slides will be made available from the e-classroom
  - Hopefully a few days before the next lecture
- Slides are not books!
- You will need to make your own notes to properly follow the course

Crucial: *be proactive*

- Attend the lectures (online/physically) and make notes!
- Ask questions (in class and *especially at the practicum – come prepared*)!