



SFI  
OFFSHORE  
MECHATRONICS

# ANNUAL REPORT 2020

# Table of Contents

|   |           |
|---|-----------|
| <b>Summary</b>                                    | <b>3</b>  |
| History   | 3         |
| The Research                                      | 3         |
| Organisation                                      | 3         |
| Scientific Activities and Results                 | 4         |
| International Cooperation                         | 4         |
| Recruitment                                       | 4         |
| Communication and Dissemination activities        | 4         |
| <b>Activities</b>                                 | <b>5</b>  |
| Vision  | 5         |
| Mission Statement                                 | 5         |
| Grand Challenges                                  | 5         |
| <b>Research Plan / Strategy</b>                   | <b>7</b>  |
| <b>Organisation</b>                               | <b>12</b> |
| Centre Management                                 | 12        |
| Organisation Map                                  | 12        |
| Work Packages WP1 – WP7                           | 13        |
| Steering Board                                    | 20        |
| Partners  | 21        |
| <b>Innovation</b>                                 | <b>24</b> |
| <b>Scientific Activities and Results</b>          | <b>26</b> |
| <b>International Cooperation</b>                  | <b>28</b> |
| <b>Recruitment</b>                                | <b>30</b> |
| <b>Communication and Dissemination Activities</b> | <b>32</b> |
| <b>Dissemination Activities</b>                   | <b>34</b> |
| Student Projects                                  | 38        |

# Annual Report 2020

## Summary

### HISTORY

SFI Offshore Mechatronics has its origins from the Agder cooperation within the field of Mechatronics, initiated by University of Agder with partners from the local industry related to offshore engineering. This cooperation has been active for several years, and has its origin in the establishment of Master and PhD education to produce candidates for the regional and national labour market. Since then, the cooperation has developed to include R&D projects and mobility between industry companies and UiA. During the project period a strong relation between the industry partners and the other universities and research institute partners (NTNU, Aalborg University, RWTH Aachen and NORCE) have been formed.

### THE RESEARCH

The main goal is to develop new concepts for autonomous systems where the construction, engineering and design invite autonomy to minimize the number of manual processes, as well as to reduce risk and cost related to offshore engineering and operations. The research will result in enabling technologies, equipment, processes and solutions for autonomy and monitoring of heavy machinery, and for handling and analysing large data flows under demanding conditions. The research is carried out in seven work packages: WP1 Drives, WP2 Motion Compensation, WP3 Robotics and Autonomy, WP4 Modelling and Simulation, WP5 Monitoring Techniques, WP6 Data Analytics, IT Integration and Big Data and WP7 Technology Vision.

### ORGANISATION

SFI Offshore Mechatronics is hosted by UiA, Faculty of Engineering and Science. UiA is responsible for three work-packages, NTNU for two, University of Aalborg for one and NORCE for one work package. In addition, NTNU Aalesund and RWTH Aachen participate in different WPs. GCE NODE heads a non-scientific work package for technology vision. The industrial partners are ABB, Bosch Rexroth, Cameron, Klueber Lubrication, Egde consulting, Lundin, MacGregor, MHWirth, National Oilwell Varco, Skeie Technology Consulting and Stepchange. The SFI Offshore Mechatronics Steering board consists of 7 partners, where the industry partners hold majority. The Centre Director heads the daily operations, assisted by an administrative manager.

SCIENTIFIC ACTIVITIES AND RESULTS

Each PhD defense is a milestone in the SFI Offshore Mechatronics centre. In 2020 seven PhD fellows defended their thesis. In 2020 a large share of the scientific publications was at the highest level (Level2 in Norway). Out of 19 journal papers 6 (32%) were published at the highest level.

INTERNATIONAL COOPERATION

The SFI Offshore Mechatronics center is distributed with industry and research partners across four countries (Norway, Denmark, The Netherlands and Germany). In addition to this, the researchers in the centre utilize their extensive international networks. Due to COVID-19, the opportunities to travel and accommodate guest researchers have been limited in 2020.

RECRUITMENT

In 2020 five new PhD students and three new Post.Doc positions were hired. By the end of 2020 all final PhD and Post.Doc positions have been filled. During the project period a total of 40 researcher and technicians have been recruited. Unfortunately, it was not possible to recruit any female PhD students or Post.Doc positions in 2020.

COMMUNICATION AND DISSEMINATION ACTIVITIES

The main event for communication and dissemination in the project is the SFI Offshore Mechatronics Annual Conference. In 2020, the conference was planned on May 12-13, however due to the situation with COVID-19 it was postponed and eventually cancelled. To compensate for the cancellation of the annual conference short bi-weekly webinars were introduced targeting attendees from both industry and the research partners.

Vision and Objectives

VISION

The SFI Offshore Mechatronics will become the international knowledge and research hub for the next generation of advanced offshore mechatronic systems for autonomous operation and condition monitoring of offshore engineering systems under the control of land-based operation centres, to ensure safe and efficient operation in deeper water and in harsh environments. The centre shall contribute significantly to growth and innovation in the industry, creating jobs and business with potential both within the target sector, and beyond, such as maritime industry, with a net positive impact on society.

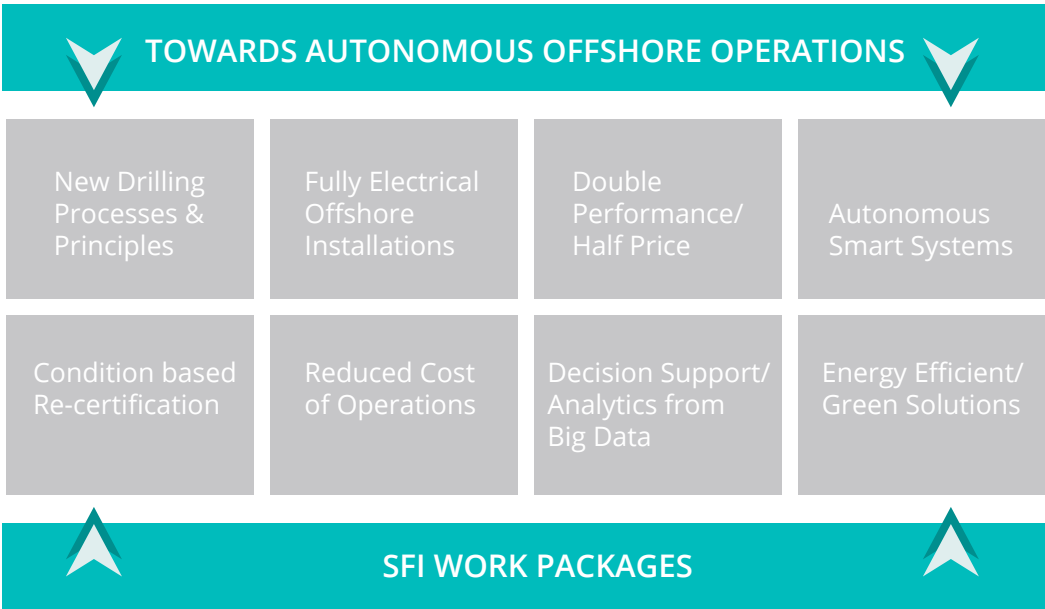
MISSION STATEMENT

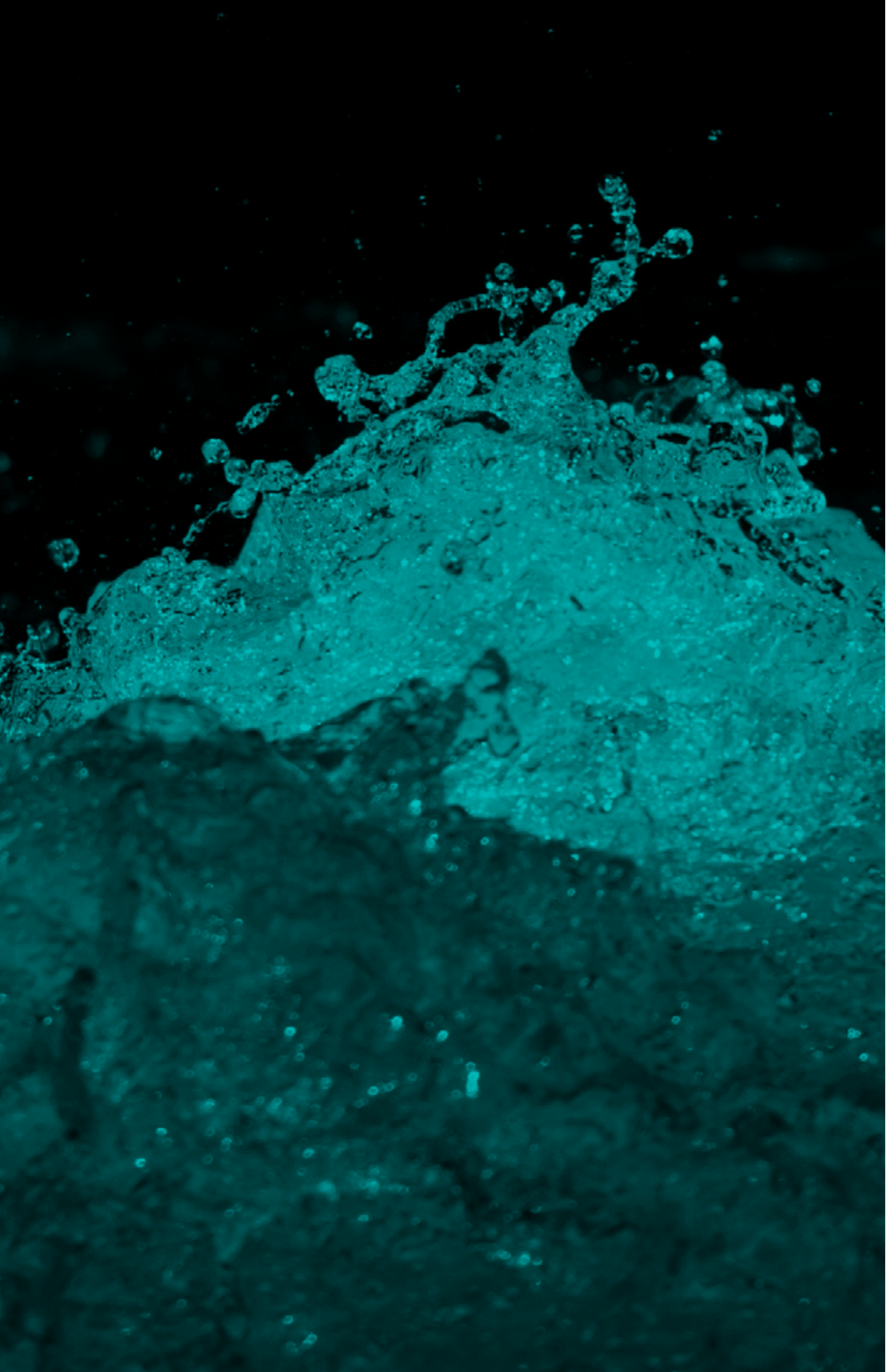
By 2023, SFI Offshore Mechatronics shall have succeeded in becoming an internationally renowned research-based innovation centre reaching national, international and long-term targets.

- National target** – develop new concepts for autonomous systems where the construction, engineering and design invite autonomy to minimize the number of manual processes, as well as to reduce risk and cost related to offshore operations.
- International target** – support the industry partners to strengthen the global position by developing the most efficient and safe future offshore operations.
- Long-term target** – enable technologies, equipment, processes and solutions for autonomy and monitoring of heavy machinery, and for handling and analysing large data flows under demanding conditions.

GRAND CHALLENGES

The grand challenges are:





## Research Plan/Strategy

The research shall result in enabling technologies, equipment, processes and solutions for autonomy and monitoring of heavy machinery, and for handling and analysing large data flows under demanding conditions. Since there are several companies in the centre which operate in the same business segment, it has been decided that the researchers focus on enabling technologies and technological building blocks, rather than working too closely with product specific development.

The research themes of all the positions have been defined in close cooperation with the partner companies. The work program of each work-package is approved annually by the General Assembly.

The research is carried out in seven work packages:

- Work-Package 1: Drives
- Work-Package 2: Motion Compensation
- Work-Package 3: Robotics And Autonomy
- Work-Package 4: Modelling And Simulation
- Work-Package 5: Monitoring Techniques
- Work-Package 6: Data Analytics, It Integration And Big Data
- Work-Package 7: Technology Vision





## WORK-PACKAGE 1: DRIVES

| 2015    | 2016                           | 2017                                  | 2018                                | 2019    | 2020                                     | 2021                                    | 2022    | 2023    |
|---------|--------------------------------|---------------------------------------|-------------------------------------|---------|--|---|---------|---------|
| 1 2 3 4 | 1 2 3 4                        | 1 2 3 4                               | 1 2 3 4                             | 1 2 3 4 | 1 2 3 4                                  | 1 2 3 4                                 | 1 2 3 4 | 1 2 3 4 |
|         | WP1.2 Sondre Nordås (PhD, UiA) |                                       |                                     |         | WP1.6, Wei Zhao (PhD, UiA)               |   |         |         |
|         | WP1.4 Daniel Hagen (PhD, UiA)  |                                       |                                     |         |  |   |         |         |
|         |                                | WP1.3 Viktor H. Donkov (PhD, Aalborg) |                                     |         | WP1.7, Thomas Farsakoglou (PhD, Aalborg) |   |         |         |
|         |                                |                                       | WP1.5 Søren Ketelsen (PhD, Aalborg) |         |  |   |         |         |
|         |                                |                                       |                                     |         |  | WP1.8, New Position (Post.Doc, Aalborg) |         |         |

## WORK-PACKAGE 2: MOTION COMPENSATION

| 2015    | 2016                                   | 2017   | 2018    | 2019    | 2020  | 2021    | 2022    | 2023    |
|---------|--|--|---------|---------|---|---------|---------|---------|
| 1 2 3 4 | 1 2 3 4                                | 1 2 3 4  | 1 2 3 4 | 1 2 3 4 | 1 2 3 4   | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 |
|         | WP2.1 Geir Ole Tysse, (PhD, NTNU)      |  |         |         |   |         |         |         |
|         | WP2.2 Torstein Myhre, (Post.Doc, NTNU) |  |         |         |   |         |         |         |
|         |  | WP2.3 Andrej Cibicik, (PhD, NTNU)              |         |         | WP2.7, Hans Kristian Holen (PhD, NTNU)          |         |         |         |
|         |  | WP2.4 Alexander Meyer Sjøberg, (PhD, NTNU)     |         |         | WP2.8, Alexander Meyer Sjøberg (Post.Doc, NTNU) |         |         |         |
|         | WP2.5 Sondre Sanden Tørdal (PhD, UiA)  |  |         |         |   |         |         |         |
|         |  | WP2.6 Philip Schubert, IRT, (PhD, RWTH Aachen) |         |         |   |         |         |         |

## WORK-PACKAGE 3: ROBOTICS AND AUTONOMY

| 2015    | 2016                                      | 2017                             | 2018                                       | 2019  | 2020                                  | 2021    | 2022    | 2023    |
|---------|---|----------------------------------|--|---|---------------------------------------|---------|---------|---------|
| 1 2 3 4 | 1 2 3 4                                   | 1 2 3 4                          | 1 2 3 4                                    | 1 2 3 4   | 1 2 3 4                               | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 |
|         | Researcher, Dr. Knut Berg Kaldestad (UiA) |                                  |  |   |                                       |         |         |         |
|         |   | WP3.1 Joacim Dybedal, (PhD, UiA) |  |   |                                       |         |         |         |
|         |   | WP3.2 Atle Aalerud, (PhD, UiA)   |  |   |                                       |         |         |         |
|         |   | WP3.3 Aksel Sveier, (PhD, NTNU)  |  |   |                                       |         |         |         |
|         |   |                                  | WP3.5 Thilina Nuwan Weerasinghe (PhD, UiA) |   |                                       |         |         |         |
|         |   |                                  |  | WP3.6 Dipendra Subedi, (PhD)                    |                                       |         |         |         |
|         |   |                                  |  | WP3.7 Ronny Landsverk (PhD)                     |                                       |         |         |         |
|         |   |                                  |  | WP3.8 Yvonne Murray, (Integr. master/ PhD, UiA) |                                       |         |         |         |
|         |   |                                  |  |   | WP3.9/WP6.5 Jose Amendola, (PhD, UiA) |         |         |         |

## WORK-PACKAGE 4: MODELLING AND SIMULATION

| 2015    | 2016    | 2017  | 2018    | 2019    | 2020    | 2021                                | 2022    | 2023    |
|---------|---------|---|---------|---------|---------|-------------------------------------|---------|---------|
| 1 2 3 4 | 1 2 3 4 | 1 2 3 4                                       | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4                             | 1 2 3 4 | 1 2 3 4 |
|         |         | WP4.1 Savin Viswanathan (PhD, NTNU)           |         |         |         |                                     |         |         |
|         |         | WP4.2 Njål Tengesdal (PhD, NTNU)              |         |         |         |                                     |         |         |
|         |         | WP4.3 Lars Ivar Hatledal (PhD, NTNU Aalesund) |         |         |         |                                     |         |         |
|         |         | WP4.4 Gaute Fotland (PhD, NTNU)               |         |         |         |                                     |         |         |
|         |         |   |         |         |         | WP4.5 Savin Viswanathan (PhD, NTNU) |         |         |

## WORK-PACKAGE 5: MONITORING TECHNIQUES

| 2015    | 2016                            | 2017  | 2018    | 2019                           | 2020                             | 2021    | 2022    | 2023    |
|---------|---------------------------------|---|---------|--------------------------------|----------------------------------|---------|---------|---------|
| 1 2 3 4 | 1 2 3 4                         | 1 2 3 4   | 1 2 3 4 | 1 2 3 4                        | 1 2 3 4                          | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 |
|         | WP5.1 Martin Hemmer, (PhD, UiA) |   |         |                                |                                  |         |         |         |
|         |                                 | WP5.2 Rune Schlanbusch - NORCE                              |         |                                |                                  |         |         |         |
|         |                                 | WP5.3 Shaun Falconer (PhD, UiA)                             |         |                                |                                  |         |         |         |
|         |                                 | WP5.4 Achim Feldermann and Lothar Wöll, (PhD, IME - Aachen) |         |                                | Mohammed Yusuf, (PhD IME Aachen) |         |         |         |
|         |                                 | WP5.5 Zbigniew Mikulski, (PhD, UiA)                         |         |                                |                                  |         |         |         |
|         |                                 |   |         | WP5.6 Vignesh Shanbhag - NORCE |                                  |         |         |         |

## WORK-PACKAGE 6: DATA ANALYTICS, IT INTEGRATION AND BIG DATA

| 2015    | 2016    | 2017                                      | 2018                                 | 2019    | 2020                                       | 2021                                  | 2022    | 2023    |
|---------|---------|---|--------------------------------------|---------|--|---------------------------------------|---------|---------|
| 1 2 3 4 | 1 2 3 4 | 1 2 3 4                                   | 1 2 3 4                              | 1 2 3 4 | 1 2 3 4                                    | 1 2 3 4                               | 1 2 3 4 | 1 2 3 4 |
|         |         | WP6.1 Luis M. Lopez-Ramos (Post.Doc, UiA) |                                      |         |  |                                       |         |         |
|         |         |   | WP6.2 Emilio Ruiz Moreno, (PhD, UiA) |         |  |                                       |         |         |
|         |         |   |                                      |         | WP6.3 Kevin Roy, (PhD, UiA)                |                                       |         |         |
|         |         |   |                                      |         | WP6.4 Luis M. Lopez-Ramos, (Post.Doc, UiA) |                                       |         |         |
|         |         |   |                                      |         |  | WP3.9/WP6.5 Jose Amendola, (PhD, UiA) |         |         |

## WORK-PACKAGE 7: TECHNOLOGY VISION

| 2015    | 2016    | 2017    | 2018    | 2019    | 2020                                | 2021    | 2022    | 2023    |
|---------|---------|---------|---------|---------|-------------------------------------|---------|---------|---------|
| 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 | 1 2 3 4                             | 1 2 3 4 | 1 2 3 4 | 1 2 3 4 |
|         |         |         |         |         | WP7.1 Marius Kristiansen (PhD, UiA) |         |         |         |

# The working titles of the positions

|  |   |  |  |
|--|---|--|--|
| <b>WP1.2</b> Using digital hydraulic in secondary control of motor drive.                                | <b>WP2.5</b> Real-time multiple DOF motion compensation using an industrial robot, sensor fusion and conformal geometric algebra.       | <b>WP3.7</b> Coupled dynamics between vessel and crane (associated PhD position).                                | <b>WP5.4</b> Condition-based lifetime prediction as result of calculated component loads.  |
| <b>WP1.3</b> Using digital hydraulic in secondary control of cylinder drive.                             | <b>WP2.6</b> Real-time teleoperation and model-based control of cranes with loads.  | <b>WP3.8</b> Formal Methods in Robotics (integrated MSc / PhD position).   | <b>WP5.5</b> Modelling the fatigue damage mechanism in welded joints (associated PhD position).  |
| <b>WP1.4</b> Electrical and electrohydraulic linear actuators.   | <b>WP2.7</b> Vision systems for supervision of offshore drilling operations.  | <b>WP3.9 / WP6.5</b> Sensor fusion for perception, collision avoidance and navigation towards autonomous systems | <b>WP5.6</b> Monitoring of Hydraulic Cylinders   |
| <b>WP1.5</b> Cylinder direct drive.  | <b>WP2.8</b> Fusion of vision, Lidar and IMU data for 3D tracking of objects in offshore crane operations.                              | <b>WP4.1</b> Integrated simulation of multi-physical systems in offshore operations.                             | <b>WP6.1</b> Distributed in-network intelligence across multiple components.   |
| <b>WP1.6</b> Energy efficient mobile hydraulic systems with focus on rotary actuation.                   | <b>WP3.1</b> Development of offshore 3D sensor package.   | <b>WP4.2</b> Component-based simulation systems for drilling automation and crane systems.                       | <b>WP6.2</b> Coordinated multi-variable data acquisition, intelligent data reduction, as well as automatic data quality verification and validation. |
| <b>WP1.7</b> Energy efficient mobile hydraulic systems with focus on linear actuation.                   | <b>WP3.2</b> Autonomy systems foundation development.   | <b>WP4.3</b> Protocols and standard for integration of simulation models and co-simulation.                      | <b>WP6.3</b> Design of soft-sensors based on novel context-aware data fusion techniques  |
| <b>WP1.8</b> Energy efficient mobile hydraulic systems with focus on digital valve technology.           | <b>WP3.3</b> Handling of sensor fusion, point-clouds and 3D maps.   | <b>WP4.4</b> Modelling and simulation of cable and pulley systems in offshore cranes.                            | <b>WP6.4</b> Optimization of energy consumption and emission reduction for O&G production platforms.   |
| <b>WP2.1</b> Computer vision and 3D sensors for topside automation of offshore drilling.                 | <b>WP3.4</b> Implementation of situational awareness/human factors concepts for operators using virtual arena.                          | <b>WP4.5</b> Modeling and simulation of the motion of ships, cranes and drilling systems in waves                | <b>WP6.5 / WP3.9</b> Sensor fusion for perception, collision avoidance and navigation towards autonomous systems                                     |
| <b>WP2.2</b> High-performance control for motion compensation.   | <b>WP3.5</b> Reliable Communication in 5G.  | <b>WP5.1</b> Tapered big bearings.   | <b>WP7.1</b> The management of digital business model innovation   |
| <b>WP2.3</b> Nonlinear friction compensation in motion compensation systems with significant elasticity. | <b>WP3.6</b> Instrumentation and real-time control of long-reach, light-weight arm intended for use offshore (associated PhD position). | <b>WP5.2</b> Large diameter steel ropes.   |  |
| <b>WP2.4</b> Vision systems for offshore crane control in ship-to-ship operations.                       |   | <b>WP5.3</b> Fibre ropes.  |  |

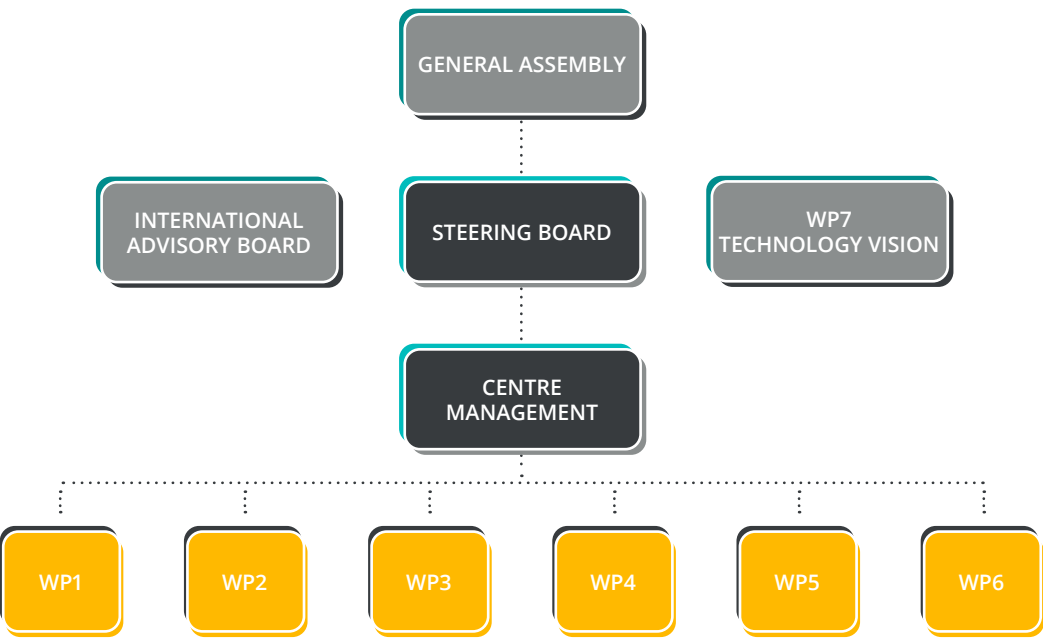


# Organisation

**CENTRE MANAGEMENT**  
 The SFI Offshore Mechatronics centre is hosted by UiA and the management is led by Centre Director, Professor **Geir Hovland** with assistance from Administrative Manager **Anne-Line Agedal** and Innovation Manager **Asle Pedersen**. In addition, UiA provides necessary resources from the Faculty and Central Management.



## ORGANISATION MAP



# Work Packages WP1 – WP7



WP-leaders: Olav Egeland, Torben Ole Andersen, Thomas Meyer, Anne Grete Ellingsen (replaced by Marianne Engvoll in 2019), Geir Hovland, Baltasar Beferull-Lozano and Morten Kjeld Ebbesen.

## WP1

**WP1 LEADER 1**  
**Morten Kjeld Ebbesen, UiA**  
 Co-sup. WP1.2, co-sup. WP1.3, and sup. WP1.4

**WP1 LEADER 2**  
**Torben Ole Andersen, AAU**  
 Sup. WP1.2, sup. WP1.3, and co-sup WP1.4

**WP1.2**  
**Sondre Nordås**  
 UiA

**WP1.3**  
**Viktor Hristov Donkov**  
 AAU

**WP1.4**  
**Daniel Hagen**  
 UiA

**WP1.5**  
**Søren Ketelsen**  
 AAU

**WP1.6**  
**Wei Zhao**  
 UiA

**WP1.7**  
**Thomas Farsakoglou**  
 AAU

**WP1.8**  
**New position**  
 AAU



## WP2



WP2 LEADER  
**Olav Egeland, NTNU**  
Supervisor WP2.1-2.4



**Dirk Abel**  
RWTH Aachen  
Sup. WP2.6



**Geir Hovland**  
UiA  
Sup. WP2.5



WP2.1  
**Geir O. Tysse**  
NTNU



WP2.2  
**Torstein Myhre**  
NTNU



WP2.3  
**Andrej Cibicik**  
NTNU



WP2.4  
**Alexander M. Sjøberg, NTNU**



WP2.5  
**Sondre S. Tørdal**  
UiA



WP2.6  
**Philip Schubert**  
RWTH Aachen

## WP3



WP3 LEADER  
**Geir Hovland, UiA**  
Supervisor WP3.1 and WP3.2, Co-supervisor WP3.6, WP3.7



WP2.7  
**Hans Kristian Holen, NTNU**



WP2.8  
**Alexander M. Sjøberg, NTNU**



**Olav Egeland**  
NTNU  
Sup. WP3.3



**Houxiang Zhang**  
NTNU Aalesund  
Sup. WP3.4



**Ilya Tyapin**  
UiA Sup. WP3.6



**Jing Zhou**  
UiA Sup. WP3.7



**David Anisi**  
ABB  
Co.Sup WP3.2



WP3.1  
**Joacim Dybedal**  
UiA



WP3.2  
**Atle Aalerud**  
UiA



**Ajit Jha**  
UiA  
Sup. WP 3.9



**Frank Y. Li**  
UiA  
Sup. WP 3.5



**Knut Berg Kaldestad**  
UiA  
Technician  
Sup. WPs



**Charlotte Skourup**  
ABB  
Co.Sup WP3.4



WP3.3  
**Aksel Sveier**  
NTNU



WP3.4  
**Thiago G. Monteiro**  
NTNU  
Aalesund



WP3.5  
**Thilina N. Weerasinghe**  
UiA



WP3.6  
**Dipendra Subedi**  
UiA



WP3.7  
**Ronny Landsverk**  
UiA



WP3.8  
**Yvonne Murray,**  
UiA



WP3.9  
**Jose Amendola**  
UiA





## WP4



WP2 LEADER  
**Olav Egeland, NTNU**  
Supervisor WP2.1-2.4



**Christian Holden, NTNU**  
Sup. WP4.1 & WP4.2



**Houxiang Zhang**  
NTNU Aalesund  
Sup. WP4.3



**Terje Rølvåg**  
NTNU  
Sup. WP4.4



**Geir Hovland**  
UiA  
Co-Sup. WP4.3



**Bjørn Haugen**  
NTNU  
Co-sup. WP4.4



**Arne Styve**  
NTNU  
Aalesund  
Co-sup. WP4.3



WP4.1  
**Savin Viswanathan**  
NTNU



WP4.2  
**Njål Tengesdal**  
NTNU



WP4.3  
**Lars Ivar Hatledal**  
NTNU Aalesund



WP4.4  
**Gaute Fotland**  
NTNU



WP4.5  
**Savin Viswanathan**  
NTNU

## WP5



WP5 LEADER  
**Thomas J.J. Meyer**  
NORCE



**Ian K. Jennions**  
Cranfield U.

Subtask 5.1  
«Big tapered roller bearings»



**Tor Inge Waag**  
Task leader, NORCE



**Kjell Gunnar Robbersmyr**  
UiA  
Sup. WP5.1

Subtask 5.2  
«Big steel ropes»



**Rune Schlanbusch**  
Task leader, NORCE



WP5.1  
**Martin Hemmer**  
UiA

Subtask 5.3  
«Big fiber ropes»



**Ellen Nordgård-Hansen**  
Task leader, NORCE



WP5.3  
**Shaun Falconer**  
UiA



**Geir Grasmo**  
UiA  
Sup. WP5.3

Subtask 5.4  
«Winch Lifetime predictions»



**Achim Feldermann**  
Task leader, Aachen IME



WP5.4  
**Mohammed Yusuf**  
Aachen IME

Subtask 5.5  
«Welded joints fatigue predictions»



**Tom Lassen**  
Task leader, UiA



WP5.5  
**Zbigniew Mikulski**  
UiA



WP5.6  
**Vignesh Shanbhag**  
NORCE



## WP6



WP6 LEADER  
**Baltasar Beferull-Lozano, UiA**  
Supervisor WP6.1 - WP6.2



**Daniel Romero**  
UiA  
Co. Sup. WP6.1



**Linga Cenkeramaddi**  
UiA  
Co. Sup.



**Jing Zhou**  
UiA  
Co. Sup. WP6.2



**Ajit Jha**  
UiA  
Sup. WP6.3 and WP6.5



WP6.1/WP6.4  
**Luis M. Lopez-Ramos**  
UiA



WP6.2  
**Emilio Ruiz Moreno**  
UiA



WP6.3  
**Kevin Roy**  
UiA



WP6.5/WP3.9  
**Jose Amendola**  
UiA

## WP7



WP7 LEADER  
**Marianne Engvoll, GCE NODE**



WP7 LEADER  
**Øyvind Haugen, NORCE**



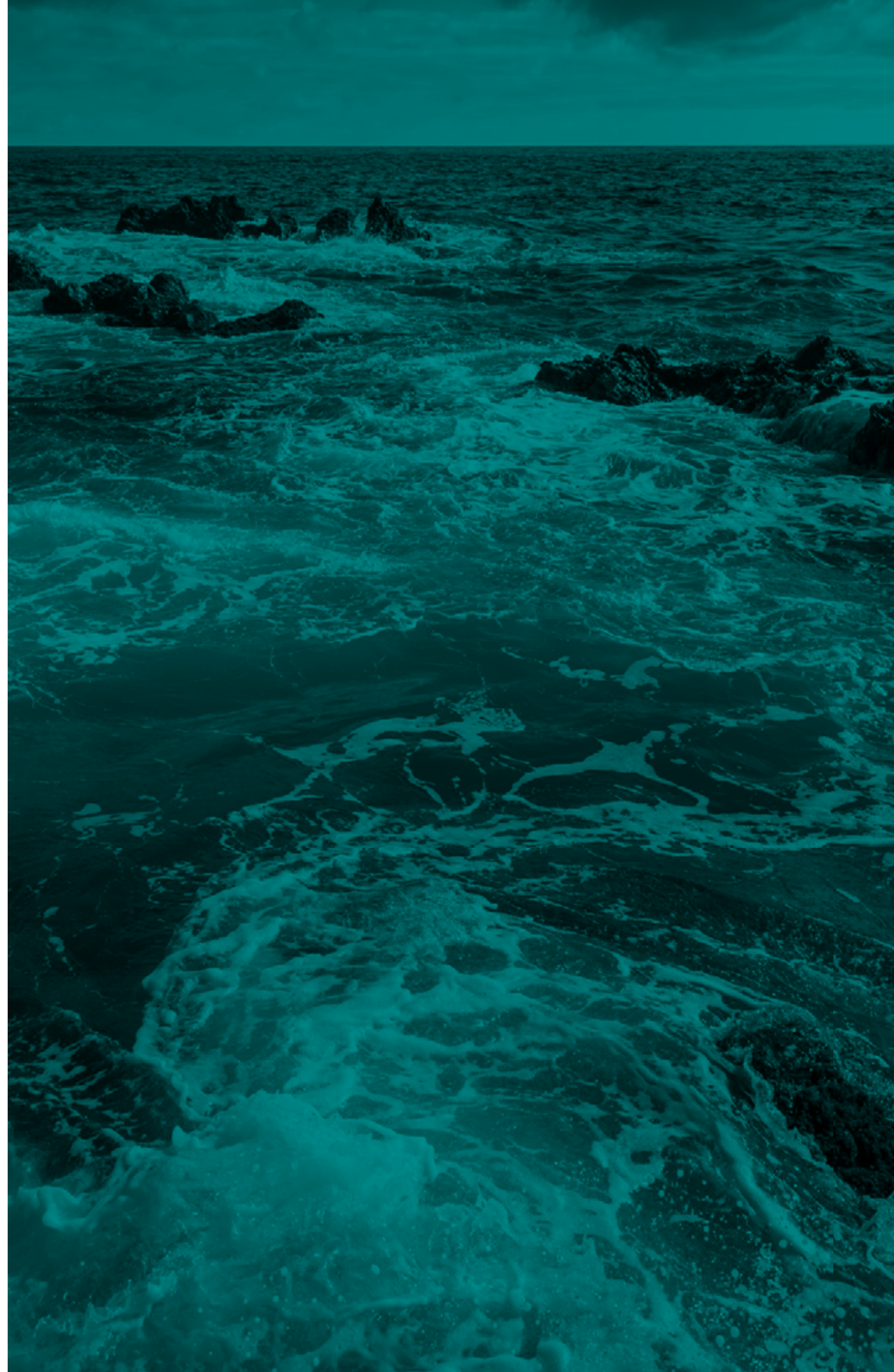
**Thor Helge Aas, UiA**  
Supervisor WP7.1



**Jan Helge Viste, GCENode**  
Supervisor WP7.1



WP7.1  
**Marius T. Kristiansen**  
UiA



# Steering Board

The Steering board (2019-2020) consists of 7 members, and 2 deputy members: Leif Haukom (GCE NODE), Morten Halvorsen (NOV), Sjur Henning Hollekim (MHWirth), Øyvind Mydland (Stepchange) , Houxiang Zhang (NTNU), Philipp Schubert (RWTH Aachen) and Geir Grasmø (UiA), Eivind Gimming Stensland (Deputy, MacGregor) and Thor Arne Håverstad (Deputy, Norce).

The majority of the SFI Offshore Mechatronics Steering Board members are from the Industry Partners. The Steering board is appointed for 2 years. It is the General Assembly which appoints the Steering board.



**Leif Haukom**  
GCE NODE  
Chairperson



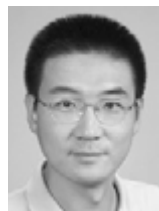
**Morten Halvorsen**  
NOV  
Deputy Chairperson



**Sjur Henning Hollekim**  
MHWirth



**Øyvind Mydland**  
Stepchange



**Houxiang Zhang**  
NTNU Aalesund



**Philipp Schubert**  
RWTH Aachen



**Geir Grasmø**  
UiA



**Eivind Gimming Stensland**  
MacGregor



**Thor Arne Håverstad**  
Norce

The Centre has one General Assembly every year, where all partners meet and work-plans for the following year are presented and discussed.

The General Assembly was held on November 11, 2020, where the budget for next three years and the WP annual work plans were presented and approved.

| KEY NUMBERS 2019         |    |
|--------------------------|----|
| Steering Board Meetings  | 4  |
| WP leader meetings       | 10 |
| Workshops/Webinars       | 6  |
| Reference Group Meetings | 6  |
| Conferences              | 0  |
| General Assembly         | 1  |

# Partners



Partners gathering on the SFI OM annual conference.





## Tom Fidjeland replaces Leif Haukom as Chairperson of the Board

“Leif has been a tremendous asset for the SFI. Based on his long and strong track-record in the industry, Leif has chaired the SFI in a brilliant way since its inception. We thank him for his efforts in leading the SFI Offshore Mechatronics,” says Tom Fidjeland, CEO of GCE NODE.

Leif Haukom chaired the SFI’s Board of Directors on behalf of GCE NODE. A few years into retirement, Haukom has now decided to leave this position. Tom Fidjeland, CEO of GCE NODE, was elected as the new Chairperson of the Board in the General Assembly on November 11.

“From the companies’ point of view there has traditionally been a gap between academic research and industrial needs. As a result of the companies’ involvement, research in the SFI centre has been more focused,” says Haukom. Some of the PhD fellows were recruited from the industry partners and return to their company after completion of their thesis. These candidates bring valuable industry insight into the research and then valuable research experience back into the companies.

In addition to this, several of the graduated PhD fellows have been hired by the industry partners. Recruitment, bachelor and master theses, and various forms of mobility contribute to maintaining a strong relation between the academic and industrial partners.

“A valuable outcome of the SFI centre is achieved when PhD fellows complete their research, get hired by the industry and utilize their new knowledge to develop better products for the companies,” says Haukom.

“Building on the idea of co-creation of knowledge, which is the vision of the University of Agder, the industry and all the research partners have come close in the SFI centre. Both parties will for years to come continue to gain from the technological knowledge and personal relationships established through the centre,” says Haukom.

### The new Board of Directors (2021-2023):

- Tom Fidjeland (GCE NODE), new member of the board and new chairperson
- Morten Halvorsen (NOV), re-elected member of the board and new deputy chairperson
- Sjur Henning Hollekim (MHWirth), re-elected member of the board
- Jisha Panikar (Klüber Lubrication), new member of the board
- Olav Egeland (NTNU), new member of the board
- Torben Ole Andersen (Aalborg University), new member of the board
- Geir Grasmø (UiA, in 2021) and Jorunn Gislefoss (UiA, in 2022), re-elected
- Anstein Jorud (Cameron), new deputy member of the board
- Thomas Meyer (NORCE), new deputy member of the board

# Innovation

Research based innovation is a demanding interplay with equally important contributions from the industry partners and the academic partners. The main mode of innovation in SFI Offshore Mechatronics is utilization of research results and knowledge created in the centre by the industry partners to make new or improved processes or products.

The path from a TRL3-4 (Technology Readiness Level) up to TRL7-9 which is expected for a company to make large investments into new concepts and technology is known to be challenging. To reach a higher TRL level we encourage the companies to establish industry-driven spin-off projects.

An innovation usually evolves over an extended period, involving a lot of people and results from multiple research projects. To single out the contributing factors to an innovation can be difficult, however in some cases new innovations can be tracked and linked back to the research efforts and spin-off projects.

We try to keep track of spin-off projects from the centre and in 2020 a total of 8 spin-off projects were created. Some projects are direct spin-offs from the centre and initiated in collaboration with the academic partners. Other projects are indirect spin-offs initiated independently by the industry partners.

From time to time the researchers in the centre come up with new innovative ideas and this is handled according to procedures outlined in the consortium agreement such as reporting an Invention Disclosure (DOFI). The first patent filed based on an invention from the centre was published in June 2020.

The patent pending concept is related to improvements in the performance of spinning LiDARs and the inventors are PhD fellows Atle Aalerud and Joacim Dybedal. A spin-off project to commercialize the invention has been created in a partnership between UiA and Innoventus Sør and with funding from the Research Council of Norway, in the FORNY program.

An example of a direct spin-off project in 2020 is "Increasing Operational Efficiency by Retrofitting Sensor-Based Anti-Swing Technology on Offshore Cranes" initiated by MacGregor in collaboration with University of Agder. The project is funded by the Research Council of Norway Maroff-2 program. Research from the project will greatly support a newsolution innovation from MacGregor in collaboration with Kongsberg Maritime called Motion Compensated Pile Gripper. The scientific challenges related to the innovation is close to the research in the SFI Offshore Mechatronics such as wave compensation and control systems. The motion compensated pile gripper will be used for installation of offshore wind towers foundations.

## Releated research:

- Real-Time Motion Compensation in Ship-to-Ship Load Handling (Sondre Sanden Tørdal WP2.5)
- Quaternions and Dual Quaternions for State and Parameter Estimation (Axel Sveier WP3.3)
- High-Performance Control for Motion Compensation (Torstein Myhre WP2.2)
- Integrated simulation of multi-physical systems in offshore operations (Savin Viswanathan, WP4.1)
- Modeling and simulation of the motion of ships, cranes and drilling systems in waves (Savin Viswanathan, WP4.5)
- Protocols and standards for integration of simulation models and co-simulation (Lars Ivar Hatledal, WP4.3)

## Motion Compensated Pile Gripper

Static pile gripper frames are well known in the industry and are traditionally used for jack-up vessels. With the Offshore Wind market trends, wind farms being installed further offshore and the requirement of handling much larger monopiles, legacy jack-up vessels are not capable of handling the job. Therefore, the market demanded for an innovative approach for installing monopiles by means of a floating vessel, with the pile gripper frame capable of compensating for the vessel motions. One example of this is the use of next generation wind foundation installation vessels as OHT Alfa Lift, combined with a 3000 t crane from Liebherr and MacGregor motion compensated pile gripper. It is the combination of multiple innovative elements that makes the solution unique and new compared to existing solutions, but certainly the integration to the vessel control system is the way to increase efficiency, operability and safety of the overall installation operation.





# Scientific Activities and Results

**Each PhD defense is a milestone in the SFI Offshore Mechatronics centre. In 2020 seven PhD fellows defended their thesis:**

Andrej Cibicik (NTNU), PhD thesis defended on January 8, 2020. Title of Thesis: Dynamics of Rigid and Flexible Manipulators Using Screw Theory.

Alexander Meyer Sjøberg (NTNU), PhD thesis defended on January 30, 2020. Title of Thesis: Estimation and Control on Lie Groups based on Formulations on the Lie Algebra.

Aksel Sveier (NTNU), PhD thesis defended on February 18, 2020. Title of Thesis: Quaternions and Dual Quaternions for State and Parameter Estimation.

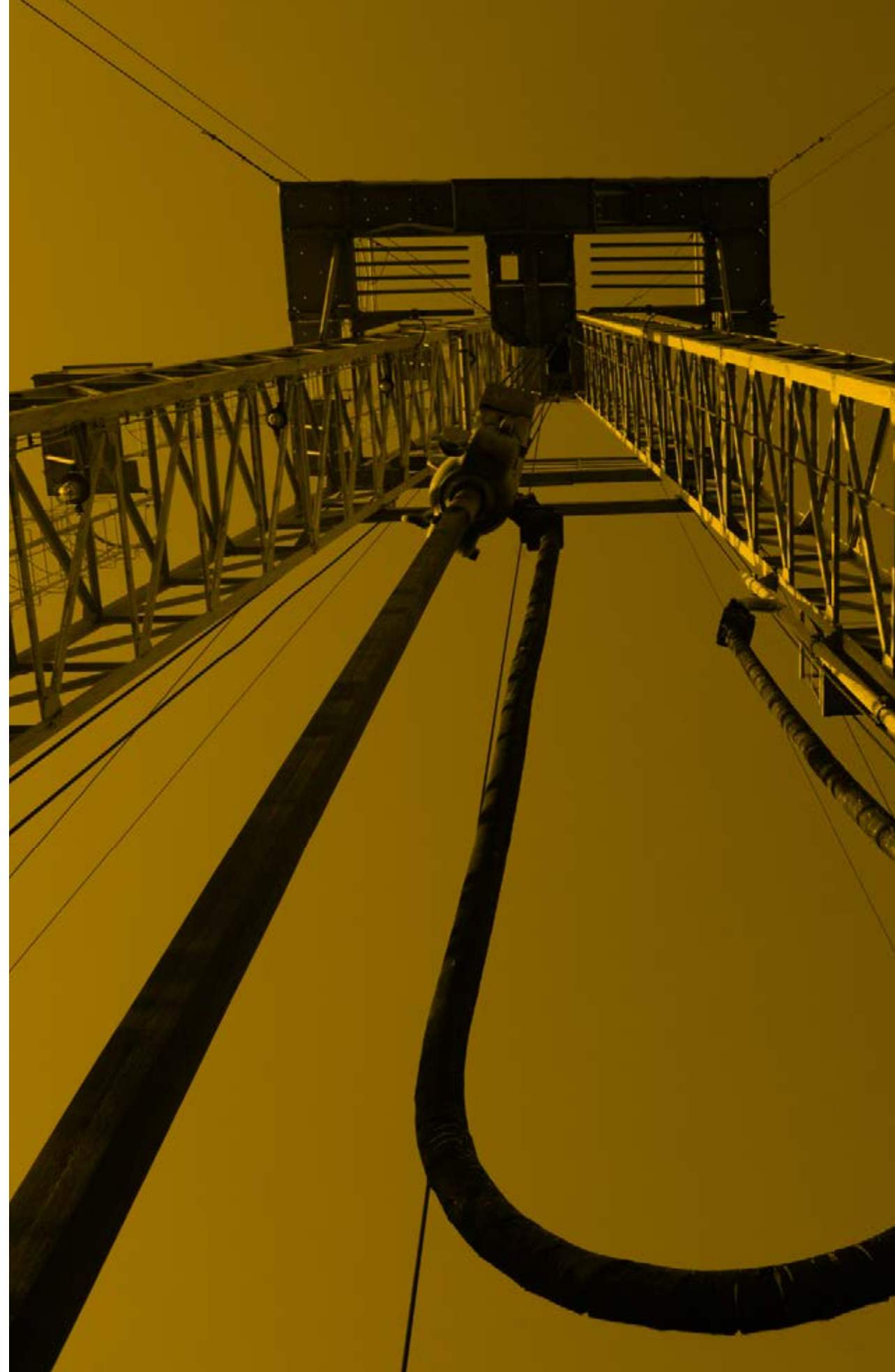
Sondre Nordås (UiA), PhD thesis defended on April 16, 2020. Title of Thesis: Using Digital Hydraulics in Secondary Control of Motor Drive.

Martin Hemmer (UiA), PhD thesis defended on May 15, 2020. Title of Thesis: Condition Monitoring Methods for Large Low-speed Bearings.

Geir Ole Tysse (NTNU), PhD defended on August 11, 2020. Title of thesis: Modeling and Control of Ship-Mounted Cranes.

Daniel Hagen (UiA), PhD defended on September 2, 2020. Title of Thesis: Improving Energy Efficiency and Motion Control in Load-Carrying Applications using Self-Contained Cylinders.

In 2020 a large share of the scientific publications was at the highest level (Level2). Out of 19 journal papers 6 (32%) were published in the highest ranked journals.







## International Cooperation

The SFI Offshore Mechatronics centre is distributed with industry and research partners across four countries (Norway, Denmark, The Netherlands and Germany). In addition to this the researchers in the centre utilize their extensive international networks.

The centre has a small international advisory board. It consists of the following persons: Professor Rolf Johannsson, Lund University, Sweden, Professor Ian Jennions, Cranfield University, UK and Professor Iraj Ershagi, University of Southern California, USA. This board was more active in the early stages of the centre.

Due to COVID-19, in 2020 the opportunities to travel and accommodate guest researchers have been limited. However, most of the PhD defenses have international opponents. The written examination reports serve as valuable feedback on the relevance, quality and impact of the research in the centre. The following are a few excerpts of some very positive feedback:

- Dr. Isabelle Fantoni, France: "The contributions of the thesis are substantial with a thorough theoretical foundation and are also well documented experimentally."
- Prof. Lorenzo Marconi, Italy: "The thesis is extremely rigorous from a mathematical viewpoint and definitely provides an elegant and powerful framework by contributing with new knowledge to the state of the art."
- Prof. Joris de Schutter, Belgium: "The contribution is original and the development of the theoretical framework and the presentation in the thesis is of high quality."
- Prof. Oliver Sawodny, Germany: "The candidate made important achievements in modelling of ship crane and load dynamics, in combination with the wave excitation."
- Prof. Demba Diallo, France: "A significant contribution of the candidate is the development of a test rig for replicating the scoring on roller end and the analysis of the observed arc-shaped scoring through an analytical model."
- Prof. Svante Gunnarsson, Sweden: "Throughout the thesis the candidate combines solid theoretical work with extensive experiments, and this combination gives a strong support for the industrial relevance of the results."
- Prof. Heikki Handroos, Finland: "The author's clearly novel individual contribution in the overall study is the proposed new version of the partial stroke displacement control strategy."



PhDs and Post.Docs in SFI Offshore Mechatronics

## Recruitment

In 2020 five new PhD students and three new Post.Doc positions were hired. By the end of 2020 all final PhD and Post.Doc positions have been filled. During the project period a total of 40 researcher and technicians have been recruited. The following researchers and technicians were hired in SFI Offshore Mechatronics in 2015-2020. Unfortunately, it was not possible to recruit any female PhD students or Post.Doc positions in 2020.

| NAME                      | POSTITION / INSTITUTION | PERIOD    |
|---------------------------|-------------------------|-----------|
| Torstein Myhre            | Post.Doc, NTNU          | 2015-2017 |
| Geir Olav Tysse           | PhD, NTNU               | 2015-2018 |
| Sondre Sanden Tørdal      | PhD, UiA                | 2015-2018 |
| Achim Felderman           | PhD, RWTH Aachen        | 2015-2017 |
| Atle Aalerud              | PhD, UiA                | 2016-2019 |
| Andrej Cibicik            | PhD, NTNU               | 2016-2019 |
| Joacim Dybedal            | PhD, UiA                | 2016-2019 |
| Shaun Falconer            | PhD, UiA                | 2016-2019 |
| Daniel Hagen              | PhD, UiA                | 2016-2019 |
| Martin Hemmer             | PhD, UiA                | 2016-2019 |
| Sondre Nordås             | PhD, UiA                | 2016-2019 |
| Aleksander Meyer Sjøberg  | PhD, NTNU               | 2016-2019 |
| Aksel Sveier              | PhD, NTNU               | 2016-2019 |
| Thilina Nuwan Weerasinghe | PhD, UiA                | 2016-2019 |
| Philipp Schubert          | PhD, RWTH Aachen        | 2016-2019 |
| Lothar Wöll               | PhD, RWTH Aachen        | 2016-2019 |

|                         |                       |           |
|-------------------------|-----------------------|-----------|
| Zbigniew Mikulski       | PhD, UiA (associated) | 2016-2019 |
| Viktor H. Donkov        | PhD, Aalborg          | 2017-2019 |
| Thiago G. Monteiro      | PhD, NTNU Aalesund    | 2017-2021 |
| Savin Viswanathan       | PhD, NTNU             | 2017-2020 |
| Njål Tengedal           | PhD, NTNU             | 2017-2020 |
| Lars Ivar Hatledal      | PhD, NTNU Aalesund    | 2017-2020 |
| Gaute Fotland           | PhD, NTNU             | 2017-2020 |
| Luis Miguel Lopez Ramos | Post.Doc, UiA         | 2016-2018 |
| Søren Ketelsen          | PhD, Aalborg          | 2018-2021 |
| Emilio Ramiz Moreno     | PhD, UiA              | 2018-2021 |
| Yvonne Murray           | PhD, UiA (associated) | 2018-2021 |
| Hans Kristian Holen     | PhD, NTNU             | 2019-2022 |
| Dipendra Subedi         | PhD, UiA (associated) | 2019-2022 |
| Ronny Landsverk         | PhD, UiA (associated) | 2019-2022 |
| Vignesh Shanbhag        | Post.doc NORCE        | 2019-2021 |
| Mohammed Yusuf          | PhD. RWTH Aachen      | 2019-2023 |
| Alexander Meyer Sjøberg | Post.doc NTNU         | 2020-2022 |
| Kevin Roy               | PhD, UiA              | 2020-2023 |
| Marius Kristiansen      | PhD, UiA              | 2020-2023 |
| Wei Zhao                | PhD, UiA              | 2020-2023 |
| José Amendola           | PhD, UiA              | 2021-2023 |
| Savin Viswanathan       | Post.doc NTNU         | 2021-2023 |
| Tomas Farsakoglou       | PhD, AAU              | 2021-2023 |



# Communication and Dissemination Activities

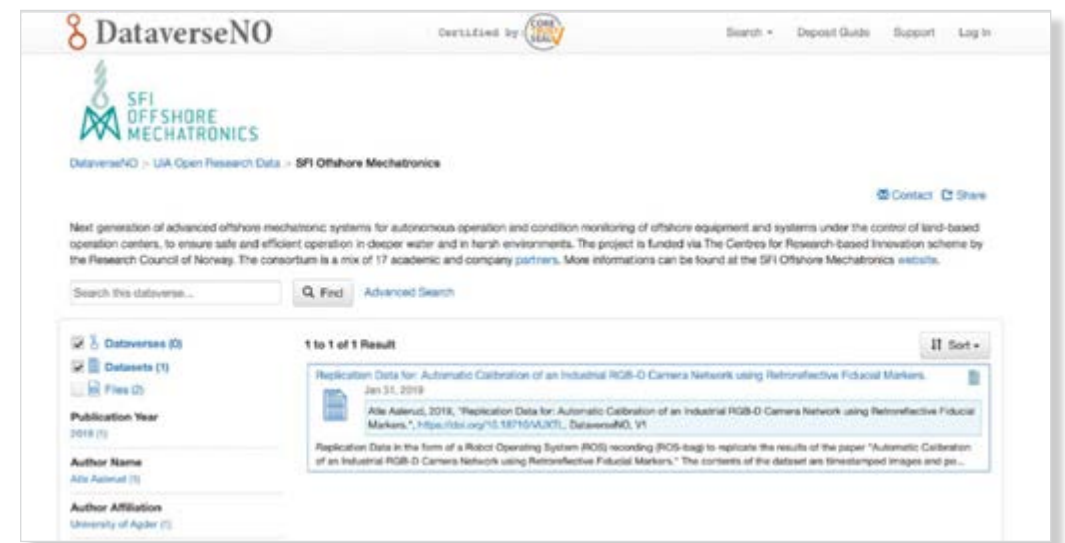
The main event for communication and dissemination in the project is the SFI Offshore Mechatronics Annual Conference. In 2020, the conference was planned on May 12-13, however due to the situation with COVID-19 it was postponed and eventually cancelled.

To compensate for the cancellation of the annual conference short bi-weekly webinars were introduced targeting attendees from both industry and the research partners. The topics of the webinars are various technical subjects with both internal and external presenters. The work-packages also invite people from the industry partners to reference group meetings which is a good opportunity to disseminate results to participate in discussions and to get valuable feedback from an industrial perspective.

SFI Offshore Mechatronics is committed to follow the FAIR principles for scientific data management and stewardship. The FAIR principles provide guidelines to improve the Findability, Accessibility, Interoperability, and Reuse of digital assets.

Github (<https://github.com/SFI-Mechatronics>) is used to host both public and private repositories with source code related to the research in the centre. In 2020 we also started using Dataverse.no to publish datasets. Dataverse.no is hosted by University of Tromsø and is based on The Dataverse Project, developed by the Dataverse Team at the Institute for Quantitative Social Science (IQSS) at Harvard University.

To publish datasets related to our centre, a sub-repository under the UiA Open Research Data repository (<https://dataverse.no/dataverse/mechatronics>) has been reserved. Each dataset published to Dataverse gets a unique DOI identifier which can be referenced in scientific publications. We expect that publishing datasets to Dataverse.no will improve external reuse of the data but also internally between researchers.



SFI Offshore Mechatronics has a web page ([sfi.mechatronics.no](http://sfi.mechatronics.no)) for news and general information about the Project. The web site is both for partners and the general public. All information about the organization, activities and results that are not sensitive is published here. From the web site there is generated a monthly newsletter, with over 350 subscribers. The project is also on Twitter (@sfimechatronics), on Facebook ([facebook.com/SFIOffshoreMechatronics](https://facebook.com/SFIOffshoreMechatronics)) and LinkedIn ([linkedin.com/groups/2556388](https://linkedin.com/groups/2556388)) with almost 500 followers.



# Dissemination Activities

## PUBLICATIONS

### JOURNAL PAPERS

Aksel Sveier and Olav Egeland, **Dual Quaternion Particle Filtering for Pose Estimation**, IEEE Transactions on Control Systems Technology, 2020, (Level 2).

Thiago Gabriel Monteiro, Guoyuan Li, Charlotte Skourup and Houxiang Zhang, **"Investigating an Integrated Sensor Fusion System for Mental Fatigue Assessment for Demanding Maritime Operations"**, MDPI Sensors, 2020, 20(9), 2588.

Thiago Gabriel Monteiro, Charlotte Skourup and Houxiang Zhang, **Optimizing CNN Hyperparameters for Mental Fatigue Assessment in Demanding Maritime Operations**, IEEE Access, February 2020.

Atle Aalerud, Joacim Dybedal and Dipendra Subedi, **"Reshaping Field of View and Resolution with Segmented Reflectors: Bridging the Gap Between Rotating and Solid-State LiDARs"**, Sensors 2020, 20(12), 3388.

Thilina N.Weerasinghe, Indika A.M.Balapuwaduge and Frank Y.Li, **"Priority-based Initial Access for URLLC Traffic in Massive IoT Networks: Schemes and Performance Analysis"**, Computer Networks, Vol 178, 4 Sept. 2020, 107360, (Level 2)

Vignesh Shanbagh, Thomas Meyer, Leo W. Caspers and Rune Schlanbusch, **"Condition monitoring of hydraulic cylinder seals using acoustic emission"**, The International Journal of Advanced Manufacturing Technology, 2020 (Level 2)

Geir Ole Tysse, Andrej Cibicik and Olav Egeland, **Vision-based control of a knuckle boom crane with online cable length estimation**, IEEE/ASME Transactions on Mechatronics (Level 2).

Shaun Falconer, Ellen Nordgård-Hansen and Geir Grasmø, **Computer vision and thermal monitoring of HMPE fibre rope condition during CBOS testing**, Applied Ocean Research Vol. 102, September 2020, 102248.

Mohamed Yousri, Georg Jacobs and Stephan Neumann, **Impact of fiber versus steel ropes on the lifetime of crane winches**, Modeling, Identification and Control (MIC), Vol. 41, No. 3, pp. 129-139.

Dipendra Subedi, Ilya Tyapin and Geir Hovland, **"Review on Modeling and Control of Flexible Link Manipulators"**, Modeling, Identification and Control (MIC), Vol. 41, No. 3, pp. 141-163.

Njål Tengesdal and Christian Holden, **"Identification and Optimal Control for Surge and Swab Pressure Reduction While Performing Offshore Drilling Operations"**, Modeling, Identification and Control (MIC), Vol. 41, No. 3, pp. 165-184

Søren Ketelsen, Torben Ole Andersen, Morten K. Ebbesen and Lasse Schmidt, **"A Self-Contained Cylinder Drive with Indirectly Controlled Hydraulic Lock"**, Modeling, Identification and Control (MIC), Vol. 41, No. 3, pp. 185-205

Aksel Sveier, Torstein A. Myhre and Olav Egeland, **"Extrinsic calibration for motion estimation using unit quaternions and particle filtering"**, Modeling, Identification and Control (MIC), Vol. 41, No. 3, pp. 207-221

Viktor Hristov Donkov, Torben Ole Andersen and Morten K. Ebbesen, **"An analysis of Model Predictive Control with Integral Action applied to Digital Displacement Cylinders"**, Modeling, Identification and Control (MIC), Vol. 41, No. 3, pp. 223-239

D. Romero, S. Mollaebrahim, B. Beferull-Lozano and C. Asensio, **"Fast Graph Filters for Decentralized Subspace Projection"**, IEEE Transactions on Signal Processing. (Level 2 journal).

B. Zaman, L.M. Lopez, D. Romero and B. Beferull-Lozano, **"Online Topology Identification from Vector Autoregressive Time Series"**, IEEE Transactions on Signal Processing. (Level 2 journal).

Torbjørn Moi, Andrej Cibicik and Terje Rølvåg, **Digital Twin Based Condition Monitoring of a Knuckle Boom Crane: an Experimental Study Engineering Failure Analysis**, Engineering Failure Analysis, Volume 112, May 2020.

Martin Hemmer, Andreas Klausen, Huynh Van Khang, Kjell G. Robbersmyr and Tor I. Waag, **Health Indicator for Low-Speed Axial Bearings Using Variational Autoencoders**, IEEE Access, 2020.

Zbigniew Mikulski and Tom Lassen, **Crack growth in fillet welded steel joints subjected to membrane and bending loading modes**, Engineering Fracture Mechanics, Volume 235, August 2020, 107190

Viktor Hristov Donkov, Torben Ole Andersen, Matti Linjama and Morten Kjeld Ebbesen, **"Digital Hydraulic Technology for Linear Actuation: A State of the Art Review"**, International Journal of Fluid Power, Vol 21, No. 2, ISSN 1439-9776

## CONFERENCE PAPERS:

Ajit Jha, Ilya Tyapin and Geir Hovland, **“Camera-Lidar Data Fusion for Autonomous Mooring Operation”**, IEEE ICIEA, Kristiansand, June 21-25, 2020.

Joacim Dybedal and Geir Hovland, **“GPU-Based Occlusion Minimisation for Optimal Placement of Multiple 3D Cameras”**, IEEE ICIEA, Kristiansand, June 21-25, 2020.

Ajit Jha, Dipendra Subedi, Per-Ove Løvslund, Ilya Tyapin, Linga Reddy Cenkeramaddi, Baltasar Beferull-Lozano and Geir Hovland, **“Autonomous mooring towards autonomous maritime navigation and offshore operations”**, IEEE ICIEA, Kristiansand, June 21-25, 2020.

Knut Berg Kaldestad and Geir Hovland, **“Laser Triangulation 3D Point Cloud Sensor with Long Range and Large Field of View”**, IEEE ICIEA, Kristiansand, June 21-25, 2020.

Ronny Landsverk, Jing Zhou and Geir Hovland, **“Modeling of Offshore Crane and Marine Craft in Wave Motion”**, IEEE ICIEA, Kristiansand, June 21-25, 2020.

Atle Aalerud and Geir Hovland, **“Dynamic Augmented Kalman Filtering for Human Motion Tracking under Occlusion Using Multiple 3D Sensors”**, IEEE ICIEA, Kristiansand, June 21-25, 2020.

Joacim Dybedal and Geir Hovland, **“GPU-Based Optimisation of 3D Sensor Placement Considering Redundancy, Range and Field of View”**, IEEE ICIEA, Kristiansand, June 21-25, 2020.

Atle Aalerud and Geir Hovland, **“Benchmarking Perception Latencies in a Human-Robot Collaborative Environment”**, Proc. of IEEE Intl. Conference on Robotics and Automation (ICRA), Paris, France, June 2020.

Dipendra Subedi, Ilya Tyapin and Geir Hovland, **“Modeling and Analysis of Flexible Bodies Using Lumped Parameter Method”**, 2020 IEEE 11th International Conference on Mechanical and Intelligent Manufacturing Technologies (ICMIMT 2020), January 20-22, 2020, Cape Town, South Africa.

Daniel Hagen, Damiano Padovani and Martin Choux, **“Guidelines to Select Between Self-Contained Electro-Hydraulic and Electro-Mechanical Cylinders”**, Proceedings 15th IEEE Conference on Industrial Electronics and Applications (ICIEA) – Kristiansand, Norway, June 21-25, 2020.

B. Zaman, L. M. Lopez, B. Beferull-Lozano, **“Dynamic Regret Analysis for Online Tracking of Time-varying Structural Equation Model Topologies”**, IEEE International Conference on Industrial Electronics and Applications (ICIEA), 2020.

Savin Viswanathan and Christian Holden, **“Simulating the dynamics of a chain suspended sub-sea load using modified components from the Modelica MultiBody library”**, Asian Modelica Conference 2020, Tokyo, Japan, <https://2020.asian.conference.modelica.org>

Savin Viswanathan and Christian Holden, **“Dynamic simulation of a mooring catenary based on the lumped mass approach – OpenModelica and Python implementations”**, The ASME 39th International conference on Ocean, Offshore, and Arctic engineering, OMAE2020, June 28-July 3, Fort Lauderdale, FL, USA.

Thiago G. Monteiro, Henrique M. Gaspar, Houxiang Zhang, Charlotte Skourup, **“A Model for Forecasting Mental Fatigue in Maritime Operations”**, 34th Intl. ECMS Conference on Modelling and Simulation, Wildau, Germany, June 9-12, 2020.

Lars Ivar Hatledal, Houxiang Zhang and Frederic Collonval, **Enabling Python Driven Co-Simulation Models With PythonFMU**, ECMS 2020 Proceedings.

Luis M. Lopez-Ramos and Baltasar Beferull-Lozano, **Online Hyperparameter Search Interleaved with Proximal Parameter Updates**, Proc. IEEE EUSIPCO 2020 conference.

Vignesh Vishnudas Shanbhag, Thomas. J. J. Meyer, Leo. W. Caspers and Rune Schlanbusch, **Diagnostics of seal and rod degradation in hydraulic cylinders using acoustic emissions**, Vol. 5 No. 1 (2020): Proceedings of the European Conference of the PHM Society.

Søren Ketelsen, Damiano Padovani, Morten Kjeld Ebbesen, Torben Ole Andersen and Lasse Schmidt, **A Gasless Reservoir Solution for Electro-Hydraulic Compact Drives with two Prime Movers**, ASME/Bath Symposium on Fluid Power and Motion Control, FPMC 2020, 9th-11th September 2020.

Savin Viswanathan and Christian Holden, **Modelica Component Models for Non-diffracting Floating Objects and Quasi-static Catenary Moorings**. Proceedings of the American Modelica Conference 2020, Boulder, Colorado, USA, March 23-25, 2020.

Søren Ketelsen, Giacomo Kolks, Torben Ole Andersen, Lasse Schmidt and Jürgen Weber, **“Bootstrap Reservoir Concepts for Electro-Hydraulic Compact Cylinder Drives”**, 12th International Fluid Power Conference, Dresden, Germany, October 12-14 2020.

Daniel Hagen and Damiano Padovani, **“A Method for Smoothly Disengaging the Load-Holding Valves of Energy-Efficient Electro-Hydraulic Systems”**, 1st International Electronic Conference on Actuator Technology: Materials, Devices and Applications session Actuators for hydraulic systems, MDPI, Online conference, November 23-27, 2020, ISSN 2504-3900.

## Student Projects

### UiA

Mehdi Esmaeil

**Fault Detection during Drilling using Artificial Intelligence and Model-based Control**

Christopher Bjørnara

**Pipe joint position identification**

Ilja Boginskis and Abker Ibrahim Hmdoun

**Modeling and Control of Dynamics between Crane and Vessel**

Rabah Saleh Hagag and Martin Sirevåg

**Formal verification of ABB robotic system**

Kjetil Godtfredsen and Erlend Haugan Salmon

**3R Long-reach flexible robot**

Eilef Lundevold, Gøran Brovig Olsen and Arne Edvard Taanevig

**Link Arm for Knuckle Boom Crane**

### RWTH Aachen:

Lifan Li

**Robust Load Stabilization for Crane-Based Offshore Loading Processes using a Data-Driven Approach**

Laura Mathilde Wolff

**Flatness Based Model Predictive Control of an Offshore Crane**

Christina Raphaela Ionescu

**Robust Model Predictive Control for Offshore Cranes using Sliding Modes and Databased Error Forecasting**

### NTNU:

Frode Bergli

**Vision Based Tracking of Target Ship in Offshore Crane Operations**

Markus Bjønnes and Marius Nilsen

**Development of a system for the robotic assembly of mechatronic products using constraint-based robot control**

Charlotte Heggem and Nina Marie Wahl

**Development of a System for Visual-SLAM and Mobile Manipulation using an Industrial Mobile Manipulator**

Espen Lunden

**Force Control and Constraint-based Task Specification in Robotic Assembly**

Kristian Svinterud Sørebo

**Low-cost Navigation and Collision Avoidance System**

Villarreal Lozano Carolina

**Digital Twin for Structural Monitoring and Predictive Maintenance of a Maritime Crane (NTNU Aalesund)**



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SFI Mekatronikk



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UiA University  
of Agder