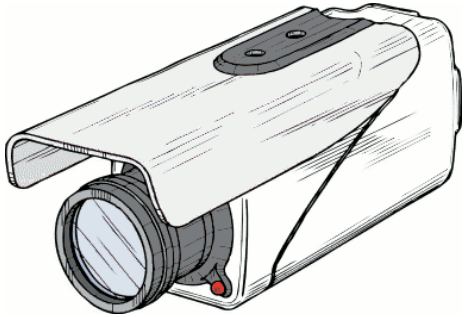
Univerza v Ljubljani

ViCOS visual cognitive systems lab

Machine perception
Introduction



Matej Kristan

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

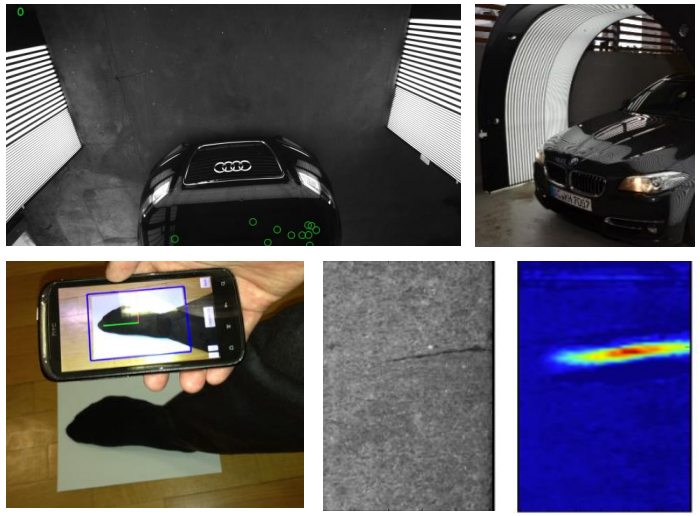
Machine perception

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

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

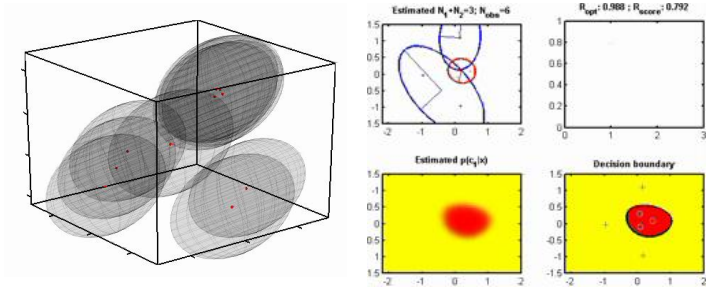
Research interests

0. Industrial R&D



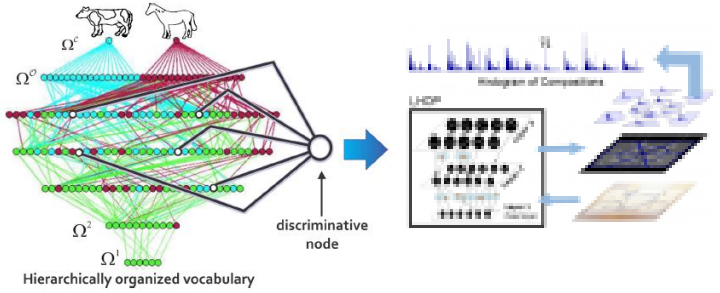
1. Online density estimation

Kristan et al., IEEE SMCB 2013 ;
Kristan et al., IVC2009; Kristan et al., PR2011 ;
Narbutas et al., VC2017;



2. Deep structured networks

Tabernik et al., CVPR 2018; Tabernik et al., CVIU 2015 ; Kristan et al., SCIA 2013 ; Tabernik et al., ICVS 2013 ; Tabernik ICPR 2012

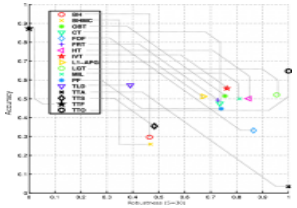


3. Robotic vision

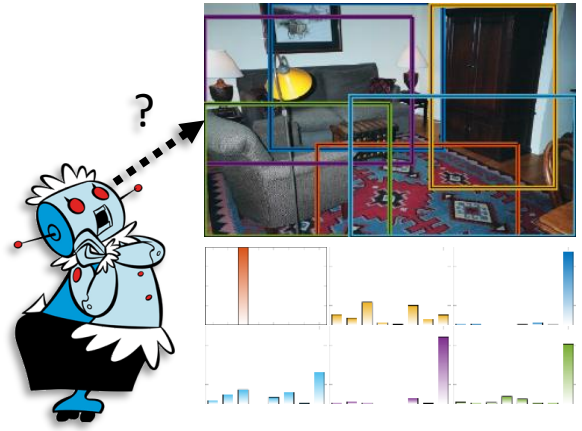
Bovcon et al., RAS 2017, IROS2018
Uršič et al., IJRR 2017;
Uršič et al., ICRA 2016 ;
Mandeljc et al., ICRA 2016 ;
Skočaj et al., TETA 2016;
Kristan et al., IEEE TCYB 2016;
Uršič et al., IJRAS 2013 ;
Kristan et al., IMAVIS 2013;
Uršič et al., IROS 2012
Skočaj et al., EPIROB 2010

4. Visual tracking

Lukežič et al., IJCV 2018;
Čehovin et al., ICCV2017;
Lukežič et al., CVPR 2017;
Lukežič et al., IEEE TCyb 2017
Kristan et al., IEEE TPAMI 2016 ;
Čehovin et al., IEEE TIP 2016 ;
Čehovin et al., WACV2016 ;
Kristan et al., ICCV-W 2015 ; Kristan et al., ECCV-W 2014 ; Čehovin et al., IEEE TPAMI 2013 ; Kristan et al., ICCV-W 2013 ; Kristan et al., IEEE SMCB 2010 ; Kristan et al., PR 2009 ; Kristan et al., CVIU 2009 ;



Vision for robotics



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

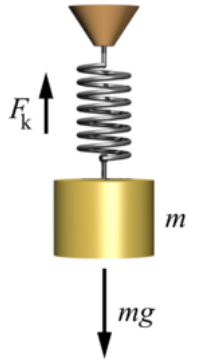
Kristan et al., IEEE TCYB 2016; Bovcon et al., ISPA2017, RAS2017, IROS2018

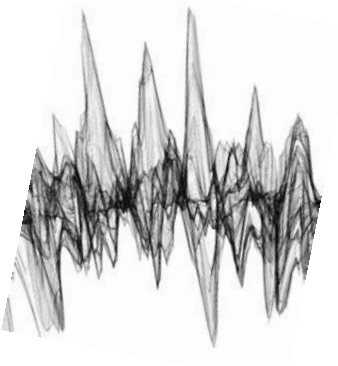
General purpose tracking

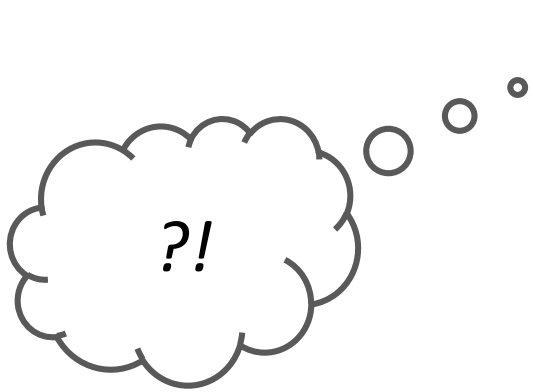
Lukežič, Čehovin, Vojir, Matas, Kristan, CVPR2017, IJCV2018

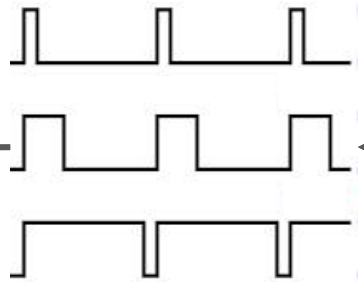
What is machine perception about?

- 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)

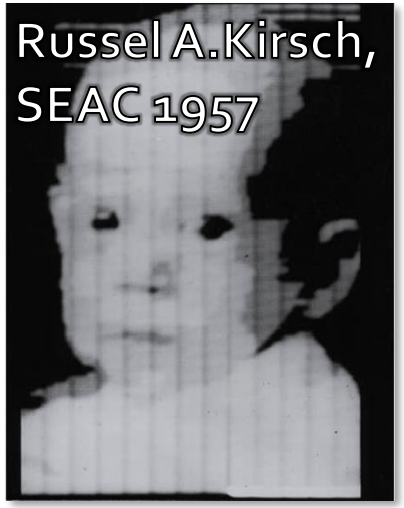


Image digitization

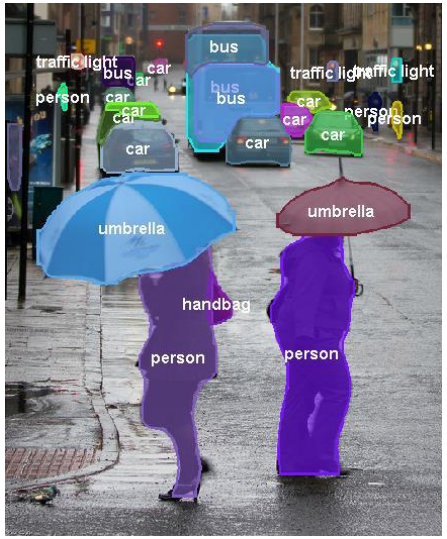
~50 years

Embedded computers
(ARM ~2001)

Face detection

~15 years

Graphic processing units
(GPU ~2016)

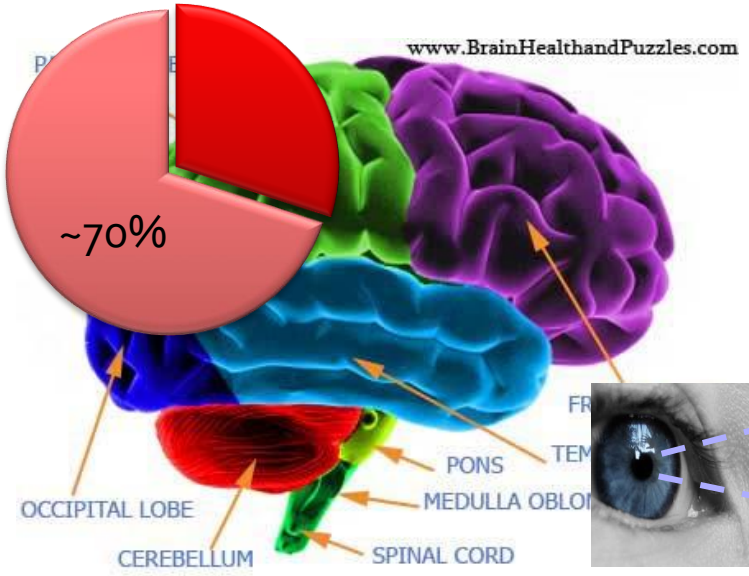


Instance segmentation

Human vs. Computer vision

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

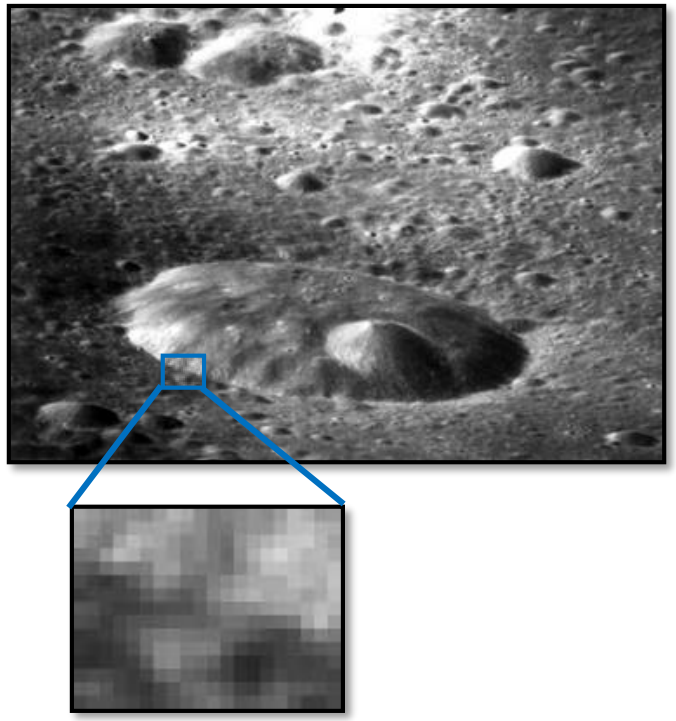
*Prof. Cornelia Fermueller ,University of Maryland in College Park



Human vs. Computer vision

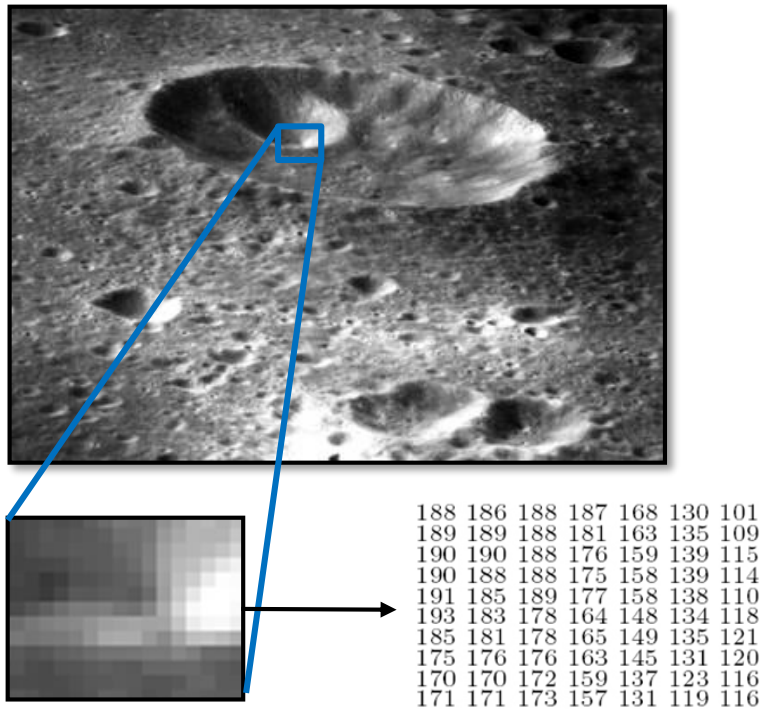
- Much harder than it looks…
- Neuroscience: >50% brain dedicated to vision
- Humans apply experience (prior knowledge)

What do you see?



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

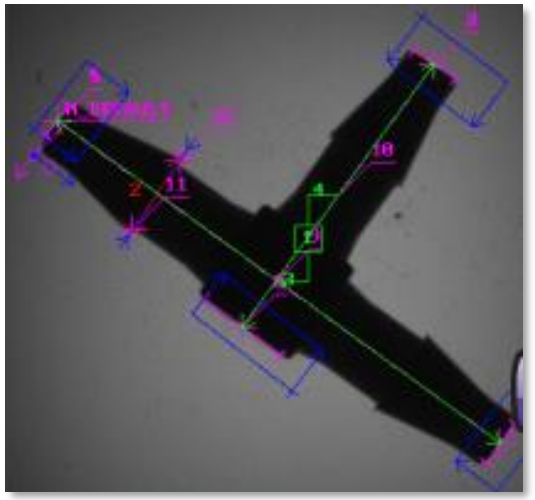
What do you see?



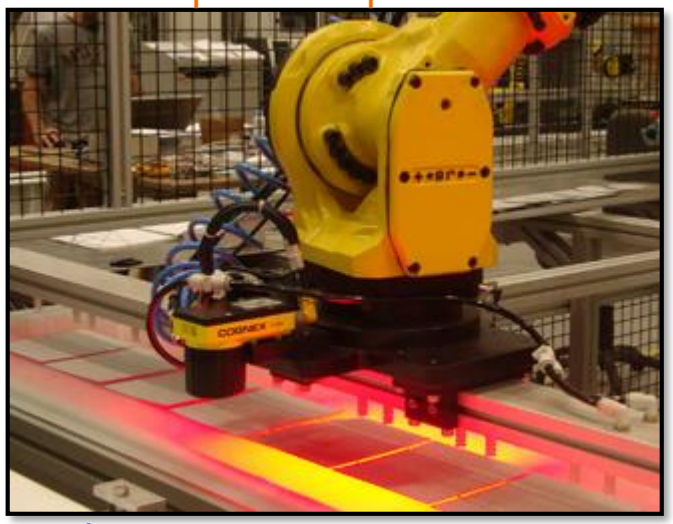
Modern industrial applications

Industrial applications CONTROL THE SETUP.

Smart cameras http://www.matrox.com



Solar panel inspection



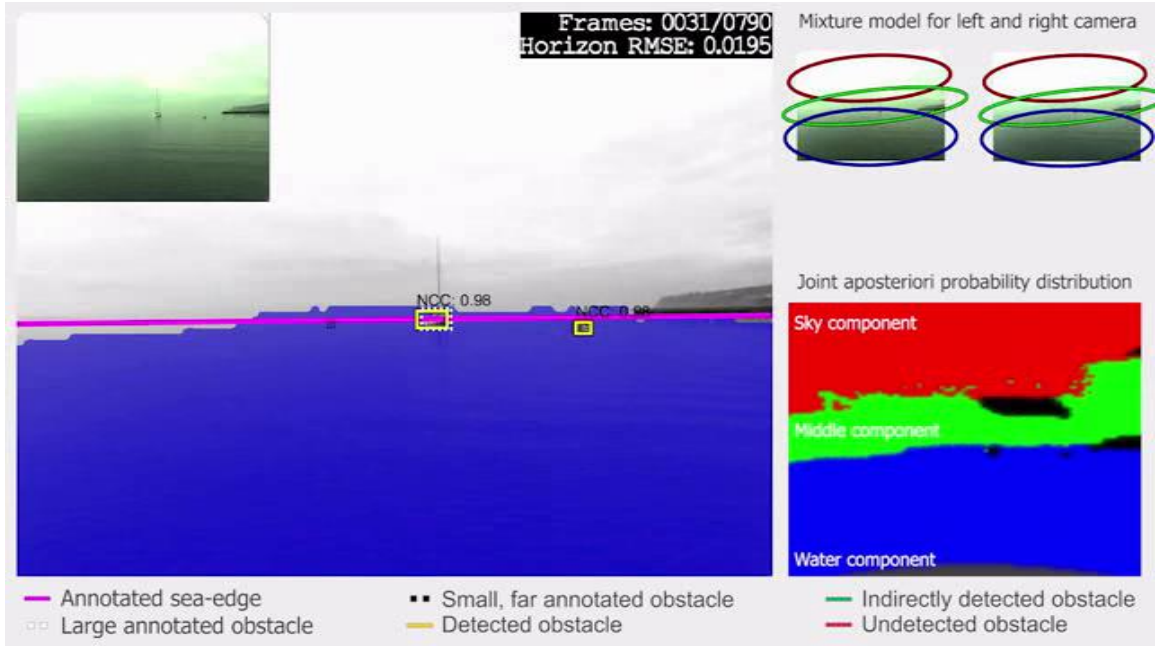
http://www.cognex.com

Car damage inspection

Vicos

Modern autonomous vehicles applications

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

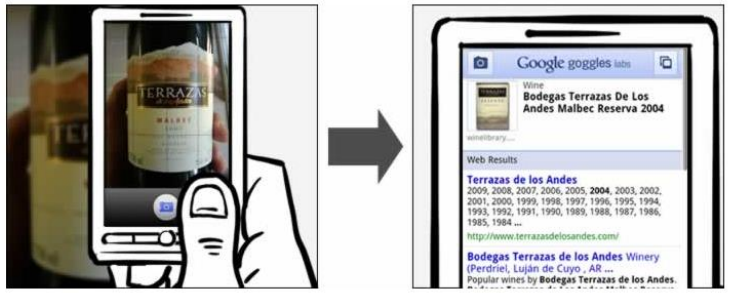


Cars: (https://youtu.be/rPj4T1__gZ4; https://youtu.be/VG68SKoG7vE)

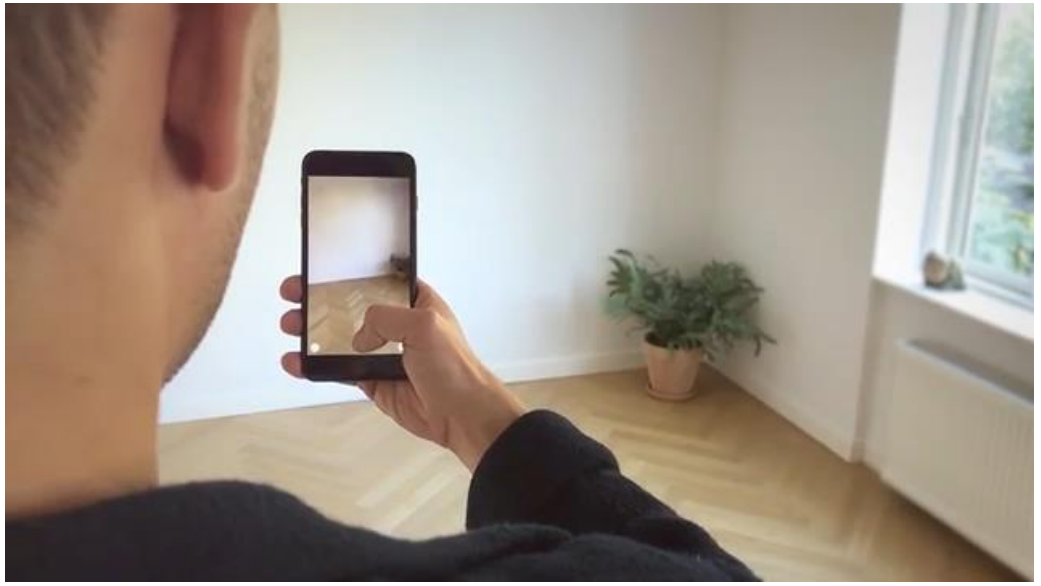
Modern visual query / AR applications

MS Hololens https://youtu.be/ihKUoZxNClA

Google goggles labs



IKEA AR

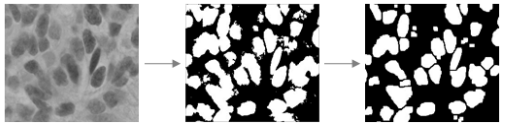


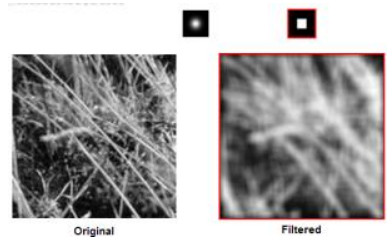
https://youtu.be/ZDWRl9A1p6s

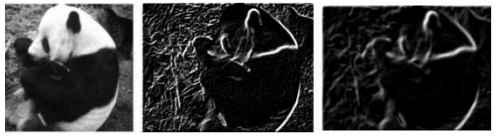
Topics covered in this course

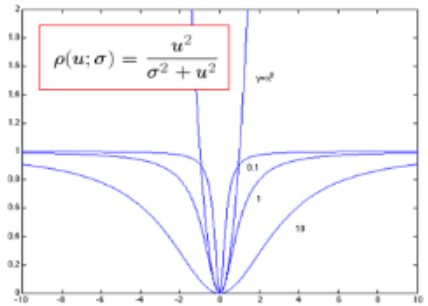
Might change a bit…

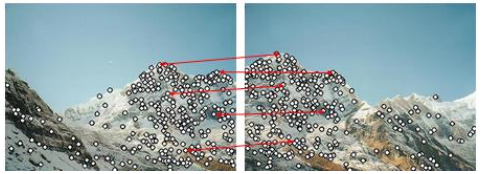
1. Image processing 1
2. Image processing 2
3. Edge detection
4. Fitting parametric models
5. Local features
6. Stereo 1
7. Stereo 2
8. Feature learning: Subspace-based recognition
9. Local-feature-based recognition
10. Object detection

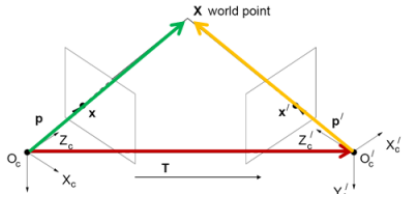


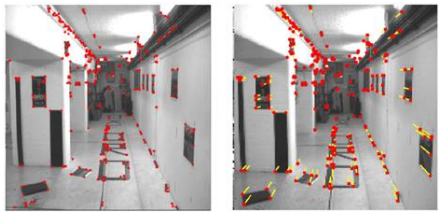


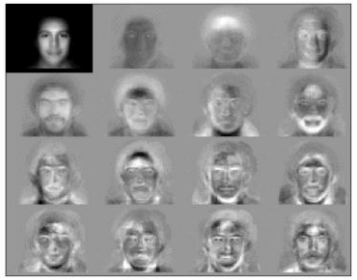


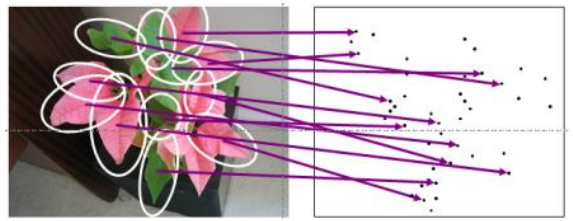


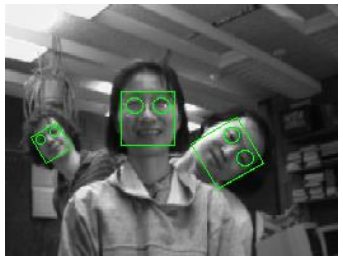












About Machine Perception course

Requirements to pass the course:

1. Practicum (lab 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)

Lab assignments (2-week long guided projects)

- Guided by: doc. dr. Luka Čehovin *(luka.cehovin@fri.uni-lj.si)*
- Practice the theory, from lectures
- Mostly implementation-oriented
  - *Result is a working source code (Matlab/Octave)*
- Partially analytical
  - *Result is derivations on a paper*

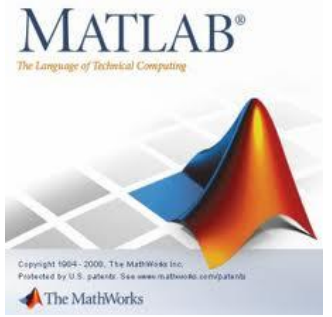
Start planned:
2nd week Details at the lab.

- Getting Started with Matlab

  http://www.mathworks.com/access/helpdesk/help/techdoc/index.html?/access/helpdesk/help/techdoc/learn_matlab/bqr_2pl.html

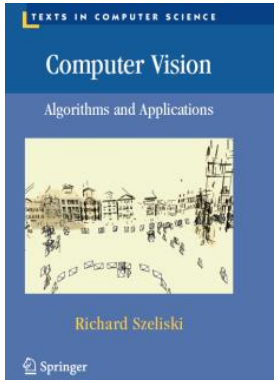
- Matlab Tutorial (74 pages)

  http://faculty.ksu.edu.sa/SultanAhmad/Documents/Matlab_Tutorial.pdf



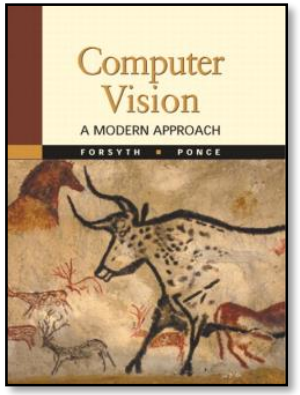
Literature

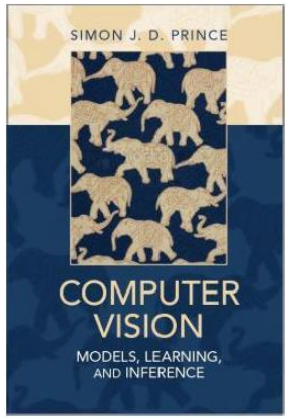
- The topics covered in lectures can be found in the following textbooks:



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/

Literature

- Use the books for studying and solving lab assignments
- Lecture slides will be made available from the e-classroom
- Slides are not books!
- You will need to make your own notes to properly follow the course

My suggestion: *be proactive*

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