



UiO : **Department of Informatics**
University of Oslo

MSc project opportunities 2020

Digital Signal Processing (DSB) group and Partners

Sven Peter Näsholm and co-supervisors

October 2020



Opportunities presented in this block

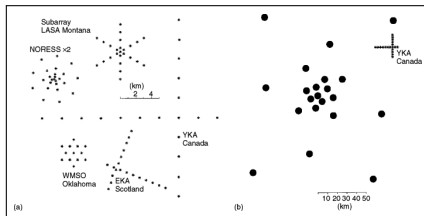
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- 5 Using optical fibers as acoustic and seismic arrays: distributed acoustic sensing**

- Associate Professor Sven Peter Näsholm & partners
- Contact: svenpn@ifi.uio.no
- Projects listed in MSc database: <https://www.mn.uio.no/ifi/studier/masteroppgaver/dsb/>

MSc project opportunity

A holistic approach to 3-component
beamforming on seismic arrays

- Algorithm development
- Signal processing
- Data analysis



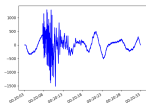
A holistic approach to 3-component beamforming on seismic arrays p. 1/2

- **Seismic arrays** with sensors distributed over several kilometers
- Some modern arrays feature **3-component sites**: displacement in x, y, z directions – not only z
- **Research oriented** project. Partnership with institute: NORSAR
- **Geoscience applications**: seismology / atmospheric acoustics / earthquakes / safer society / CO₂ storage monitoring / glaciology / volcanology / ...
- **Main objective**: Develop / test novel ideas for processing of 3-component seismic array data, to enhance characterization of waves in seismology

A holistic approach to 3-component beamforming on seismic arrays

p. 2/2

- Supported by experienced advisors both from the university & from the research institute NORSAR
- Gain hands-on experience in scientific data processing and programming using state-of-the art Python package ObsPy. Write your own code taking advantage of the ObsPy framework
- You will get the opportunity to work on real-world data that is contributing to a safer society
- You will be able to make comparisons to big datasets of earthquake catalogues
- **Interest & background requirements:**
 - Scientific programming in Python
 - Digital signal processing
 - Array signal processing / beamforming
 - Data science and visualization
 - Advantage with some geosciences knowledge

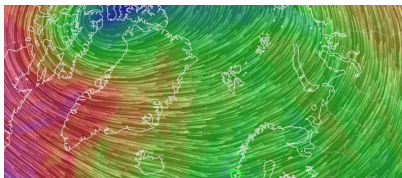


NORSAR

MSc project opportunity

Exploring atmospheric infrasound to
enhance long-term weather forecasting

- Array signal processing
- Wave propagation
- Atmospheric wind probing
- Numerical weather forecasting



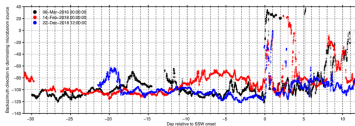
Exploring atmospheric infrasound to enhance long-term weather forecasting

p. 1/2

- The **stratosphere** has longer “memory” than lower altitude layers. Better probing of its winds can help enhancing medium/long range numerical weather prediction
- **Infrasound arrays** with pressure sensors distributed over several kilometers
- **Research oriented** project. Partnership with institute: NORSAR
- **Main objective:** Develop / test *adaptive array signal processing methods* on infrasound array data – hence enhancing the resolution and robustness of infrasound-based atmospheric probing

Exploring atmospheric infrasound to enhance long-term weather forecasting p. 2/2

- Supported by experienced advisors both from the university & from the research institute NORSAR
- Gain hands-on experience in scientific data processing and programming using state-of-the art Python package ObsPy. Write your own code taking advantage of the ObsPy framework
- Integrated with Research Council of Norway basic research project
- **Interest & background requirements:**
 - Array signal processing / beamforming
 - Scientific programming in Python
 - Digital signal processing
 - Wave propagation simulations
 - Advantage with some meteorology / atmospheric dynamics knowledge

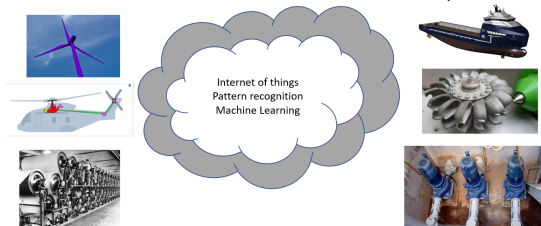


NORSAR

MSc project opportunity

Acoustical signal processing & machine
learning in machinery monitoring

- Non-destructive testing and condition monitoring
- Acoustic and vibration signal processing
- Anomaly detection
- Startup company host *VibSim AS*



Acoustical signal processing & machine learning in machinery monitoring

p. 1/2

- **Industry oriented** project
- **VibSim AS:**
Working on lifetime expectancy estimation for machinery, components, and vehicles by **analyzing sound and vibration data**
- **Project objectives:**
Develop **Pattern recognition algorithms and neural network approaches** interplay to discover damage and anomalies, as well as to estimate the lifetime expectancy for machinery and vehicles.

Acoustical signal processing & machine learning in machinery monitoring p. 2/2

- Anchored in commercial activities with VibSim & customers (energy / transport / manufacturing)
- Development of digital signal processing approaches for condition monitoring based on vibration datasets
- Pattern recognition algorithms & neural network approaches interplay to discover damage & anomalies / estimate lifetime expectancy for machinery & vehicles
- VibSim can offer part-time jobs to ambitious students / full-time after MSc
- **Interest & background requirements:**
 - Signal processing
 - Filtering and pattern recognition
 - Neural networks / machine learning
 - Data visualization in Python / Matlab
 - Interest in the physics behind machinery damage symptoms, e.g.: <https://www.youtube.com/watch?v=5MNyLM0N6I0>



MSc project opportunity

Power cable monitoring: Signal
processing / pattern
recognition / machine learning

- Power cable anomaly and health monitoring
- Signal processing
- Company host: *Wirescan Digital*

Power cable monitoring: Signal processing / pattern recognition / machine learning p. 1/2

- **Industry oriented** project
- **Wirescan Digital:**
Develops cloud-based systems for **condition monitoring of power cables**
- Big datasets are collected which request **processing and analysis algorithm development** and tailoring.
- Example: for wind power distribution networks

■ **Interest & background requirements:**

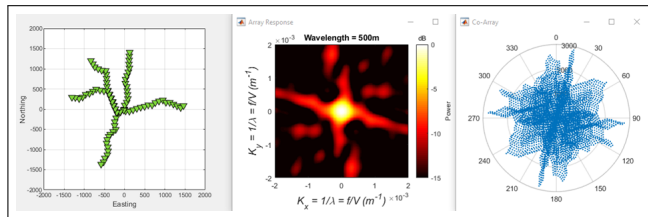
- Signal processing with transformations between time and frequency domains to produce datasets that are piped into analysis and state-of-health algorithms
- Pattern recognition: assessing the big datasets in terms of anomaly detection
- Machine learning approaches in interplay with signal processing and pattern recognition to develop autonomous systems to monitor power cable state-of-health
- Data analysis and visualization, for example using Matlab or Python
- Working with a small dynamic company



MSc project opportunity

Using optical fibers as acoustic and seismic arrays: distributed acoustic sensing

- Optical fibers as pressure sensors
- Array signal processing
- Algorithm development



Using optical fibers as acoustic and seismic arrays: distributed acoustic sensing p. 1/2

- **Optical fibers** as acoustic sensors, recording acoustic or seismic waves propagating along the fiber
- Rayleigh backscattered laser light $\implies$ distributed acoustic sensing (DAS)
- DAS can in network **array patterns** over large geographic areas
- Applications in long-distance monitoring, attracting industries as diverse as, for example, petroleum, traffic, geohazard, infrastructure, acoustics, seismology, and border security
- Massive amount of data to be handled
- Requires novel processing approaches

Using optical fibers as acoustic and seismic arrays: distributed acoustic sensing p. 2/2

- Supported by advisors from university & the research institute NORSAR
- Challenges include that the cable is only sensitive to strain along the fiber axis, so existing **array processing & design techniques will be adopted to a distribution of directions of arrival**
- We envision that methods from other array-processing fields can help identifying the most efficient approach
- Work with a novel technology & to establish professional networks in both technical institute sector & academia, as well as with industry partners
- **Interest & background** in Python / Matlab programming & one or several of the following fields will be an advantage:
 - Signal processing
 - Array signal processing
 - Wave propagation modelling
 - Data science and visualization



NORSAR



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