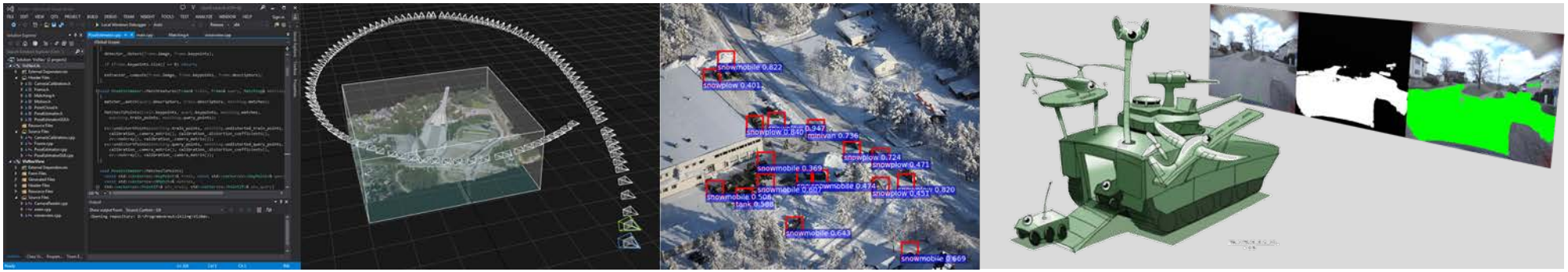


UNIK 4690 – Maskinsyn
Introduksjon

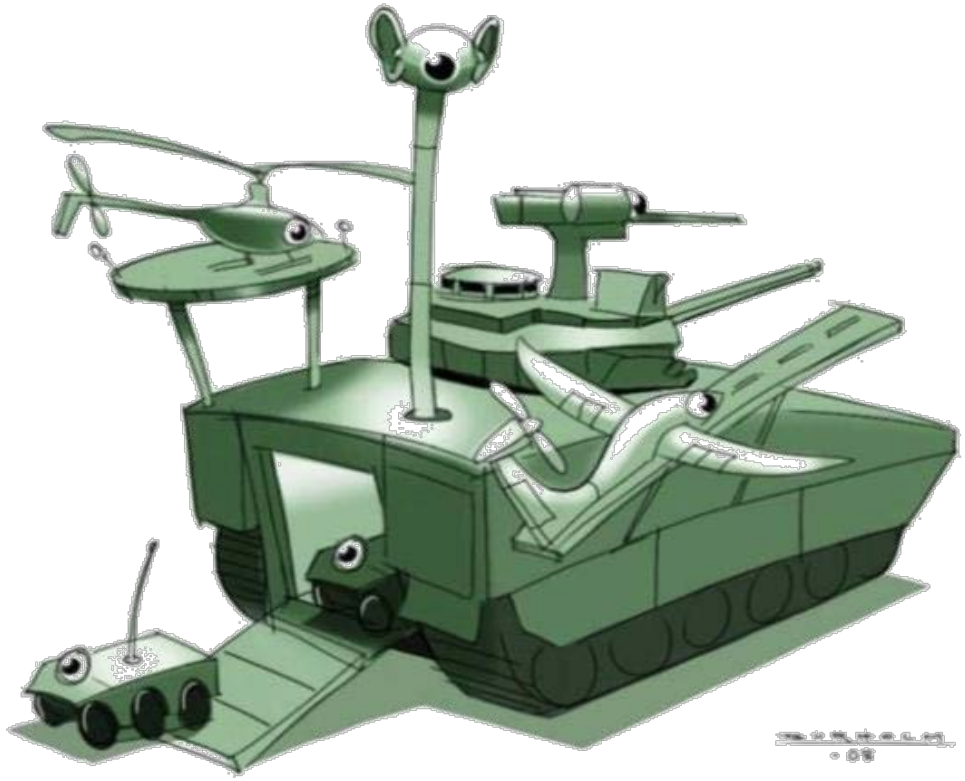
21.01.2016

Trym Vegard Haavardsholm (trymh@ifi.uio.no)
Idar Dyrdal (idar@unik.no)
Thomas Opsahl (Thomas-Olsvik.Opsahl@ffi.no)
Ragnar Smestad (Ragnar.Smestad@ffi.no)

Maskinsyn

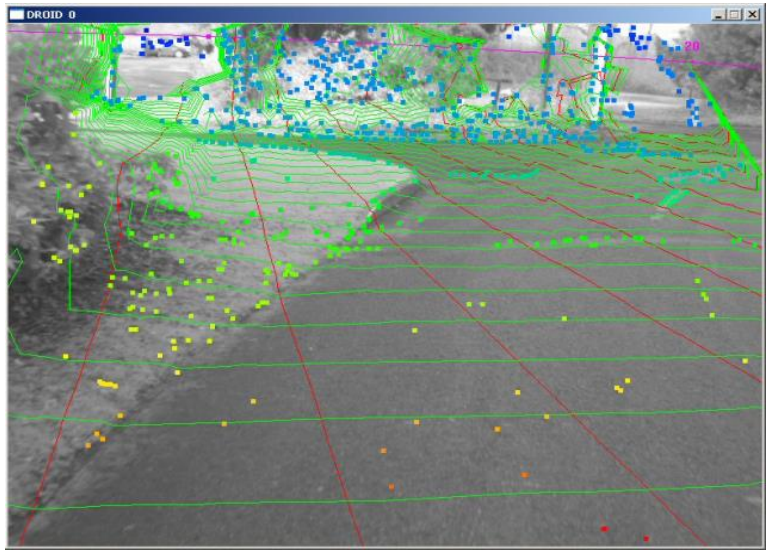
- Studien av hvordan en maskin kan tolke og forstå verden rundt seg ved hjelp av bilder

  - «Lære datamaskiner å se»!



Syn er en viktig sans også for maskiner!

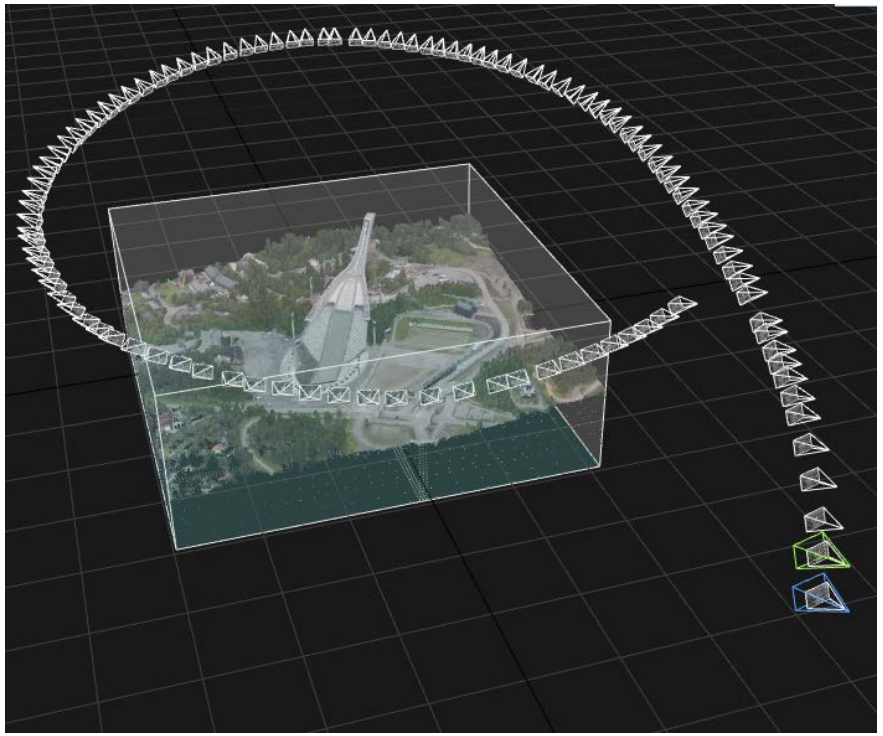
- Støtte til personell
  - Finne, tolke og forstå



- Støtte til roboter
  - Forstå egen situasjon!

Kjapp presentasjonsrunde

- Fullt navn
- Studie
- Relevante kurs/erfaringer?
- Hvorfor ta kurset?



Dagens

- Kursinnhold
- Kursopplegg

- Prosessere bilder med OpenCV

Læringsmål

- Etter å ha fullført UNIK4690:
  - har du en grunnleggende oversikt over maskinsynsfaget.
  - kjenner du til og kan bruke grunnleggende metoder og verktøy innen fagfeltet.
  - forstår du hvordan noen viktige metoder og verktøy virker i detalj.
  - kan du implementere algoritmer som løser enkle maskinssynsproblemer.
  - kan du bruke programmeringsbiblioteket OpenCV til å lage maskinsynsapplikasjoner

Læringsmål

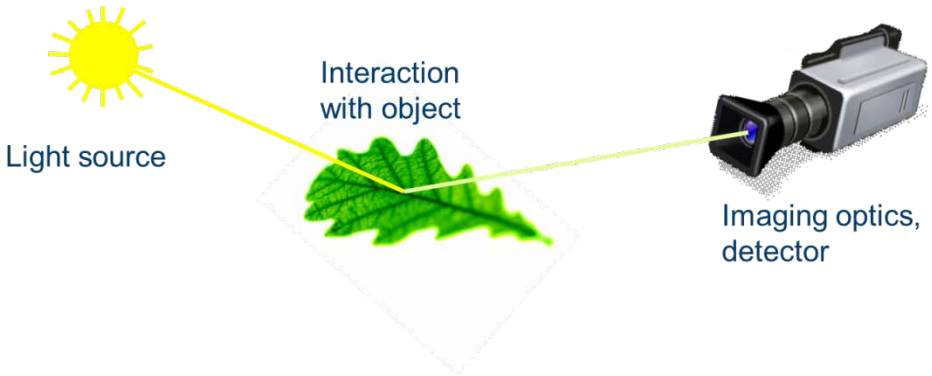
- Etter å ha fullført UNIK9690:
  - har du en grunnleggende oversikt over maskinsynsfaget.
  - kjenner du til og kan bruke grunnleggende metoder og verktøy innen fagfeltet.
  - forstår du hvordan noen viktige metoder og verktøy virker i detalj.
  - kan du implementere algoritmer som løser enkle maskinssynsproblemer.
  - kan du bruke programmeringsbiblioteket OpenCV til å lage maskinsynsapplikasjoner
  - har du en dypere innsikt i metodene, og kan videreformidle dette til øvrige studenter

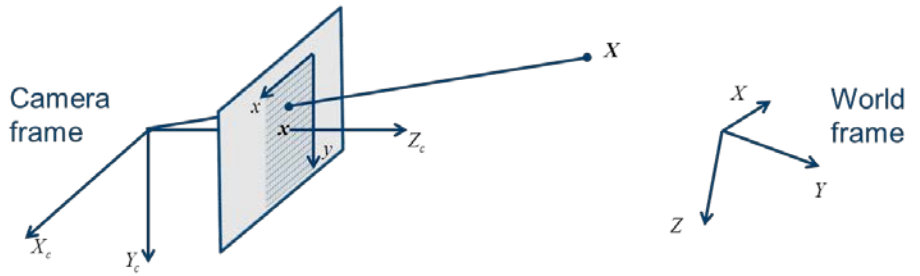
«Omvendt undervisning»

- Hensikt
  - Få så mye som mulig ut av en dag på Kjeller
- På nett
  - Forhåndsinnspilte forelesninger hver forelesningsuke
- Undervisningsdager
  - ~20 min oppsummering og spørsmål
  - ~2.5 timer programmeringseksperimenter
- Obligatorisk studentprosjekt (60%)
  - Stort, selvvalgt prosjekt, gjerne i grupper
- Individuell muntlig eksamen (40%)

Plan

Part I: Image formation, processing and features	
28.01	**1. Image formation** • Light, cameras, optics and colour • Pose in 2D and 3D • Basic projective geometry • The perspective camera model
04.02	**2. Image Processing** • Image frequency and filtering • Image pyramids • Laplace blending
11.02	**3. Feature detection** • Line features • Local keypoint features • Robust estimation with RANSAC
18.02	**4. Feature matching** • Feature descriptors • Feature matching • Estimating homographies from feature correspondences





- The general pinhole camera model then becomes

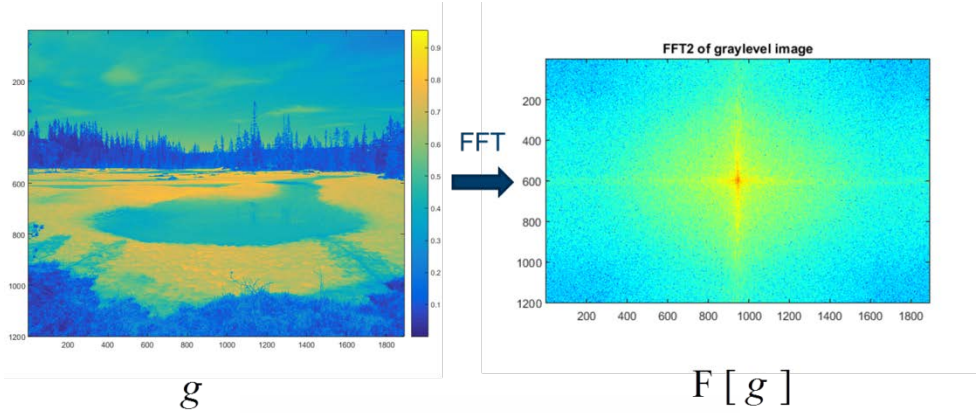
$$\tilde{\boldsymbol{x}} = \underbrace{\begin{bmatrix} f_x & s & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix}}_{K} \underbrace{\begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix}}_{\text{projection}} \underbrace{\begin{bmatrix} R & \boldsymbol{t} \\ \boldsymbol{0}^T & 1 \end{bmatrix}}_{\text{frame-change}} \tilde{\boldsymbol{X}}$$

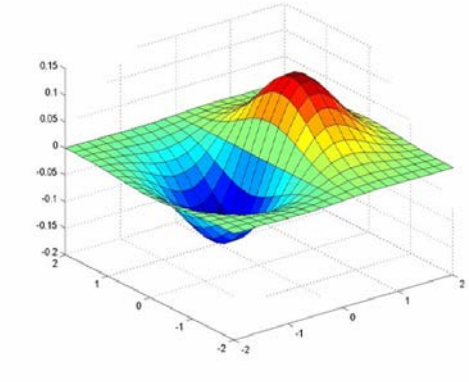
- Combining the last two matrices we can write

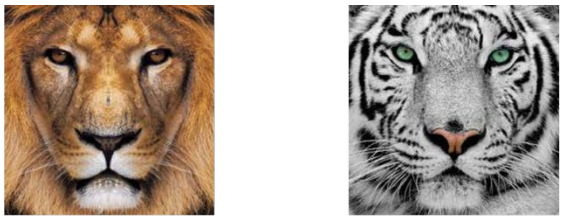
$$\tilde{\boldsymbol{x}} = K \begin{bmatrix} R & \boldsymbol{t} \end{bmatrix} \tilde{\boldsymbol{X}}$$

Plan

Part I: Image formation, processing and features	
28.01	**1. Image formation** • Light, cameras, optics and colour • Pose in 2D and 3D • Basic projective geometry • The perspective camera model
04.02	**2. Image Processing** • Image frequency and filtering • Image pyramids • Laplace blending
11.02	**3. Feature detection** • Line features • Local keypoint features • Robust estimation with RANSAC
18.02	**4. Feature matching** • Feature descriptors • Feature matching • Estimating homographies from feature correspondences

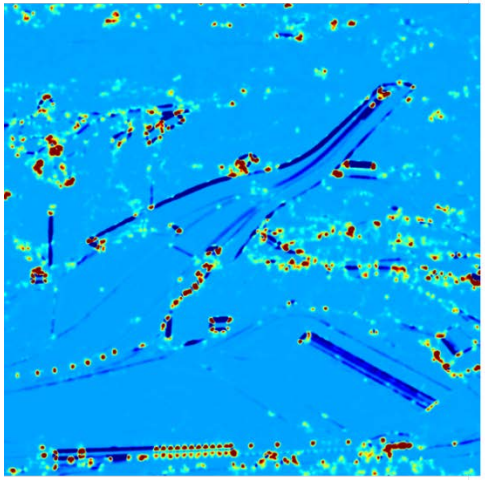


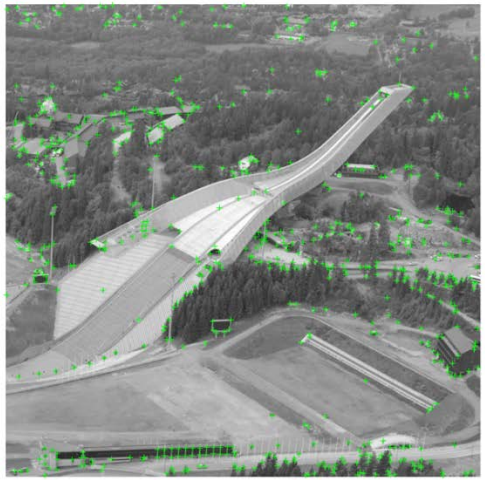


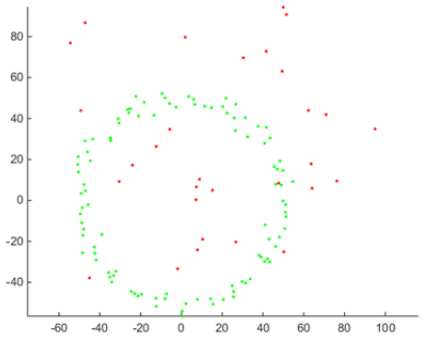


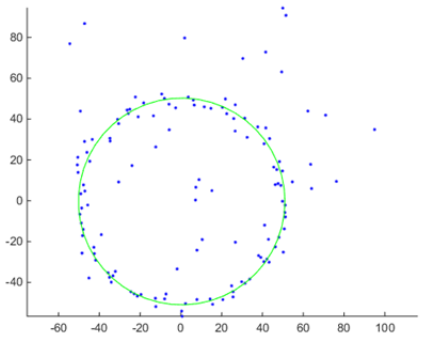
Plan

Part I: Image formation, processing and features	
28.01	**1. Image formation** • Light, cameras, optics and colour • Pose in 2D and 3D • Basic projective geometry • The perspective camera model
04.02	**2. Image Processing** • Image frequency and filtering • Image pyramids • Laplace blending
11.02	**3. Feature detection** • Line features • Local keypoint features • Robust estimation with RANSAC
18.02	**4. Feature matching** • Feature descriptors • Feature matching • Estimating homographies from feature correspondences



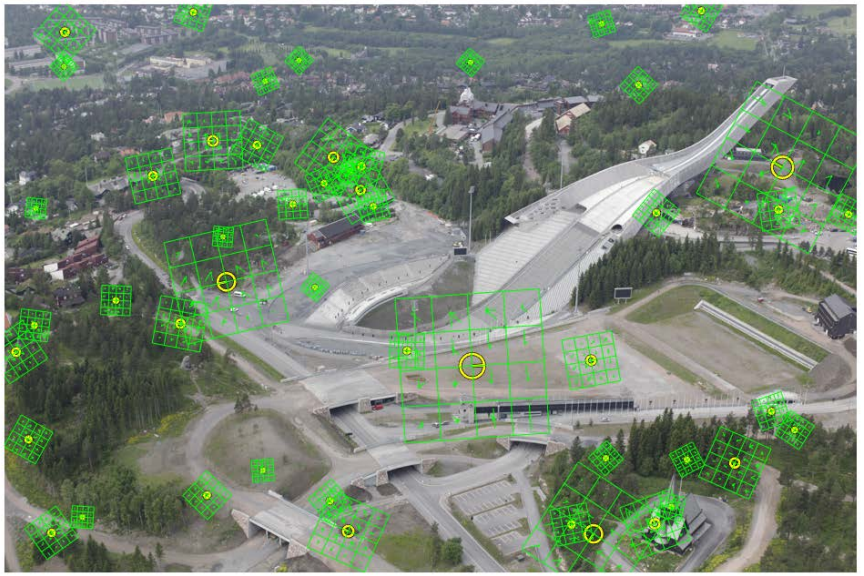


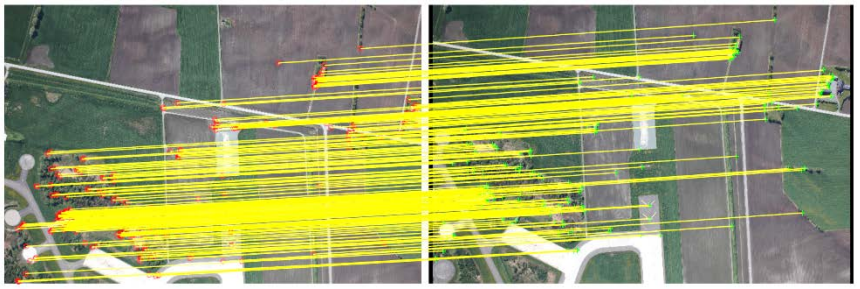




Plan

Part I: Image formation, processing and features	
28.01	**1. Image formation** • Light, cameras, optics and colour • Pose in 2D and 3D • Basic projective geometry • The perspective camera model
04.02	**2. Image Processing** • Image frequency and filtering • Image pyramids • Laplace blending
11.02	**3. Feature detection** • Line features • Local keypoint features • Robust estimation with RANSAC
18.02	**4. Feature matching** • Feature descriptors • Feature matching • Estimating homographies from feature correspondences



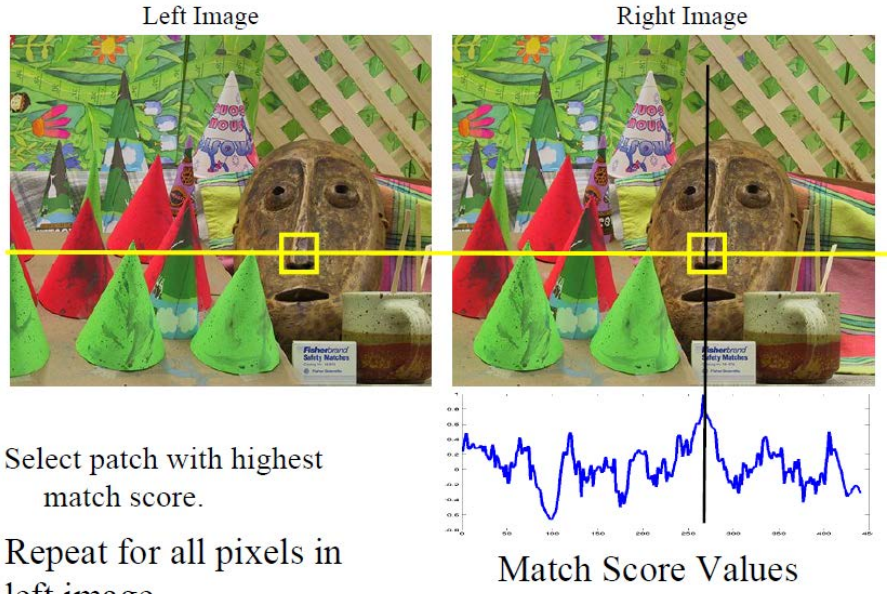


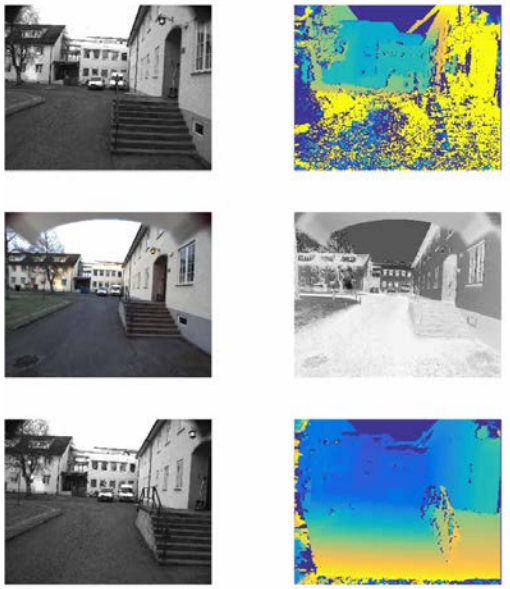
Plan

Part II: World geometry and 3D	
25.02	**5. Single-view geometry** • The camera matrix P • Pose from known 3D points • Camera calibration
03.03	**6. Stereo imaging** • Basic epipolar geometry • Stereo processing • 3D from stereo
10.03	**7. Two-view geometry** • Epipolar geometry • Triangulation • Pose from epipolar geometry
17.03	**8. Multiple-view geometry** • Structure from motion • Multiple-view stereo

Plan

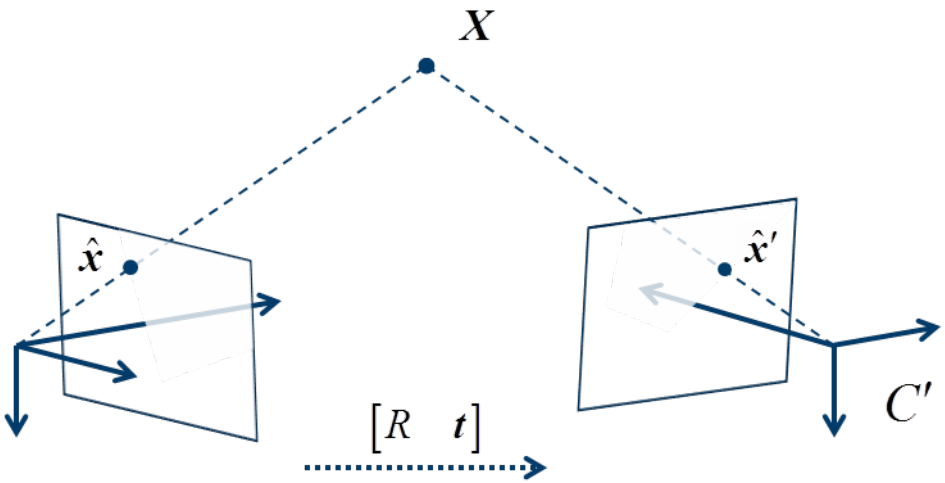
Part II: World geometry and 3D	
25.02	**5. Single-view geometry** • The camera matrix P • Pose from known 3D points • Camera calibration
03.03	**6. Stereo imaging** • Basic epipolar geometry • Stereo processing • 3D from stereo
10.03	**7. Two-view geometry** • Epipolar geometry • Triangulation • Pose from epipolar geometry
17.03	**8. Multiple-view geometry** • Structure from motion • Multiple-view stereo





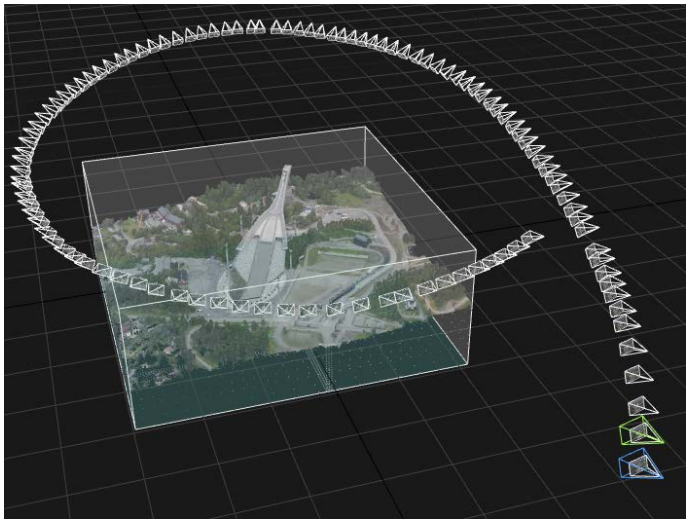
Plan

Part II: World geometry and 3D	
25.02	**5. Single-view geometry** • The camera matrix P • Pose from known 3D points • Camera calibration
03.03	**6. Stereo imaging** • Basic epipolar geometry • Stereo processing • 3D from stereo
10.03	**7. Two-view geometry** • Epipolar geometry • Triangulation • Pose from epipolar geometry
17.03	**8. Multiple-view geometry** • Structure from motion • Multiple-view stereo

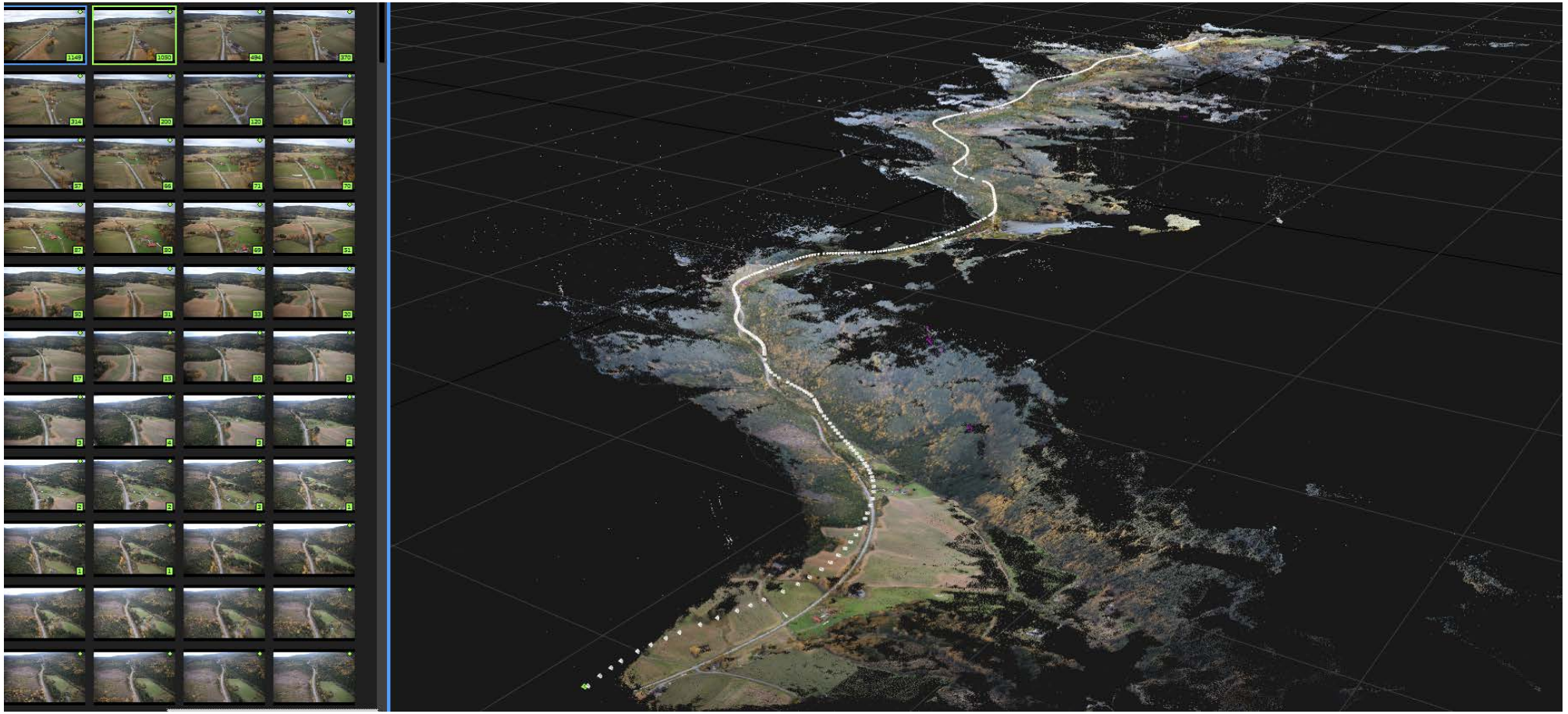


Plan

Part II: World geometry and 3D	
25.02	**5. Single-view geometry** • The camera matrix P • Pose from known 3D points • Camera calibration
03.03	**6. Stereo imaging** • Basic epipolar geometry • Stereo processing • 3D from stereo
10.03	**7. Two-view geometry** • Epipolar geometry • Triangulation • Pose from epipolar geometry
17.03	**8. Multiple-view geometry** • Structure from motion • Multiple-view stereo



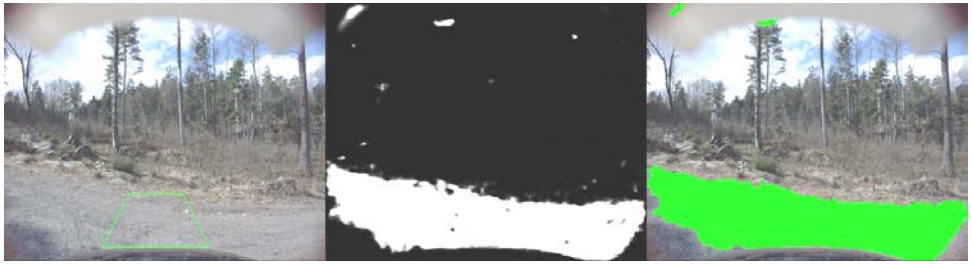
Andre eksempler
Akse: RV170 Mork – Fetsund, ~12km



Andre eksempler
Akse: RV170 Mork – Fetsund, ~12km

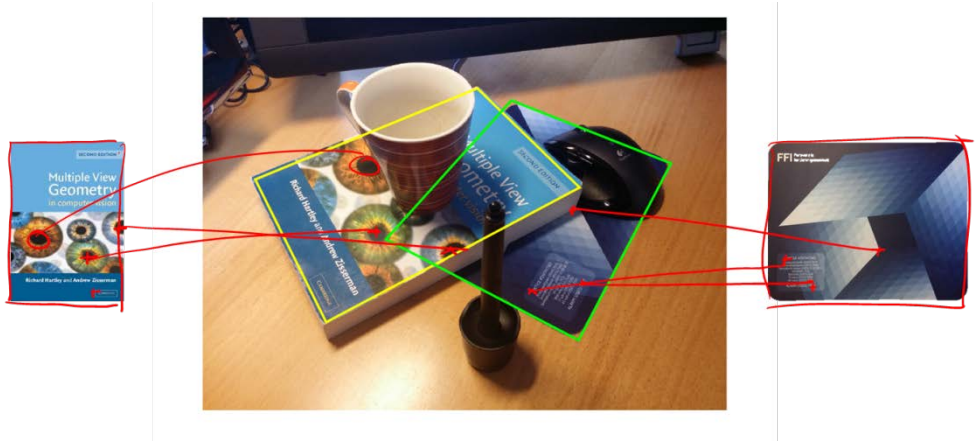
Plan

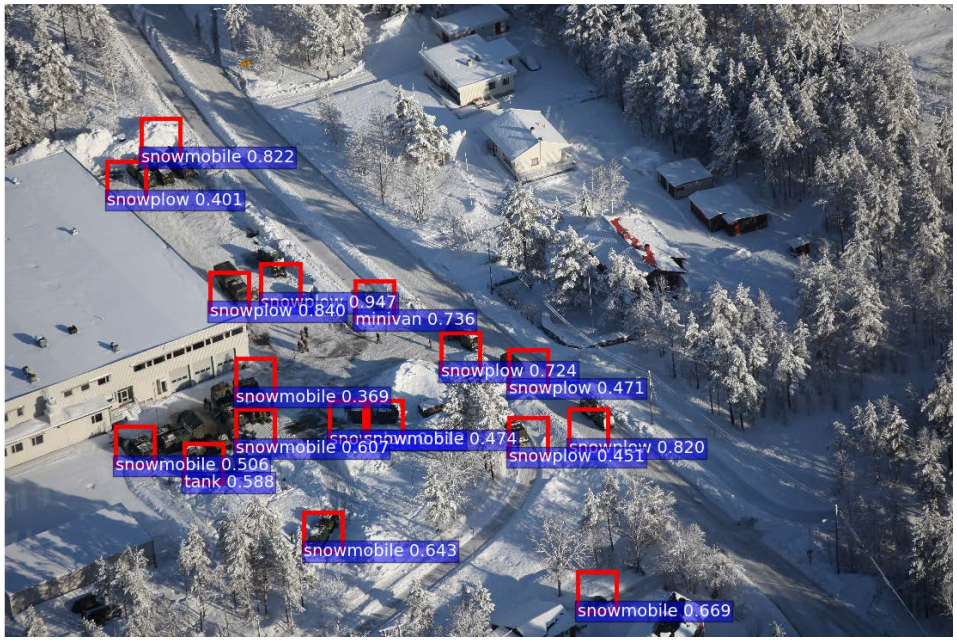
Part III:Scene analysis	
24.03	**Påske**
31.03	**9. Image analysis** • Image segmentation • Image feature extraction • Introduction to machine learning
07.04	**10. Object detection** • Feature-based detection • Detection of faces and people • Introduction to deep learning (CNN)
14.04	**11. Object and scene recognition** • Bag-of-words models • Deep learning for computer vision



Plan

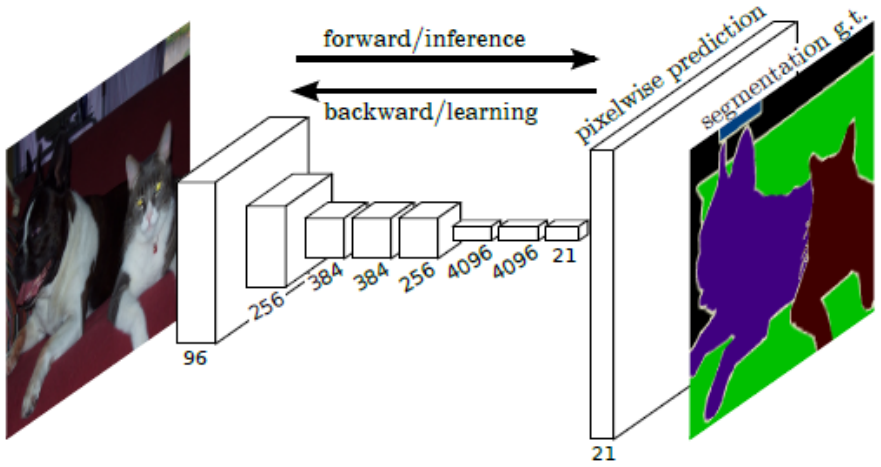
Part III:Scene analysis	
24.03	**Påske**
31.03	**9. Image analysis** • Image segmentation • Image feature extraction • Introduction to machine learning
07.04	**10. Object detection** • Feature-based detection • Detection of faces and people • Introduction to deep learning (CNN)
14.04	**11. Object and scene recognition** • Bag-of-words models • Deep learning for computer vision





Plan

Part III:Scene analysis	
24.03	**Påske**
31.03	**9. Image analysis** • Image segmentation • Image feature extraction • Introduction to machine learning
07.04	**10. Object detection** • Feature-based detection • Detection of faces and people • Introduction to deep learning (CNN)
14.04	**11. Object and scene recognition** • Bag-of-words models • Deep learning for computer vision



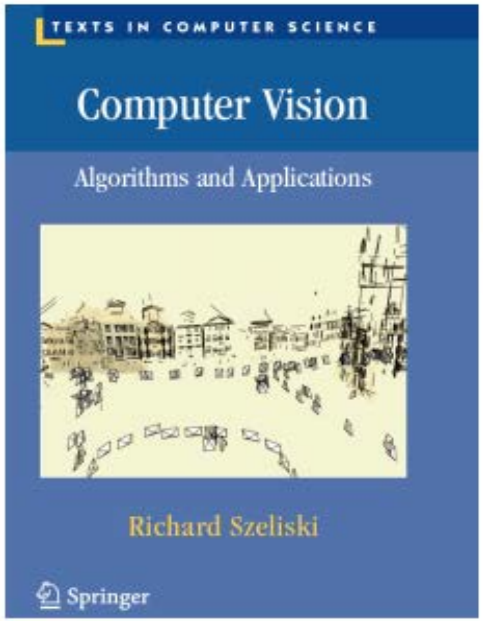
Plan

Part IV: Student project	
21.04	**Student project**
28.04	**Student project**
05.05	**Himmelfart**
12.05	**Student project**
19.05	**Student project**
26.05	**Project presentations**
02.06	**Summary and conclusions**
09.06	**Exam**

Lærebok

Computer Vision: Algorithms and Applications

© 2010 Richard Szeliski, Microsoft Research



Gratis på nett: http://szeliski.org/Book/
Innbundet versjon kan kjøpes

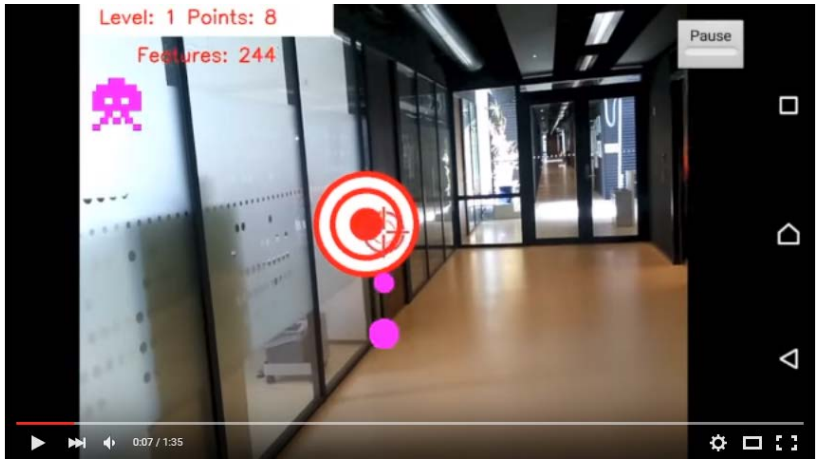
Forelesningsuker

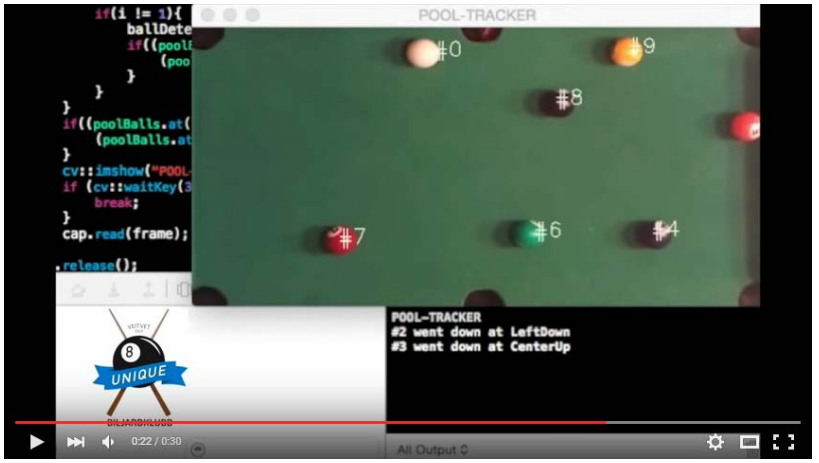
- Fredag ettermiddag/kveld uken før
  - Forelesningsvideoer publiseres på nett
  - 3-4 videoer på ~20 min hver
- Les de angitte kapitlene fra boka
- Torsdager 09:15
  - Oppsummering og spørsmål til forelesningen
  - (Basert på diskusjoner på nett?)
- Torsdager ~09:35-12:00
  - Programmeringsoppgaver fra ukens forelesning
  - Veiledet av forelesere og labassistent

Studentprosjekt

- Utvikle et fungerende maskinsynssystem som gjør noe interessant
  - Stort: Mer enn en måned
  - Obligatorisk: 60% av karakteren

- Studentene foreslår oppgave selv
- Helst i grupper på inntil 3 personer



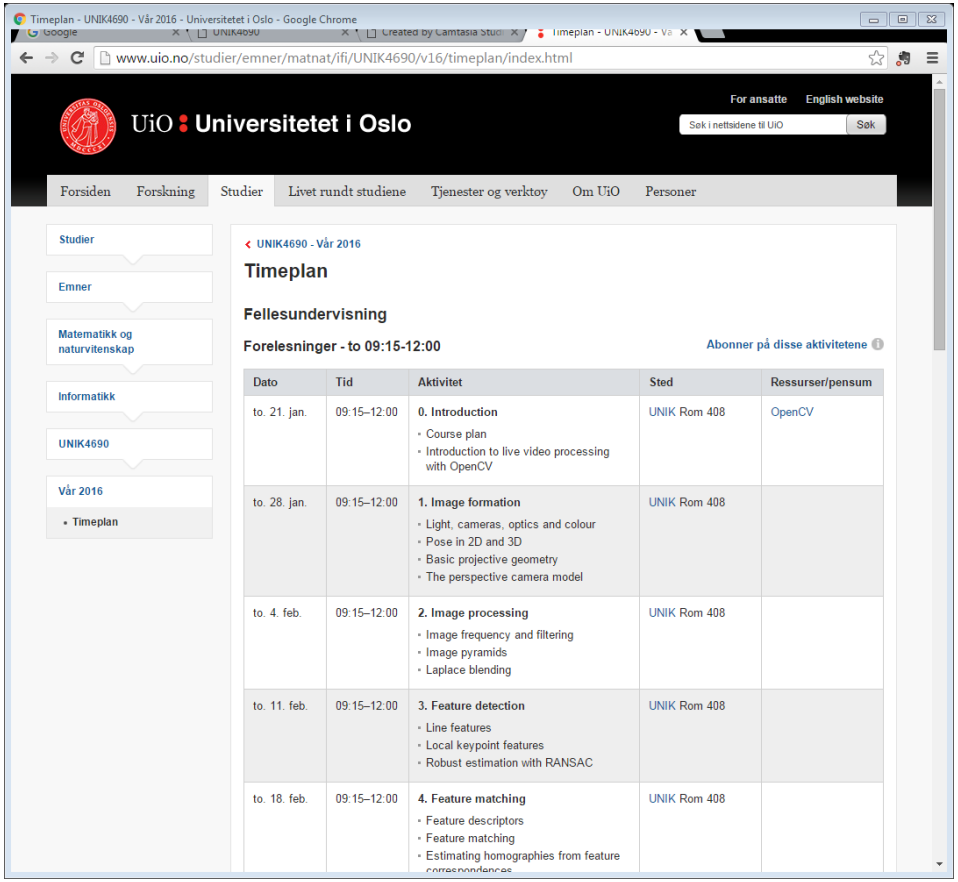


Studentprosjekt

- Stor valgfrihet
  - Plattform, programmeringsspråk, verktøy, …
- Vi kan skaffe spennende data, sensorer, plattformer, …
  - Termiske bilder, sonarbilder, uav-er, kjørende roboter, motion capture lab
- Prosjektperiode
  - 14.04: Innlevering av skriftlig prosjektforslag
  - 21.04: Muntlig tilbakemelding på prosjektforslag
  - 26.05: Muntlig presentasjon og innlevering av rapport
- Undervisningsdagene brukes til prosjektarbeid
- Lab-en er tilgjengelig ellers også

Semestersiden

- http://www.uio.no/studier/emner/matnat/ifi/UNIK4690/v16/index.html
- Beskjeder
- Kursplan
- Undervisningsmateriale
  - Forelesningsvideoer
  - Forelesninger på pdf
  - Labtutorials og oppgaver
- Fronter?
  - Diskusjonsforum?



Tilbakemelding

- Gi tilbakemelding underveis!
  - Vi er åpne for å justere opplegget
- Lever kurskritikk etter kurset
- Spørsmål?