Master topics
Digital Signal Processing and Image analysis Group

Supervisors

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CIUS: Centre for Innovative Ultrasound Solutions for healthcare, maritime, and oil & gas
http://www.mn.uio.no/ifi/english/research/projects/cius/
• Anne Solberg (DSB) anne@ifi.uio.no, keywords: image analysis, deep learning, ultrasound of muscles, remote sensing
• Andreas Austeng (DSB) andrea@ifi.uio.no, keywords: signal processing, sonar/ultrasound

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• Eigil Samset (GEVU/DSB) eigilsa@ifi.uio.no, keywords: deep learning in ultrasound
Detection and tracking of muscle tissue in ultrasound images

• In cooperation with Norges Idrettshøgskole, Olivier Seynnes.

• Purpose:
  - in pennate muscles, to measure the angle of insertion between the muscle fascicles (groups of fibres) and the deeper aponeurosis: Pennation angle
  - To measure/estimate the length of muscle fascicles

• Prerequisites:
• INF 4300, linear algebra
• Main supervisor: Anne Solberg
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ULTRASOUND IMAGES OF SKELETAL MUSCLE

Fascicles are seen here as the white, oblique, lines.

- Pennation angle is relatively variable from one fascicle to the other. We currently use an open source program based on JAVA called ImageJ. With a dedicated plugin, the orientation of all fascicles in the lower third of the image is quantified and the dominant one retained for analysis. Yet, the algorithm (DirectionJ plugin) is not ideal and we are looking for better alternatives.

- The fascicle length is currently the biggest challenge: the entire length is almost never within the field of view and we rely on geometrical constructions (extrapolations) or simple trigonometry to estimate their length. Taking the curvature of the fascicles into account is even trickier. One solutions could be to average the orientation of the fascicles along the depth of the muscle to reconstruct an “average fascicle”. This solution could be applied in a more accurate way: by obtaining a series of images from a swipe with the ultrasound probe, from one insertion of the fascicle to the other and to stitch images into a panoramic view.
A different type of analysis is also necessary when multiple cycles of muscle contraction are recorded, for example during walking. Although it is easy to pick key frames during single contractions and analyse them, recordings during walking contain far too many frames. The best existing method in this case has been developed on Matlab by one group and they published this algorithm (http://www.mathworks.com/matlabcentral/fileexchange/32770-muscle-fascicle-tracking-ultrasound). Unfortunately they only published an earlier version of it and it is too unperfect to be used as such. In any case their approach has some weaknesses: It only works for muscles (e.g., gastrocnemius) for which the whole fascicle length is visible, it does not take the curvature of fascicles into account and the direction of fascicles is segmented manually before tracking…

**Example of muscle contraction**
This is a scan of the vastus lateralis and vastus intermedius muscles. Typically, fascicles shorten and their curvature is altered.
Deep learning for applications in remote sensing

- Main goal: study how well new deep learning methods perform on oil spill detection and avalanche detection.

1. Literature study on modern machine learning
2. Learn the existing statistical algorithm for oil spill detection
3. Apply deep learning to a large data set of oil spill images, compare the performance to the existing statistical algorithm.

Requirements: challenging task for those looking for a challenging topic. Can result in a good publication.
Good grades in INF 4300/mathematics.

Main supervisor: Anne Solberg anne@ifi.uio.no
Three main parts:
• Spot detection
• Spot feature extraction
• Spot classification
  – Decide oil spill or lookalike based on a statistical model for oil in different wind conditions and of different shapes

Deep learning for ultrasound images of the heart

• Main goal: study how well new deep learning methods perform detecting structures in ultrasound images of the heart

• Supervisor: Eigil Samset (II-er), eigilsa@ifi.uio.no
Range gated imaging: seeing through murky water

- Murky water limits observation range
  - Sand, mud, plankton, ...
- No good solutions for underwater optical 3D measurements
  - Triangulation
  - Structured light
  - Stereo
Next generation 3D camera technology for the industry - «Kinect on steroids»

- 100 times more accurate than Microsoft Kinect 2
- 2.3 MP RGBD (full-color) @12 Hz
- 0.05 mm accuracy (for 50cm F.O.V.)
- Up to 1m² field-of-view (Euro-Pallet)

Targeted mainly at industrial applications:
- 3D vision for robotics and automation (e.g. localization, pick&place and assembly)
- In-line quality control in manufacturing
- 3D scanning for 3D printing