Universitetet i Sørøst-Norge

Department of Microsystems, USN Horten, Vestfold

18.000 STUDENTS

1.500 EMPLOYEES

BA **65** BACHELOR PROGRAMMES

MA **36** MASTER PROGRAMMES

PhD **9** PHD PROGRAMMES

8 CAMPUSES

BØ – DRAMMEN – KONGSBERG
NOTODDEN – PORSGRUNN
RAULAND – RINGERIKE – VESTFOLD


CAMPUS BØ


CAMPUS DRAMMEN


CAMPUS KONGSBERG


CAMPUS NOTODDEN


CAMPUS PORSGRUNN


CAMPUS RAULAND


CAMPUS RINGERIKE


CAMPUS VESTFOLD

Campus Vestfold

Faculty of Technology, Natural Sciences and Maritime Sciences (TNM)

Departments:

- Microsystems
- Maritime Operations
- Natural Sciences and Environmental Health
- Electrical Engineering, IT and Cybernetics
- Process, Energy and Environmental Technology
- Science and Industry Systems

Ansatte: ca. 250
Studenter: ca. 2 600

Engineering educations

- BSc
  - Computer science – Cybersecurity
  - Mechanical – Product Design
  - Electrical - Electro, automation and robotics
  - Electronics – Electronci systems design
  - Electronics – Micro- og nanotechnology
- MSc
  - Micro og nano system technology
  - Smart systems integrated solutions
  - E-commerce og cybersecurity
- PhD
  - Applied micro- og nano systems

Electro, automation and robotics

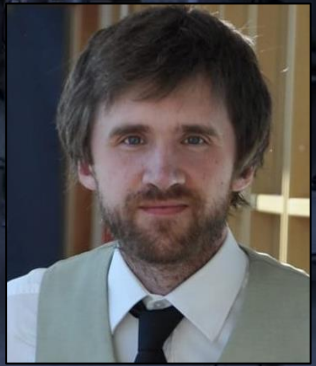
- Helge Kristiansen (Programkoord
- Marius Tannum
- Christian Hovden
- Johannes Lomsdalen
- Fabio Andrade
- Knut Åsatun
- Odd Smith-Jansen

Fabio

Helge

Marius

Knut



Odd

Johannes

Christian

Study model

1. klasse		2. klasse		3. klasse	
1. sem.	2. sem.	3. sem.	4. sem.	5. sem.	6. sem.
Robotikk	Matematikk I	Matematikk II	Statistikk	Valgfag	Systememnet
Digitalteknikk I	Fysikk I	Prosjektering av elektriske anlegg		Valgfag	Bacheloroppgave
Elektrisiteslære I	Elektrisistetslære II	Elektriske maskiner og kraftelektronikk			
Programmering for beregning	OOP grunnkurs	PLS og instrumentering		Valgfag	
Ingeniørrollen		Fysikk II for elektro	Reguleringsteknikk		

Ingeniørfaglig basis
Programfaglig basis
Teknisk spesialisering
Valgfri spesialisering

Valgfag
Digital automasjonsdesign
Maritim elektro-automasjon og robotikk
Operativsystemer for robot videregående
Introduksjon til datasikkerhet
Ingeniørpraksis
Studentbedrift
Matematikk III

Study model EAR - Robotics

1. klasse	
1. sem.	2. sem.
Robotikk	Matematikk I
Digitalteknikk I	Fysikk I
Elektrisiteslære I	Elektrisistetslære II
Programmering for beregning	OOP grunnkurs
Ingeniørrollen	

2. klasse	
3. sem.	4. sem.
Matematikk II	Statistikk
Prosjektering av elektriske anlegg	
Elektriske maskiner og kraftelektronikk	
PLS og instrumentering	
Fysikk II for elektro	Reguleringsteknikk

3. klasse	
5. sem.	6. sem.
Valgfag	Systememnet
Valgfag	Bacheloroppgave
Valgfag	

Valgfag
Digital automasjonsdesign
Maritim elektro-automasjon og robotikk
Operativsystemer for robot videregående

Study model EAR - Automation

<table>
<tr><th colspan="2">1. klasse</th><th colspan="2">2. klasse</th><th colspan="2">3. klasse</th></tr>
<tr><th>1. sem.</th><th>2. sem.</th><th>3. sem.</th><th>4. sem.</th><th>5. sem.</th><th>6. sem.</th></tr>
<tr><td>Robotikk</td><td>Matematikk I</td><td>Matematikk II</td><td>Statistikk</td><td>Valgfag</td><td>Systememnet</td></tr>
<tr><td>Digitalteknikk I</td><td>Fysikk I</td><td colspan="2">Prosjektering av elektriske anlegg</td><td rowspan="2">Valgfag</td><td rowspan="4">Bacheloroppgave</td></tr>
<tr><td>Elektrisiteslære I</td><td>Elektrisistetslære II</td><td colspan="2">Elektriske maskiner og kraftelektronikk</td></tr>
<tr><td>Programmering for beregning</td><td rowspan="2">OOP grunnkurs</td><td colspan="2">PLS og instrumentering</td><td rowspan="2">Valgfag</td></tr>
<tr><td>Ingeniørrollen</td><td>Fysikk II for elektro</td><td>Reguleringsteknikk</td></tr>
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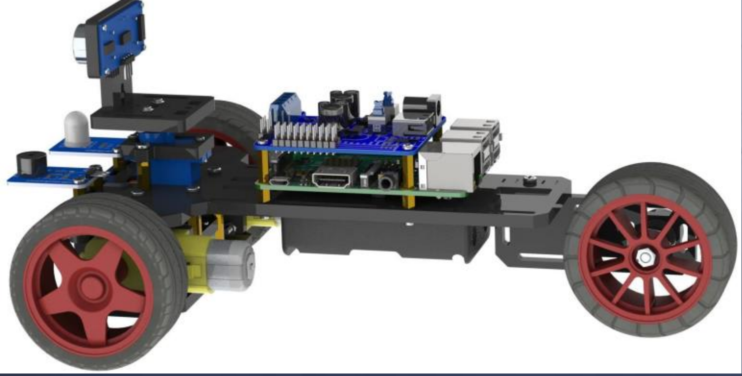
Valgfag
Digital automasjonsdesign
Maritim elektro-automasjon og robotikk
Operativsystemer for robot videregående

Study model EAR - Electro

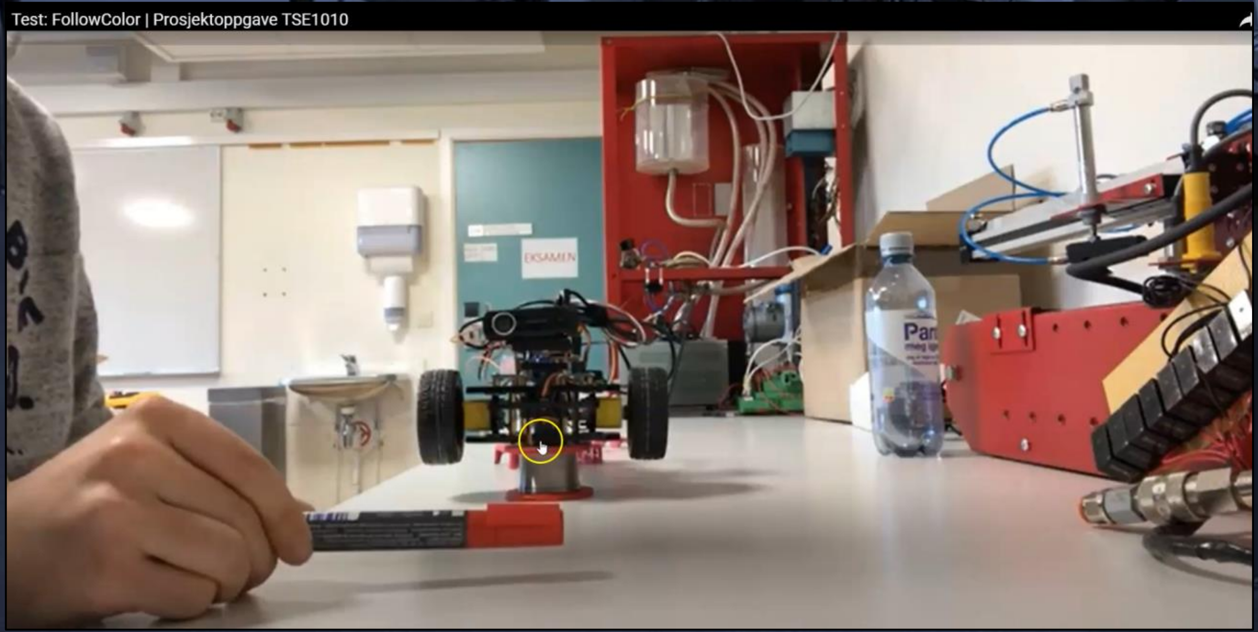
1. klasse		2. klasse		3. klasse	
1. sem.	2. sem.	3. sem.	4. sem.	5. sem.	6. sem.
Robotikk	Matematikk I	Matematikk II	Statistikk	Valgfag	Systememnet
Digitalteknikk I	Fysikk I	Prosjektering av elektriske anlegg		Valgfag	Bacheloroppgave
Elektrisiteslære I	Elektrisistetslære II	Elektriske maskiner og kraftelektronikk			
Programmering for beregning	OOP grunnkurs	PLS og instrumentering		Valgfag	
Ingeniørrollen		Fysikk II for elektro	Reguleringsteknikk		

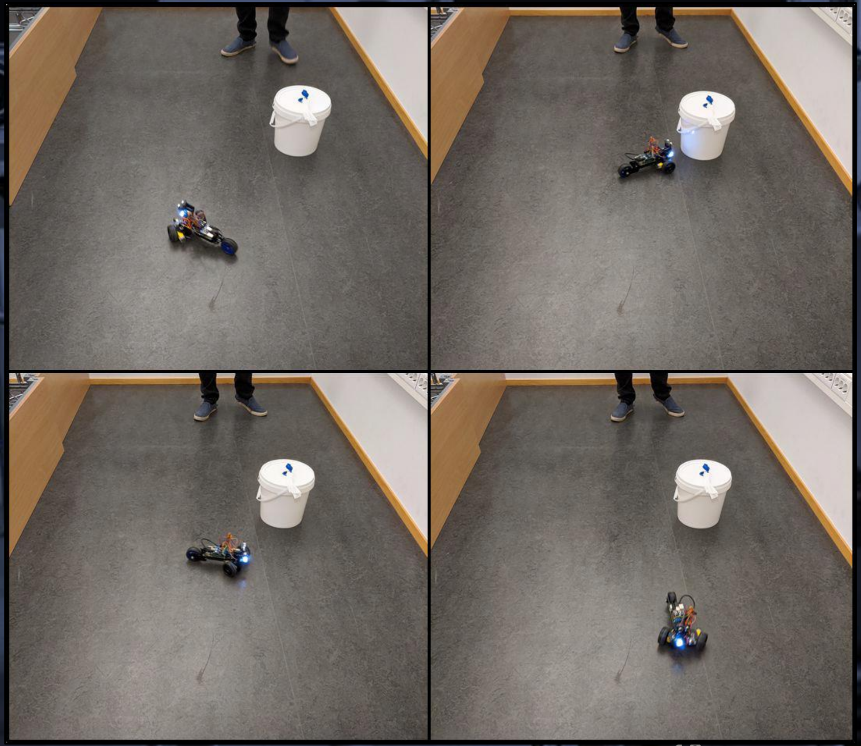
Valgfag
Digital automasjonsdesign
Maritim elektro-automasjon og robotikk
Operativsystemer for robot videregående

Robotics (1 år)



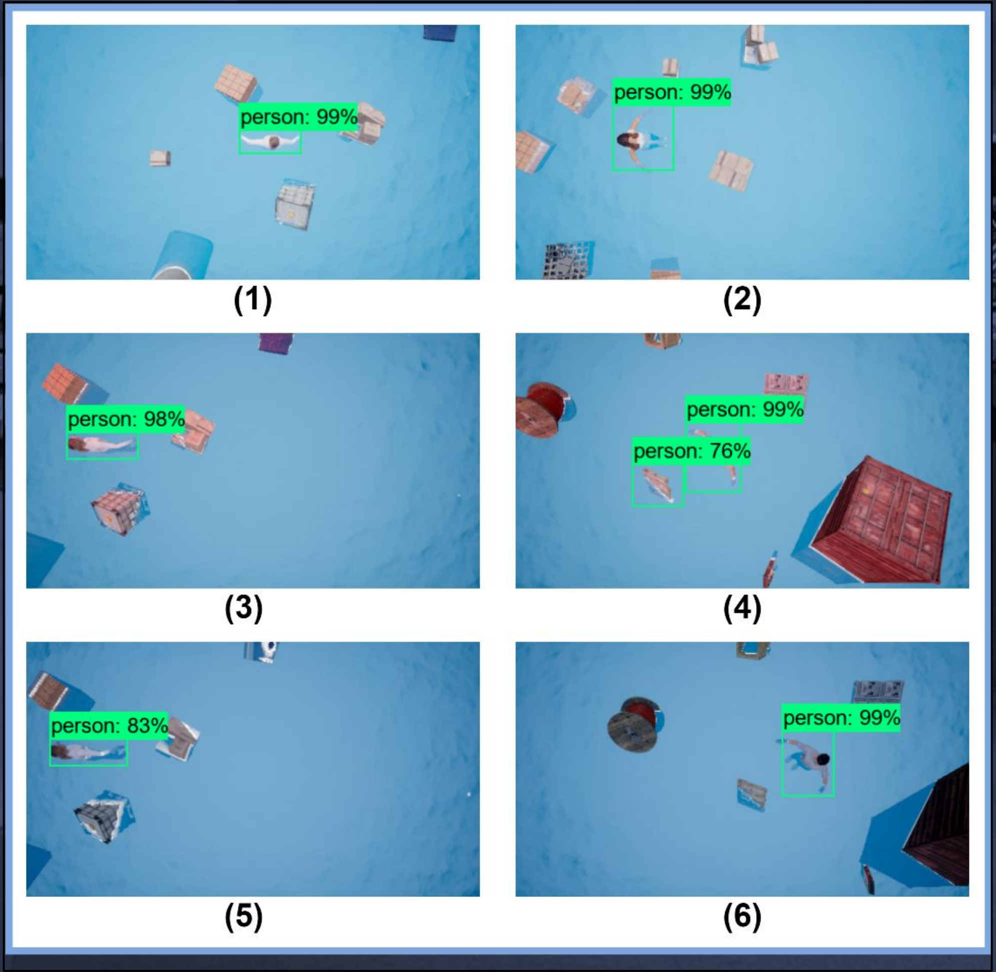
- Introduction to robot programming in the Python programming language
- Combined online learning and in-class teaching and guidance
  - https://www.theconstructsim.com/





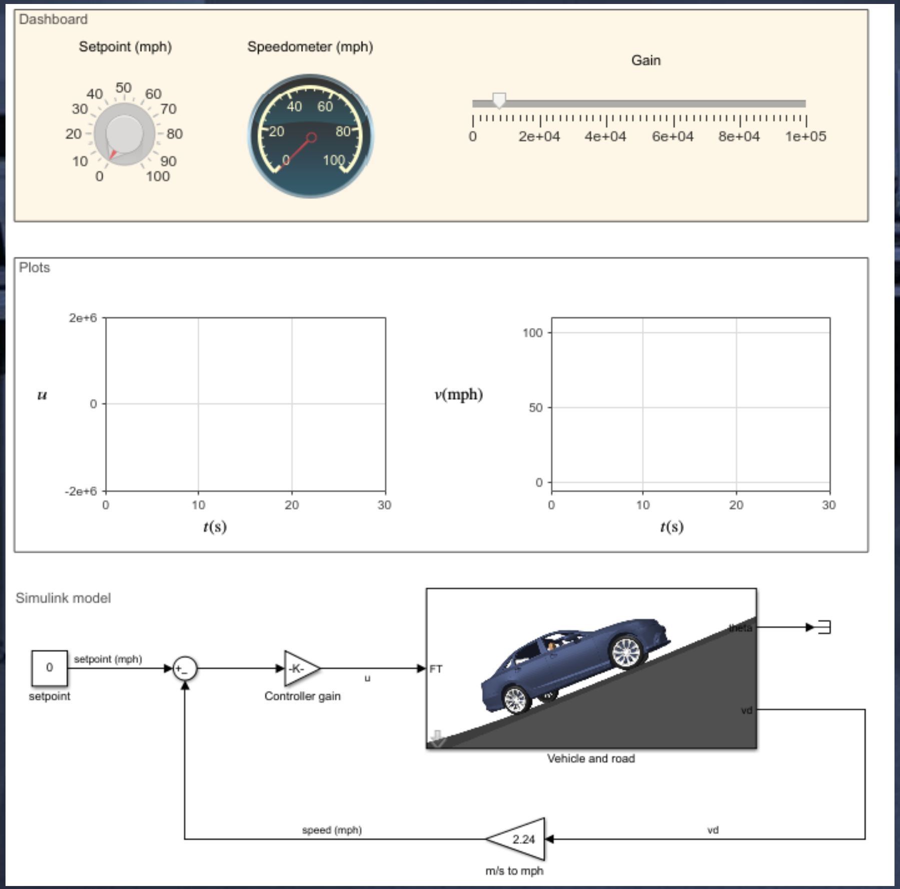
Robotics 2 - Real life challenges

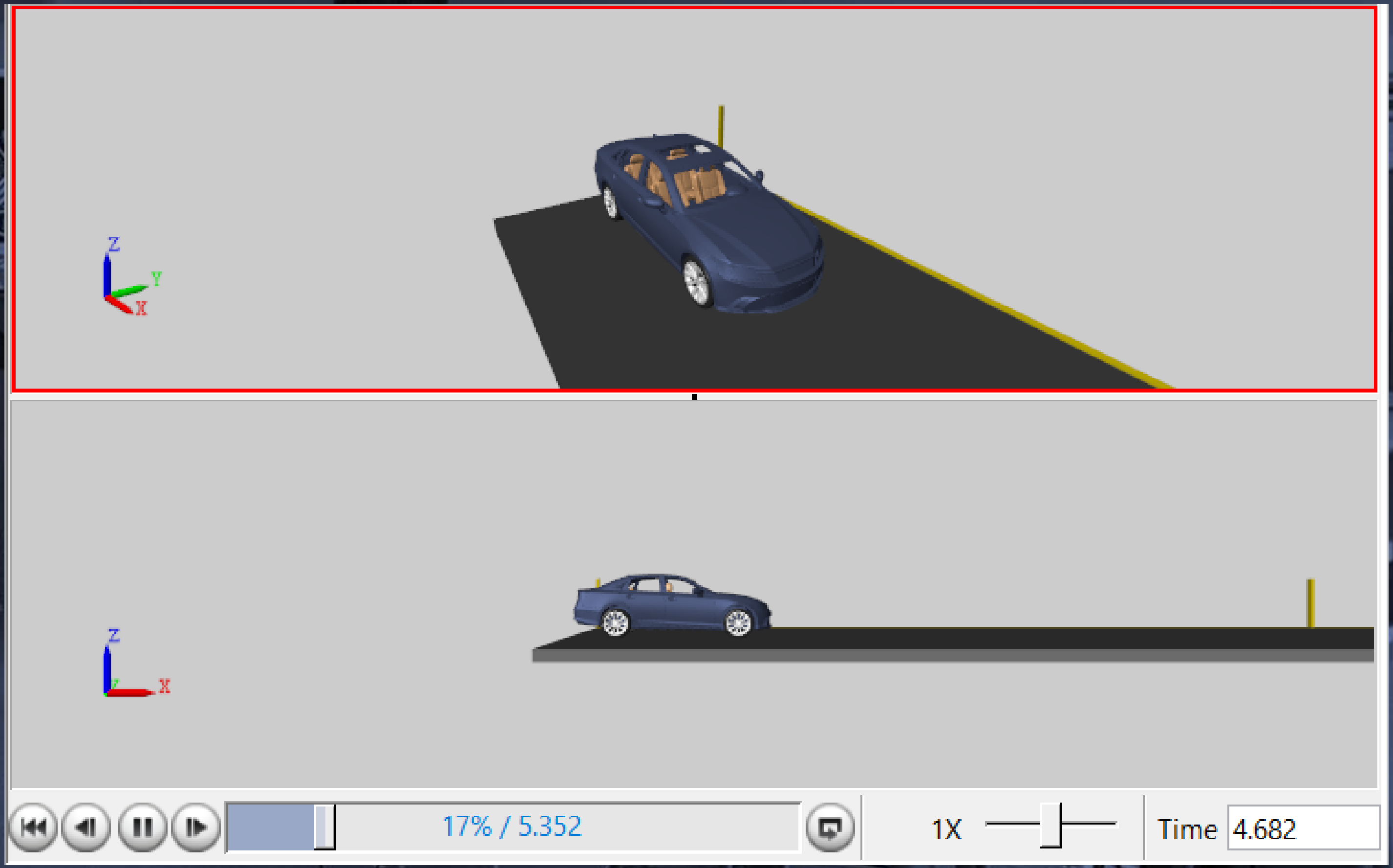
Robotics 2 - Use of new technology



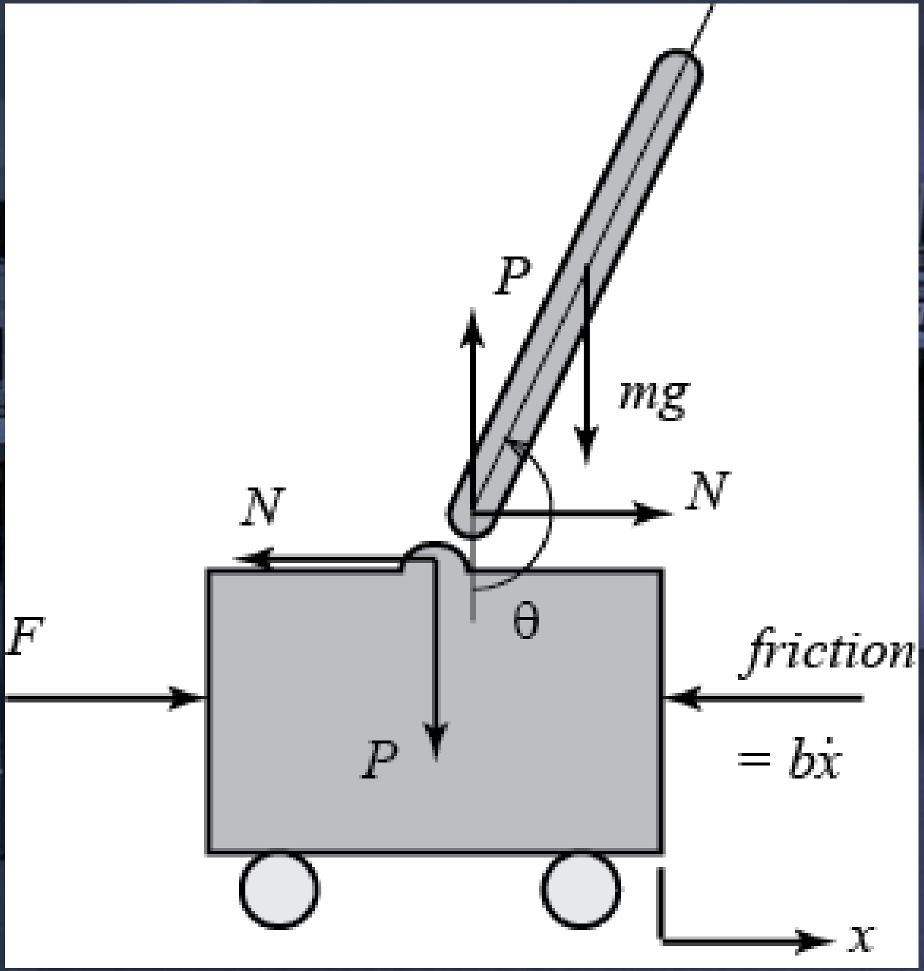
Robotics 2 - Simulated and Practical

Control systems - MATLAB Simulations





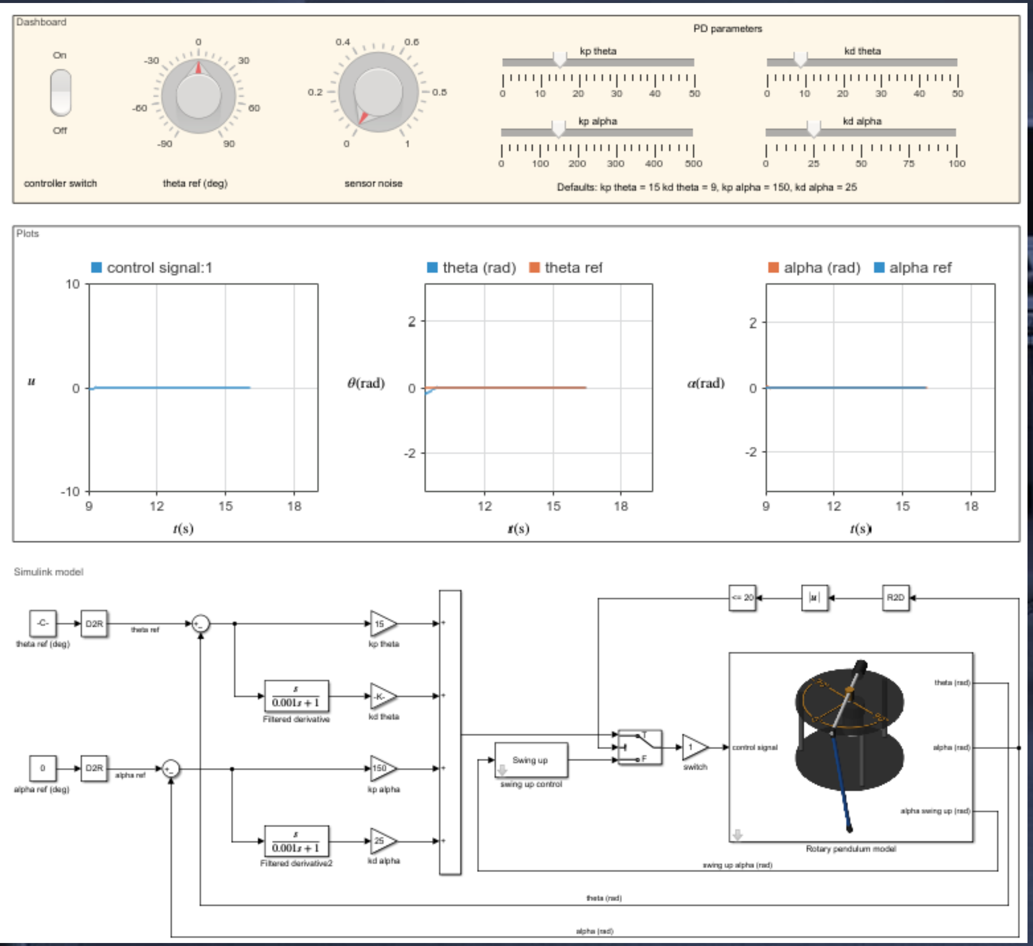
Challenging example: Inverted Pendulum

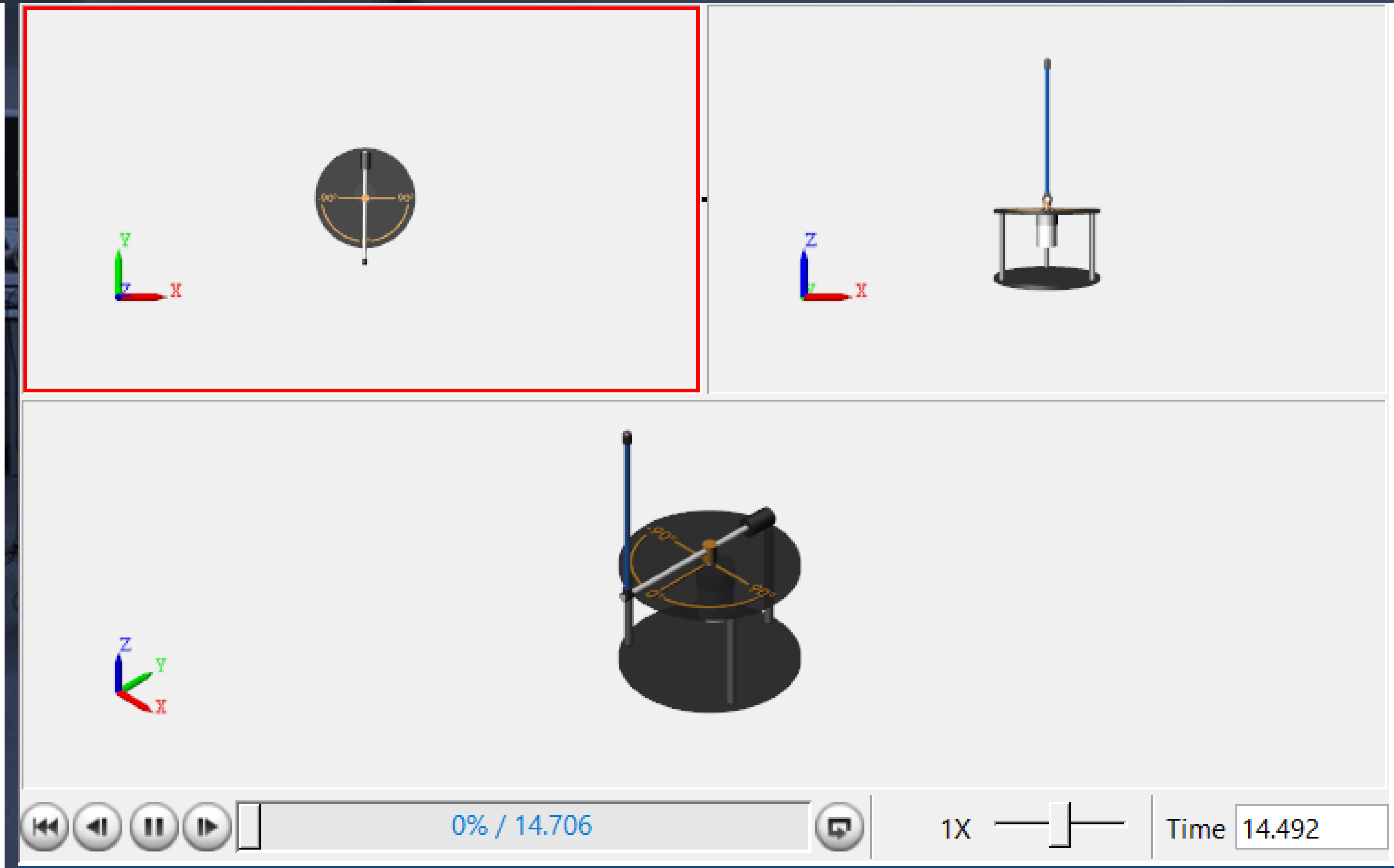


$$\begin{bmatrix} \dot{x} \\ \ddot{x} \\ \dot{\phi} \\ \ddot{\phi} \end{bmatrix} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & \frac{-(I+ml^2)b}{I(M+m)+Mml^2} & \frac{m^2gl^2}{I(M+m)+Mml^2} & 0 \\ 0 & 0 & 0 & 1 \\ 0 & \frac{-mlb}{I(M+m)+Mml^2} & \frac{mgl(M+m)}{I(M+m)+Mml^2} & 0 \end{bmatrix} \begin{bmatrix} x \\ \dot{x} \\ \phi \\ \dot{\phi} \end{bmatrix} + \begin{bmatrix} 0 \\ \frac{I+ml^2}{I(M+m)+Mml^2} \\ 0 \\ \frac{ml}{I(M+m)+Mml^2} \end{bmatrix} u$$

$$\mathbf{y} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \begin{bmatrix} x \\ \dot{x} \\ \phi \\ \dot{\phi} \end{bmatrix} + \begin{bmatrix} 0 \\ 0 \end{bmatrix} u$$

MATLAB Simulations



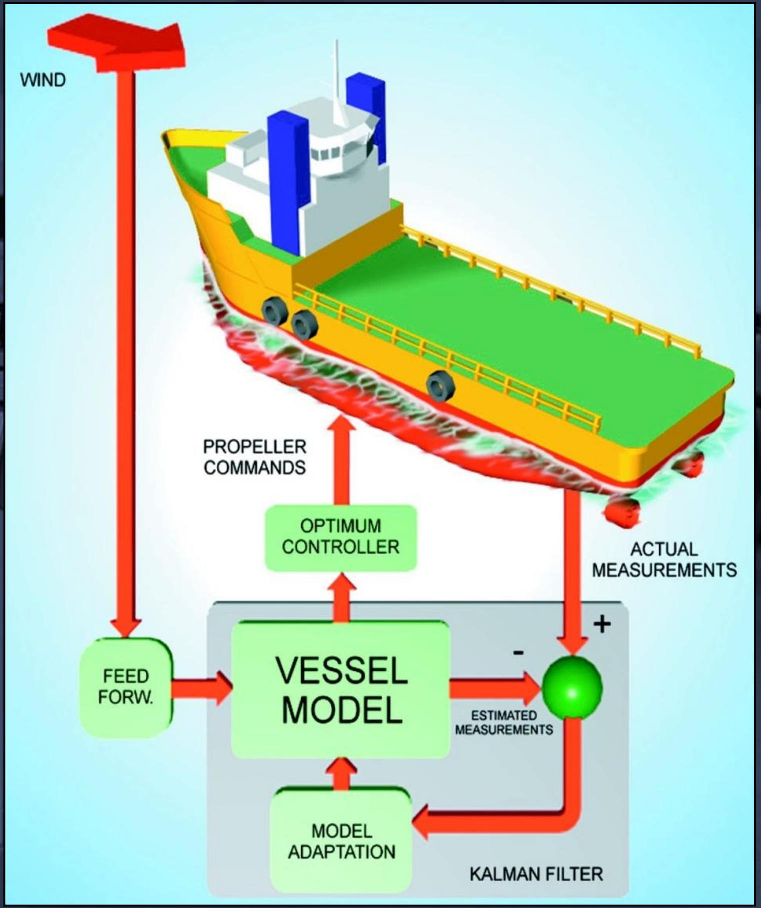


Real Implementation

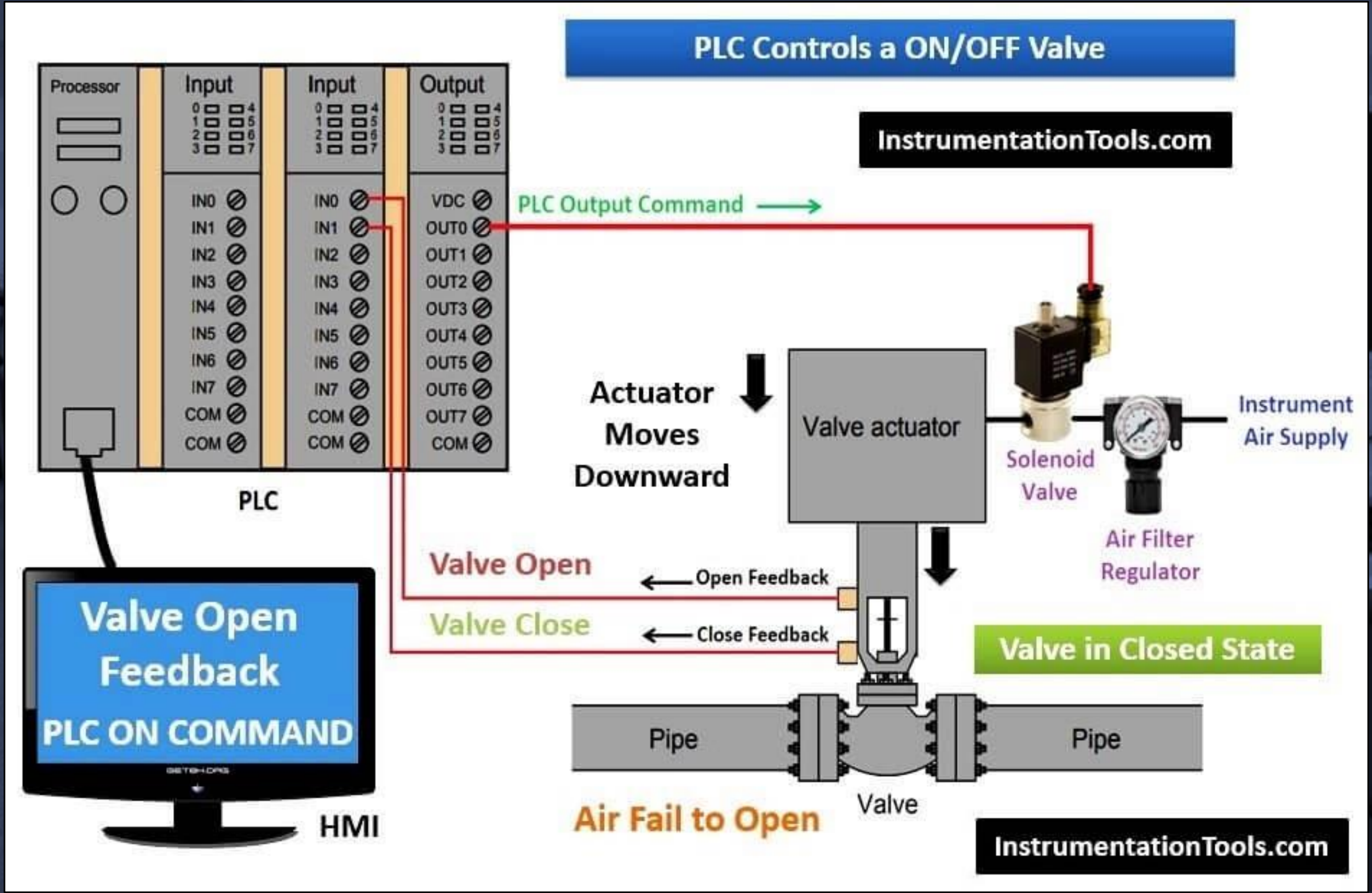
```
clear all

dq = daq('ni');
dq.Rate = 1000;
addinput(dq, "Dev1", "ai0", "Voltage");
addinput(dq, "Dev1", "ai2", "Voltage");
addinput(dq, "Dev1", "ai3", "Voltage");
addoutput(dq, "Dev1", "ao0","Voltage")
addoutput(dq, "Dev1","port0/line0","Digital")

SP = 0;
acc_error = 0;
prev_error = 0;

dt = 0.05;

Kp = 8;
Ki = 3;
Kd = 1.5;
```

```
while(1)
    sensor_data = read(dq);
    theta_rad = sensor_data{1,"Dev1_ai3"}*30/2*pi/180;
    tacho = sensor_data{1,"Dev1_ai2"}
    error = SP - theta_rad;
    rate_error = (error-prev_error)/dt;
    acc_error = acc_error + error*dt;
    if acc_error > 1
        add_error = 1;
    end
    if acc_error < -1
        add_error = -1;
    end
    prev_error = error;
    u = Kp*error+Ki*acc_error + Kd*rate_error;
    if u > 4
        u=4;
    end
    if u < -4
        u=-4;
    end
    u = -u;
    %write(dq,[u+5 1]);
    pause(dt);
end
```

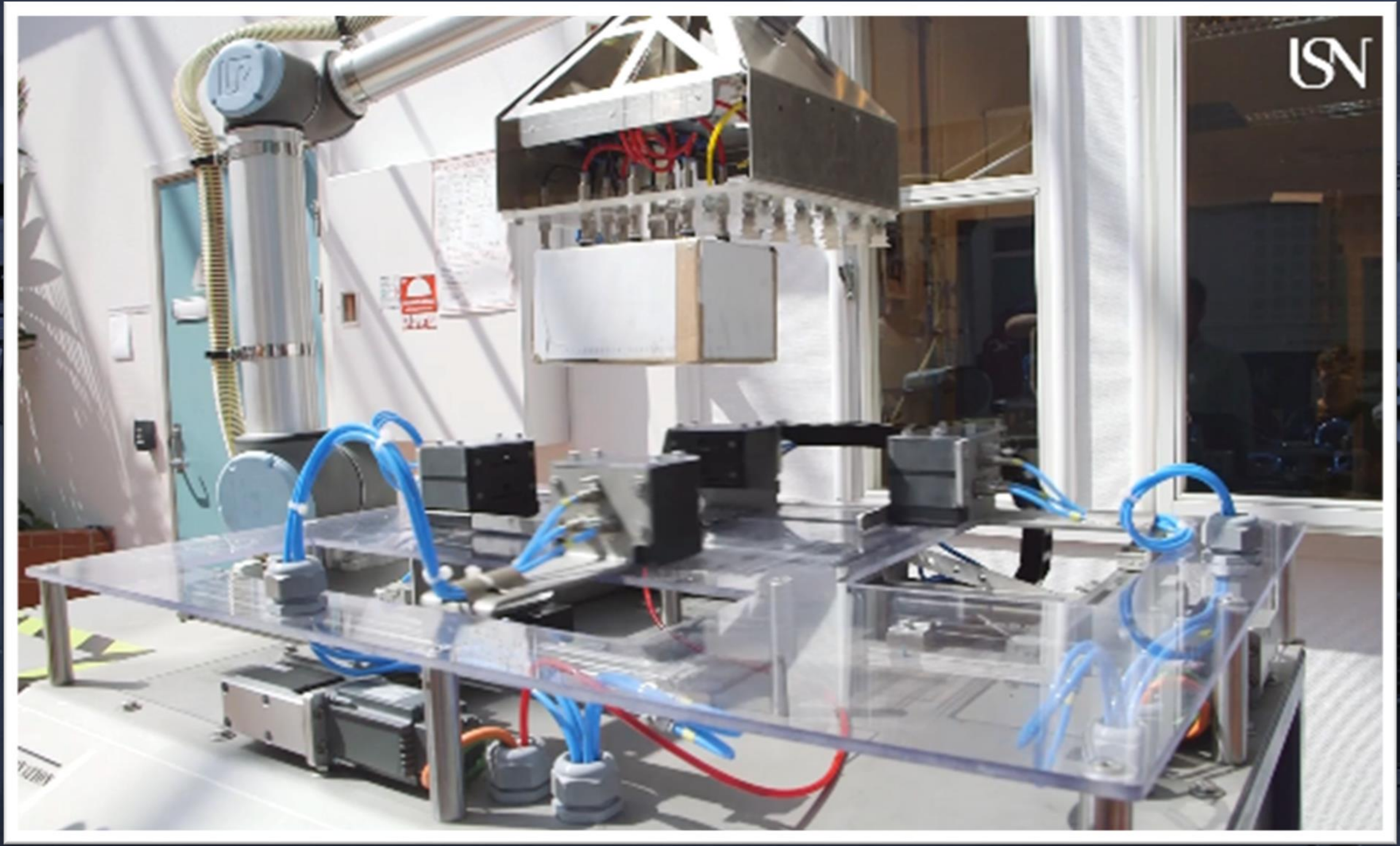
Automation

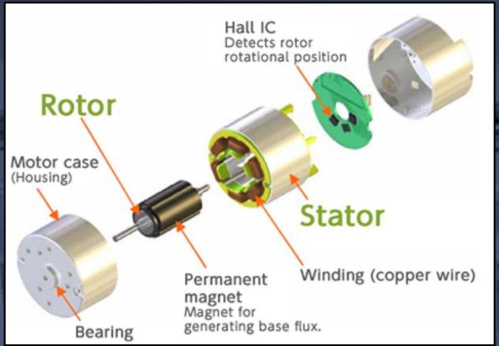

WIND
PROPELLER COMMANDS
OPTIMUM CONTROLLER
ACTUAL MEASUREMENTS
+
-
FEED FORW.
VESSEL MODEL
ESTIMATED MEASUREMENTS
MODEL ADAPTATION
KALMAN FILTER

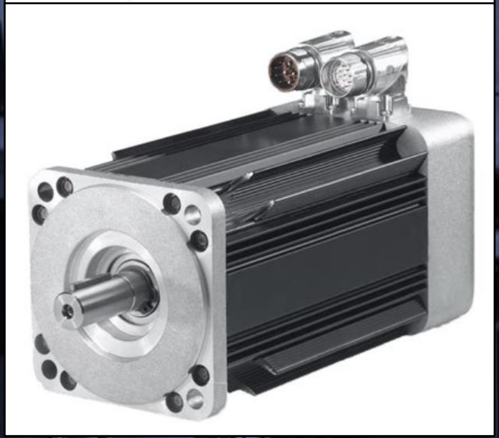
Automation – PLC programming and HMI



Robot servo = electro + automation

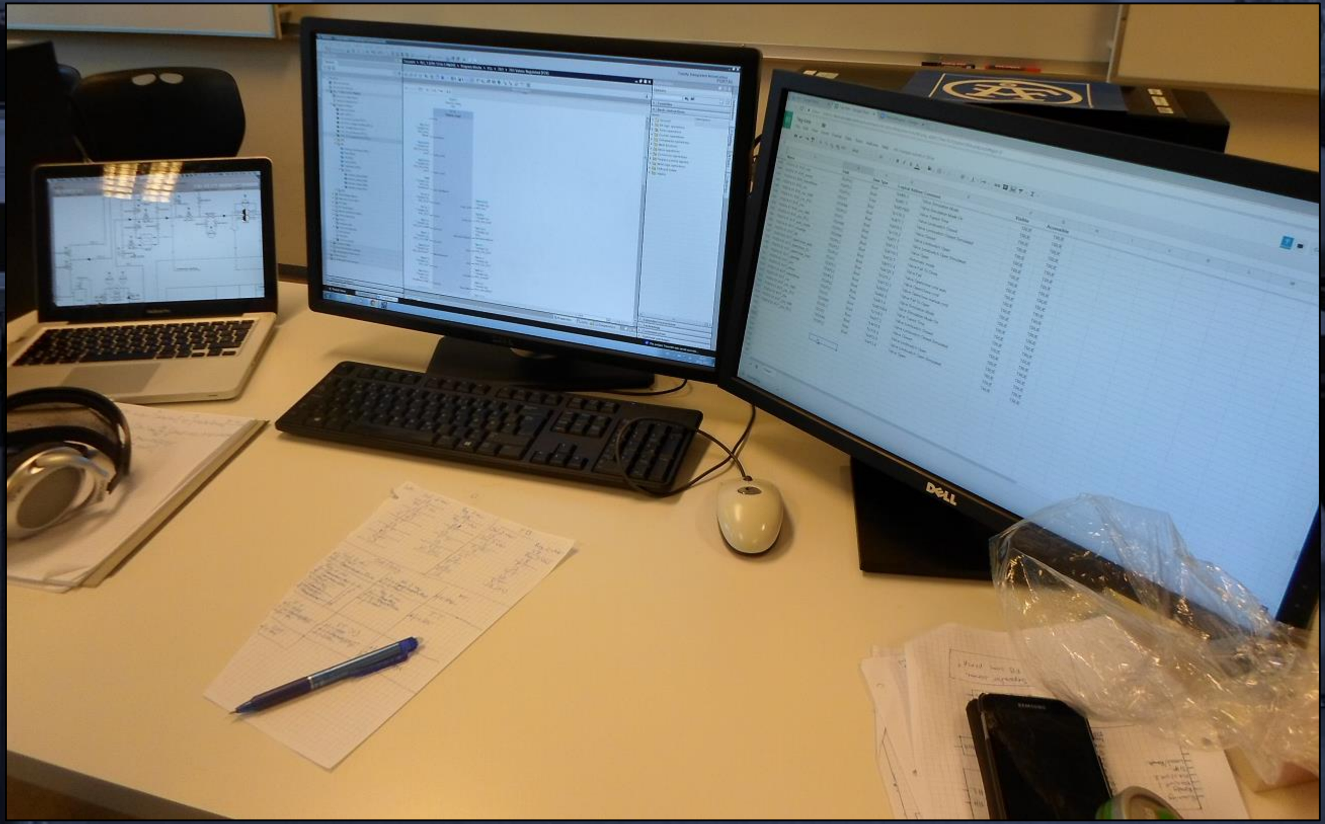


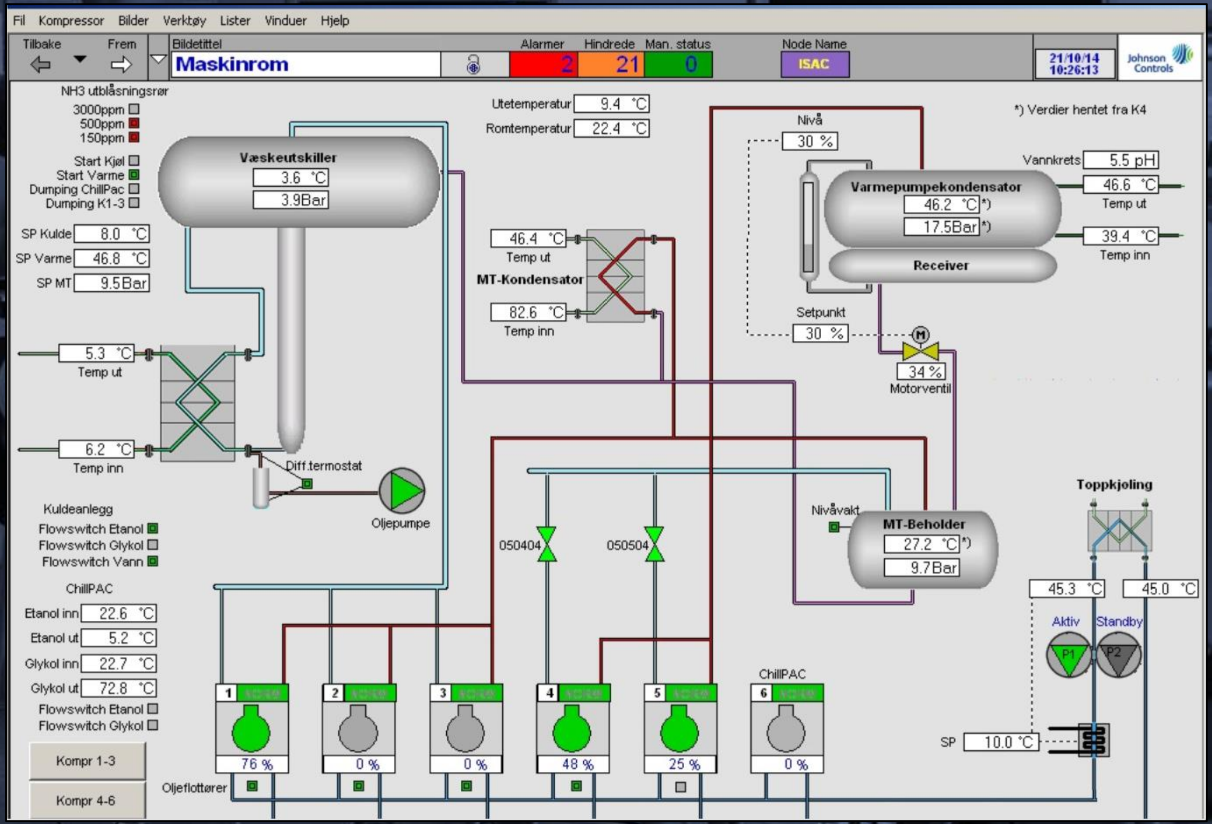




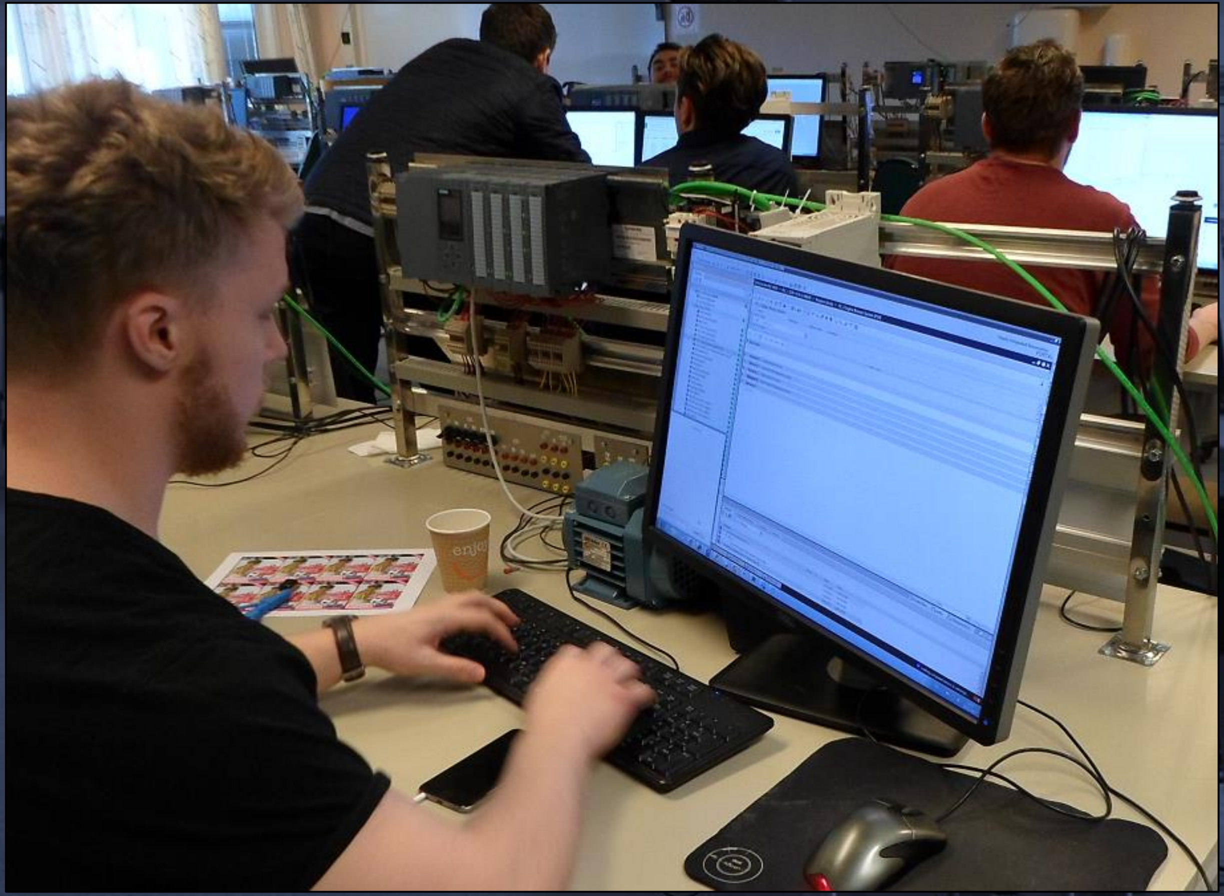

PLCs
Gateway
Site B
Clients
Database
Critical Asset
PLCs
Database
Gateway
Clients
Site A
w/ Critical Asset
DMZ
Inject to the
Cloud
amazon web services
IBM
Google
Central Ignition
Gateway
Database
Clients
Clients
Corporate
Site
Remote
Site

Engineering projects: PLS- og HMI-programming



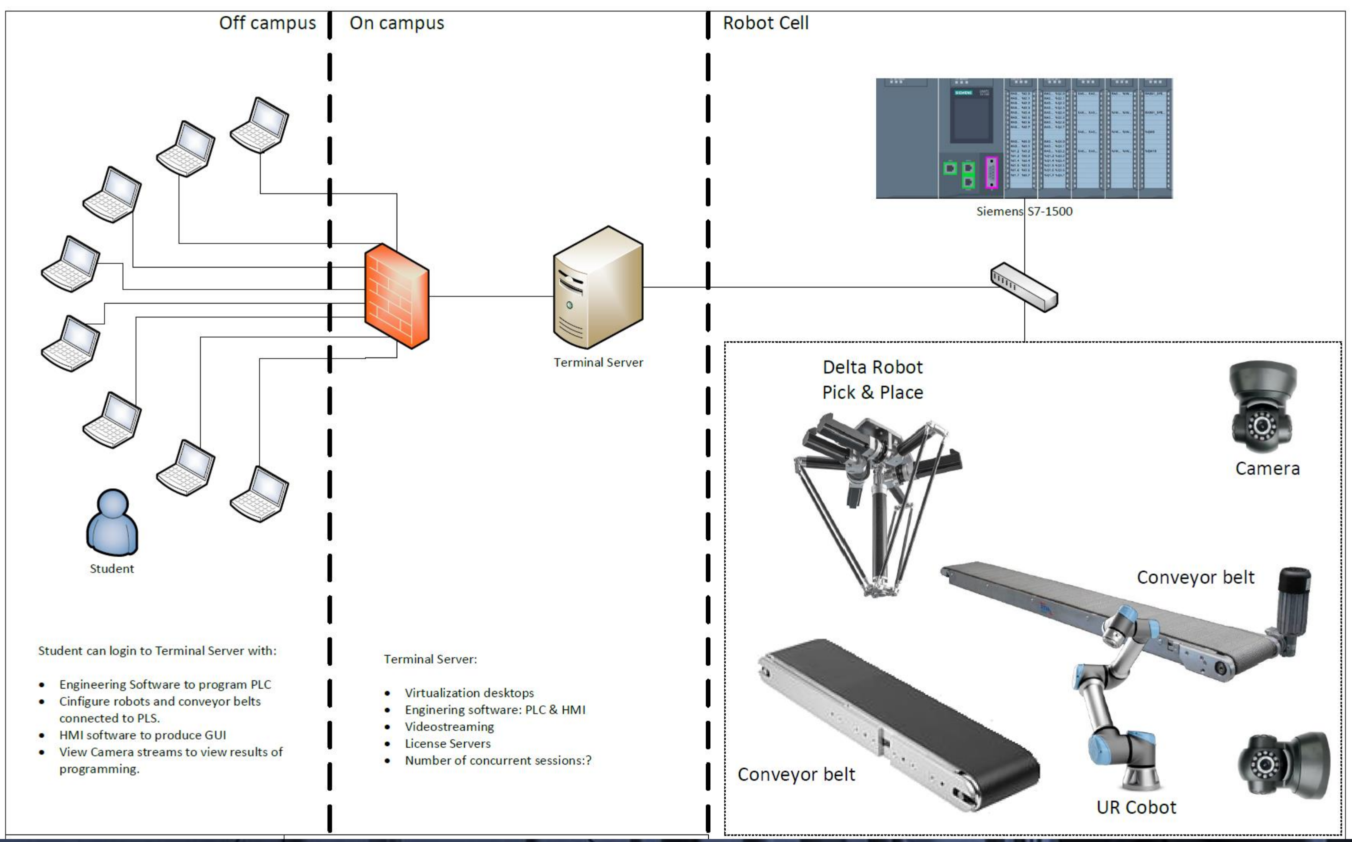


Automation labs



Digital automation design (new course fall 2022)

- The design of automation systems from local sesors to the cloud.
- Human-Machine Interaction (HMI) from an operational level (PLC & HMI) to the enterprice level (ERP) taking advantage of Information Management Systems for visualisation (Dashboards), alarm statistic, treding and reporting.
- A special focus on the design process with use-cases and prototyping

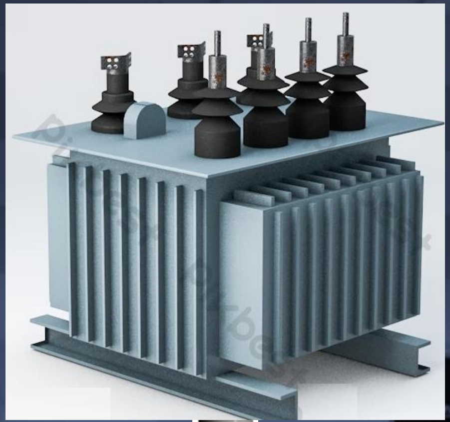


Prosjektering av elektriske anlegg

Febdok

Using computer tools

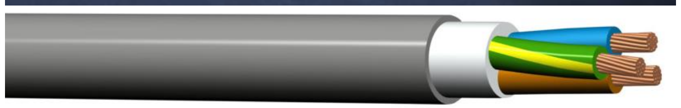
Transformers
22kV/400V



Engineering projects – power systems for production plants and buildings

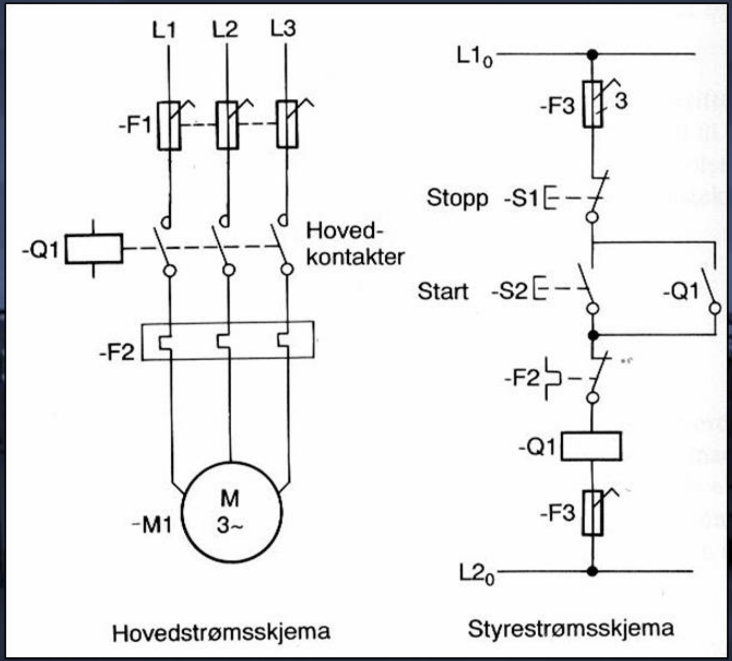
Cricuit Breakers

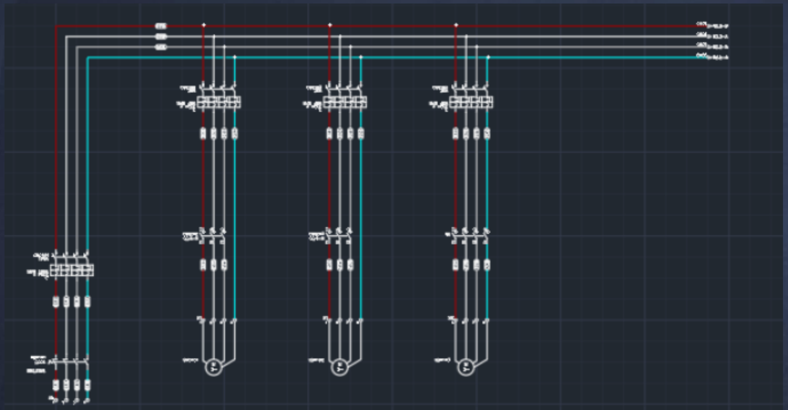
Cables

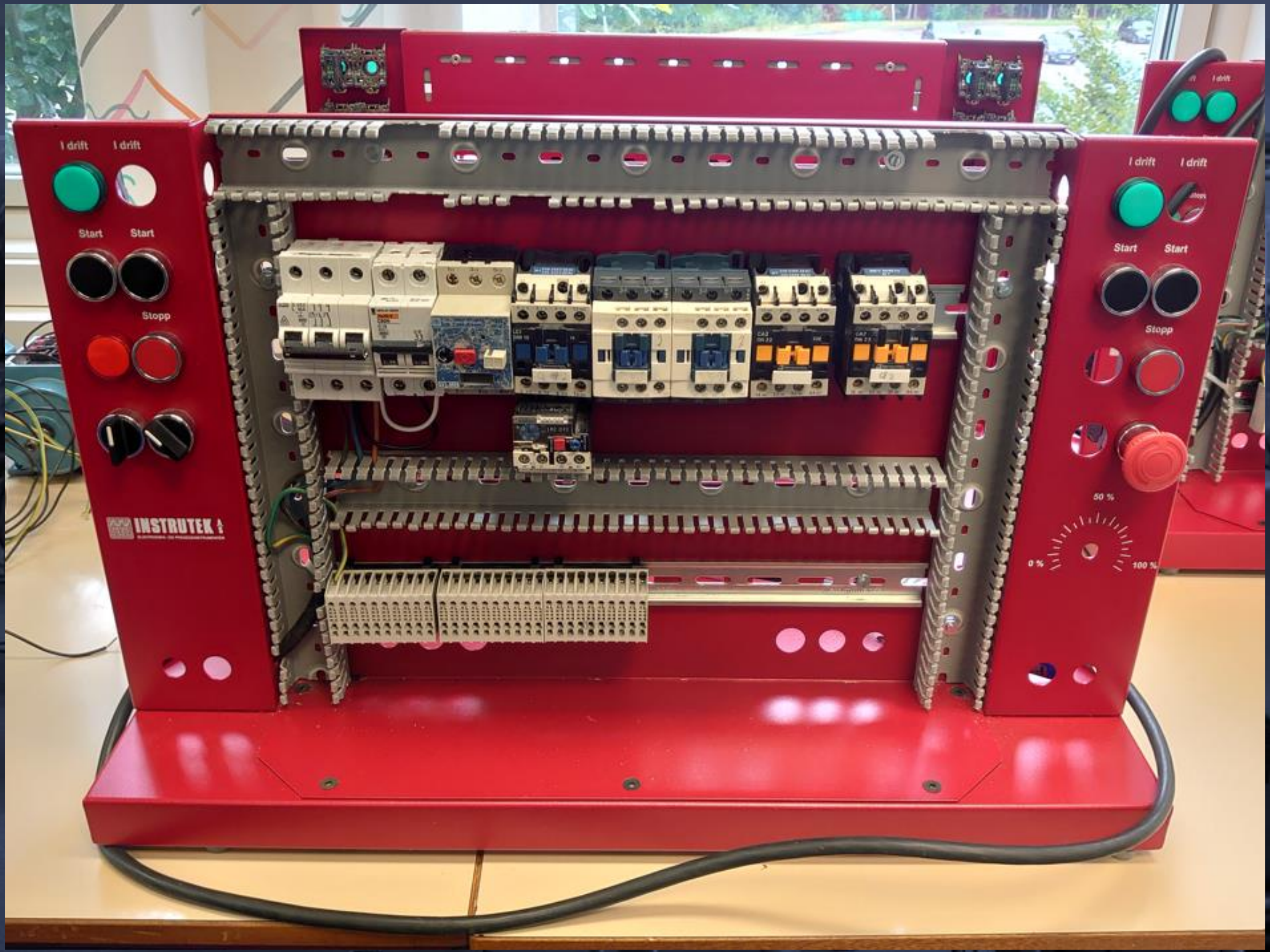


Electrical distribution and protective devices

Schematical drawings for control- and main circuits
- Plan and draw first, then test it with components

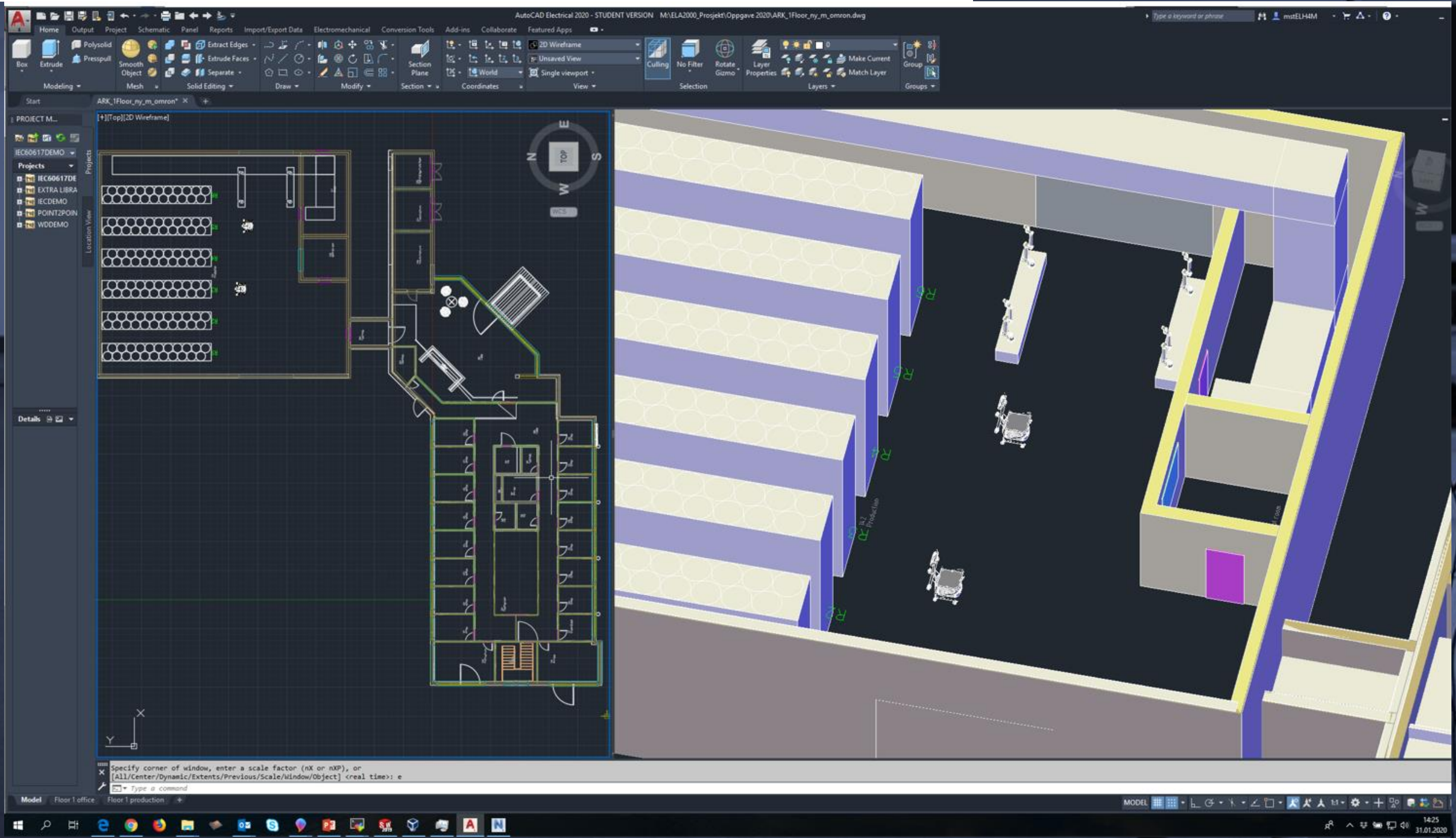






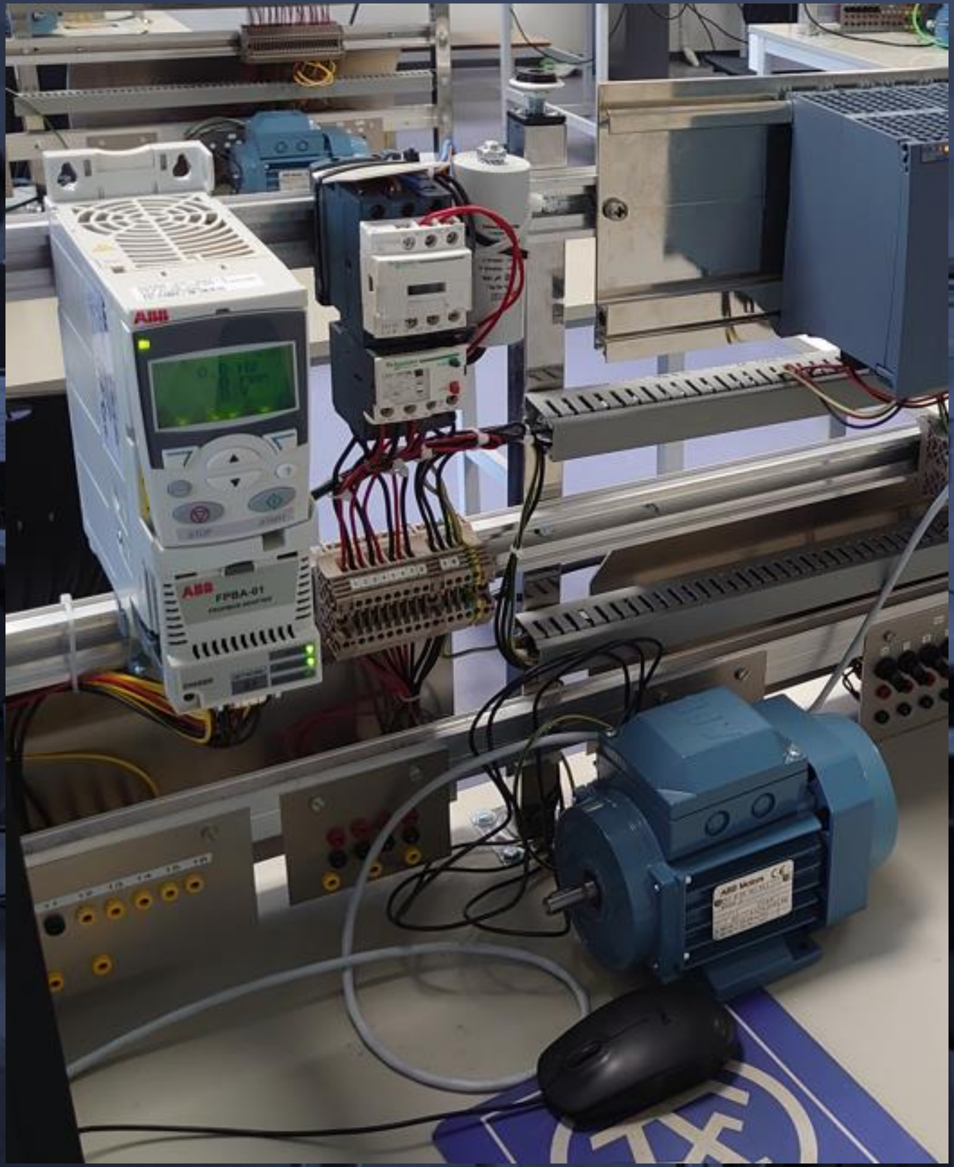
Engineering Project

Prosjektering av elektriske anlegg



Theory first, then practical lab exercises

Elektriske maskiner og kraftelektronikk



Research groups

- Autonomy
- Secure distributed Systems
- BioMEMS
- Materials and microintegration
- Micro- and nanomechanical systems

Autonomy

Research, course development and teaching of autonomous systems and related techology. The group has a particular focus on maritime applications and risk analysis.

Main areas of interest:

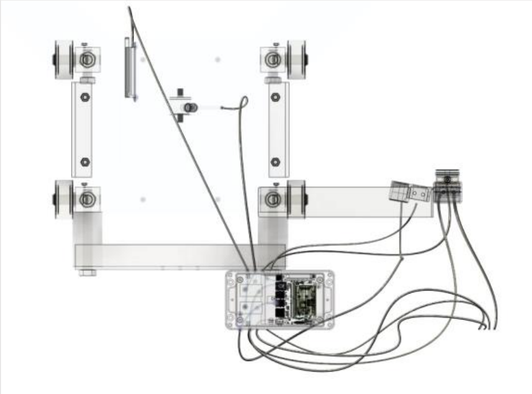
- Digital cross-disiplin development processes
- Maritime autonomous systems
- Human-machine interfaces
- Robot operating system

Members

Marius S. Tannum (leader)
Fabio Augusto de Alcantara Andrade
Helge Tor Kristiansen
Christian Hovden
Knut F. Åsatun
Odd Smith-Jahnsen

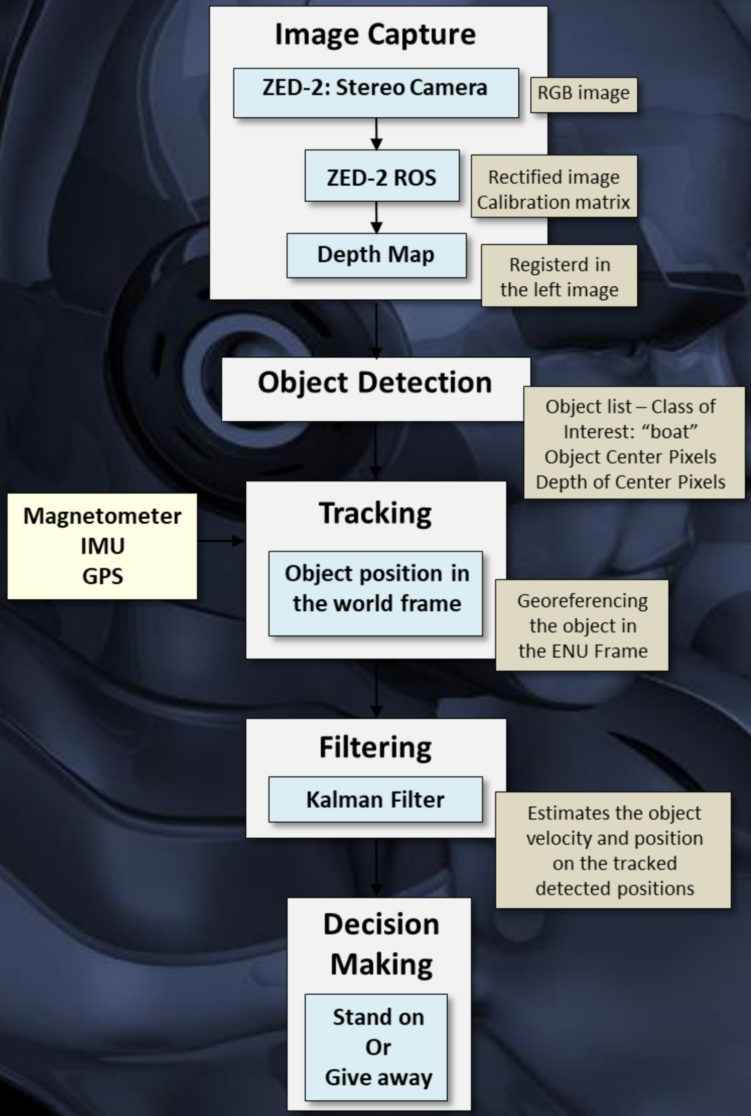
Members from other departments:
Kristin Falk (IRI)
Nils-Olav Skeie (EIK)
Ru Yan (EIK)
Hyungju Kim (IMA)

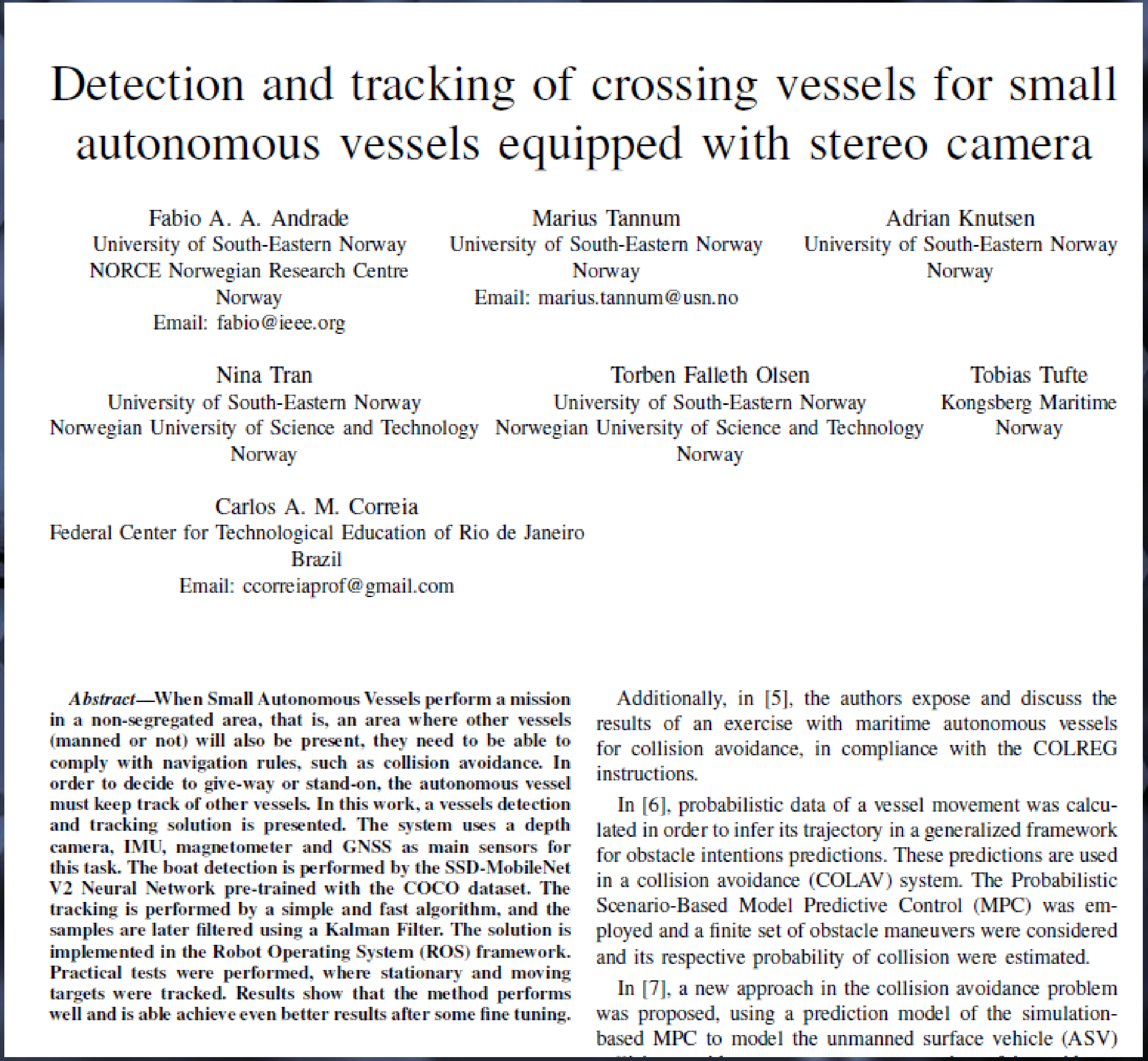
AutoDrone



Underwater sensor-system

Autonomy research





Detection and tracking of crossing vessels for small autonomous vessels equipped with stereo camera

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University of South-Eastern Norway
Norwegian University of Science and Technology
Norway

Torben Falleth Olsen
University of South-Eastern Norway
Norwegian University of Science and Technology
Norway

Tobias Tufte
Kongsberg Maritime
Norway

Carlos A. M. Correia
Federal Center for Technological Education of Rio de Janeiro
Brazil
Email: ccorreiaprof@gmail.com

***Abstract*—When Small Autonomous Vessels perform a mission in a non-segregated area, that is, an area where other vessels (manned or not) will also be present, they need to be able to comply with navigation rules, such as collision avoidance. In order to decide to give-way or stand-on, the autonomous vessel must keep track of other vessels. In this work, a vessels detection and tracking solution is presented. The system uses a depth camera, IMU, magnetometer and GNSS as main sensors for this task. The boat detection is performed by the SSD-MobileNet V2 Neural Network pre-trained with the COCO dataset. The tracking is performed by a simple and fast algorithm, and the samples are later filtered using a Kalman Filter. The solution is implemented in the Robot Operating System (ROS) framework. Practical tests were performed, where stationary and moving targets were tracked. Results show that the method performs well and is able achieve even better results after some fine tuning.**

Additionally, in [5], the authors expose and discuss the results of an exercise with maritime autonomous vessels for collision avoidance, in compliance with the COLREG instructions.

In [6], probabilistic data of a vessel movement was calculated in order to infer its trajectory in a generalized framework for obstacle intentions predictions. These predictions are used in a collision avoidance (COLAV) system. The Probabilistic Scenario-Based Model Predictive Control (MPC) was employed and a finite set of obstacle maneuvers were considered and its respective probability of collision were estimated.

In [7], a new approach in the collision avoidance problem was proposed, using a prediction model of the simulation-based MPC to model the unmanned surface vehicle (ASV)

Image Capture and Object Detection

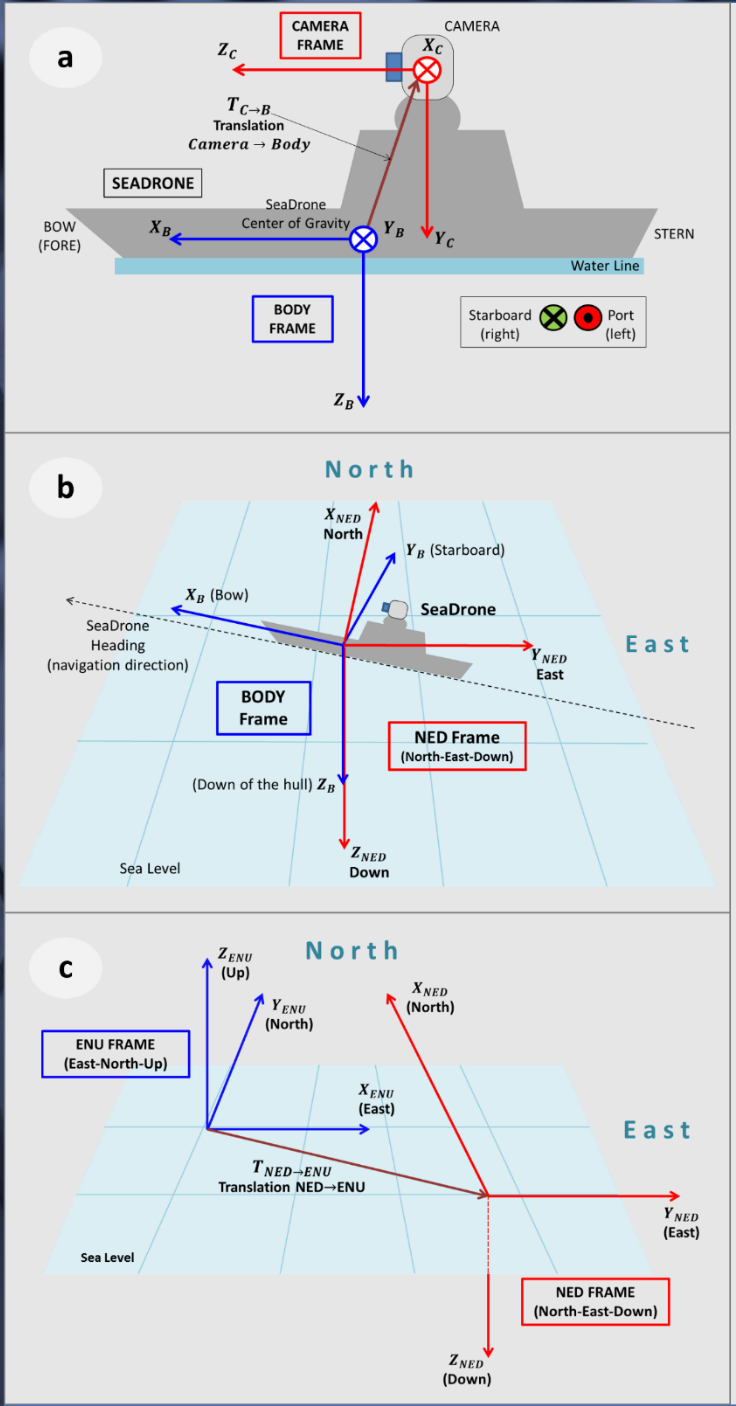
NVIDIA INFERENCE TOOLKIT

PRE-TRAINED NEURAL NETWORK

SSD-MOBILENET V2

COCO 2017 DATASET

Direct Georeferencing



$$\begin{bmatrix} x_C \\ y_C \\ z_C \end{bmatrix} = \mathbf{K}^{-1} z_C \begin{bmatrix} u \\ v \\ 1 \end{bmatrix}. \tag{1}$$

where the intrinsic camera matrix $\mathbf{K}$ is given by:

$$\mathbf{K} = \begin{bmatrix} f_x & 0 & c_x \\ 0 & f_y & c_y \\ 0 & 0 & 1 \end{bmatrix} \tag{2}$$

The matrix parameters are made available by the ZED2 Camera ROS Wrapper and obtained by subscribing to the ROS Topic /zed/left/camera_info.

Now, to calculate the detected boat position in the body frame, a simple rotation is needed followed by a translation:

$$\begin{bmatrix} x_B \\ y_B \\ z_B \end{bmatrix} = \mathbf{R_{C\to B}} \begin{bmatrix} x_C \\ y_C \\ z_C \end{bmatrix} + \mathbf{T_{C\to B}}, \tag{3}$$

where $\mathbf{T_{C\to B}}$ is the position of the camera in the body frame and the rotation from the camera to the body frame ($\mathbf{R_{C\to B}}$) is given by:

$$\mathbf{R_{C\to B}} = \begin{bmatrix} 0 & 0 & 1 \\ 1 & 0 & 0 \\ 0 & 1 & 0 \end{bmatrix} \tag{4}$$

$$\begin{bmatrix} x_{ENU} \\ y_{ENU} \\ z_{ENU} \end{bmatrix} = \mathbf{R_{NED\to ENU}} \mathbf{R_{B\to NED}} \begin{bmatrix} x_B \\ y_B \\ z_B \end{bmatrix} + \mathbf{T_{NED\to ENU}}, \tag{5}$$

Tracking Algorithm

Algorithm 1 Tracking

Define $timeout_{max}$
Define $distance_{max}$
Input $detections$
Input $points$
for $point$ in $points$ **do**
    for $detection$ in $detections$ **do**
        Calculate $distance$ between $detection$ and $point$
        if $distance > distance_{max}$ **then**
            $distances \leftarrow distance$
        end if
    end for
end for
$points_{temp} \leftarrow points$
while $distances$ **do**
    $distance_{temp} \leftarrow$ minimum $distance$ in $distances$
    $point(distance_{temp}) \leftarrow detection(distance_{temp})$
    $timeout(point(distance_{temp})) \leftarrow 0$
    Delete $detection(distance_{temp})$
    Delete $points_{temp}(distance_{temp})$
    Delete $distance$ in $distances$
end while
for $point$ in $points_{temp}$ **do**
    Add 1 to $timeout(point)$
    if $timeout(point) > timeout_{max}$ **then**
        Delete $point$ in $points$
    end if
end for
for $detection$ in $detections$ **do**
    Create a new $point$
    $point \leftarrow detection$
end for

Kalman Filter

E. Filtering

A Kalman Filter was used to estimate the positions and velocities of the detected boats based on the tracked detected positions. A new Kalman Filter is initialized and assigned to each new tracked point created.

As the boats are on sea level, only the horizontal coordinates are used. Therefore, the measurement vector $\mathbf{z}$ is equal to $[x, y]$ and the state vector $\mathbf{x}$ is equal to $[x, y, v_x, v_y]$, where x and y are the East and North positions and v_x and v_y are the East and North velocities. The observation matrix (H) is, therefore, given as:

$$\mathbf{H} = \begin{bmatrix} 1 & 0 & 0 & 0 \\ 0 & 1 & 0 & 0 \end{bmatrix}, \qquad (6)$$

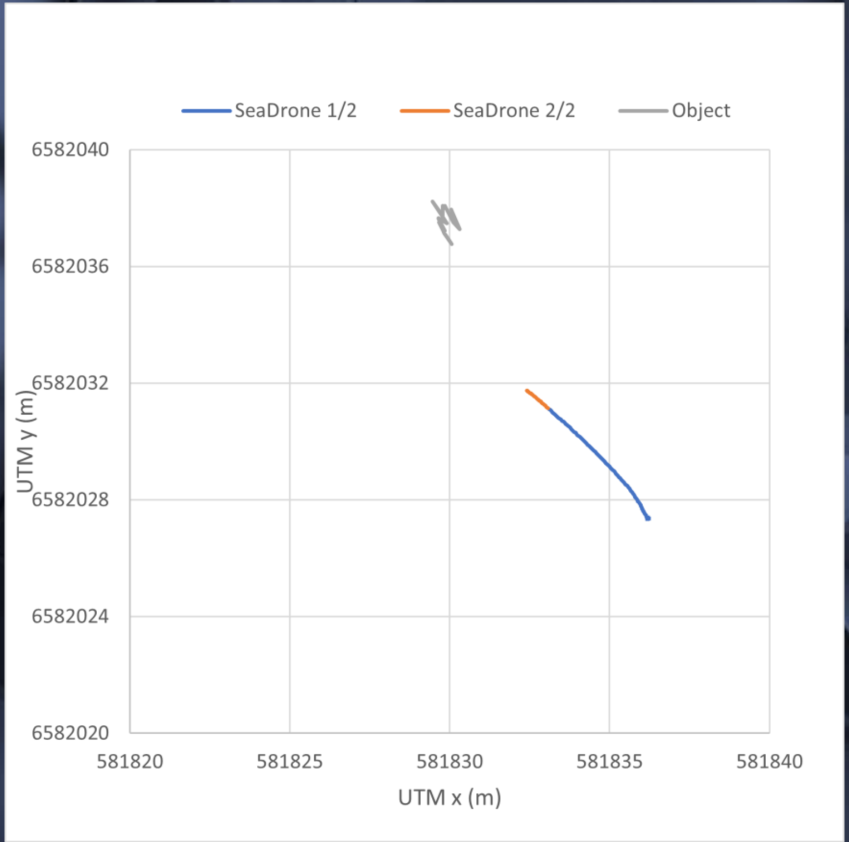
and the state transition matrix (A) is given as:

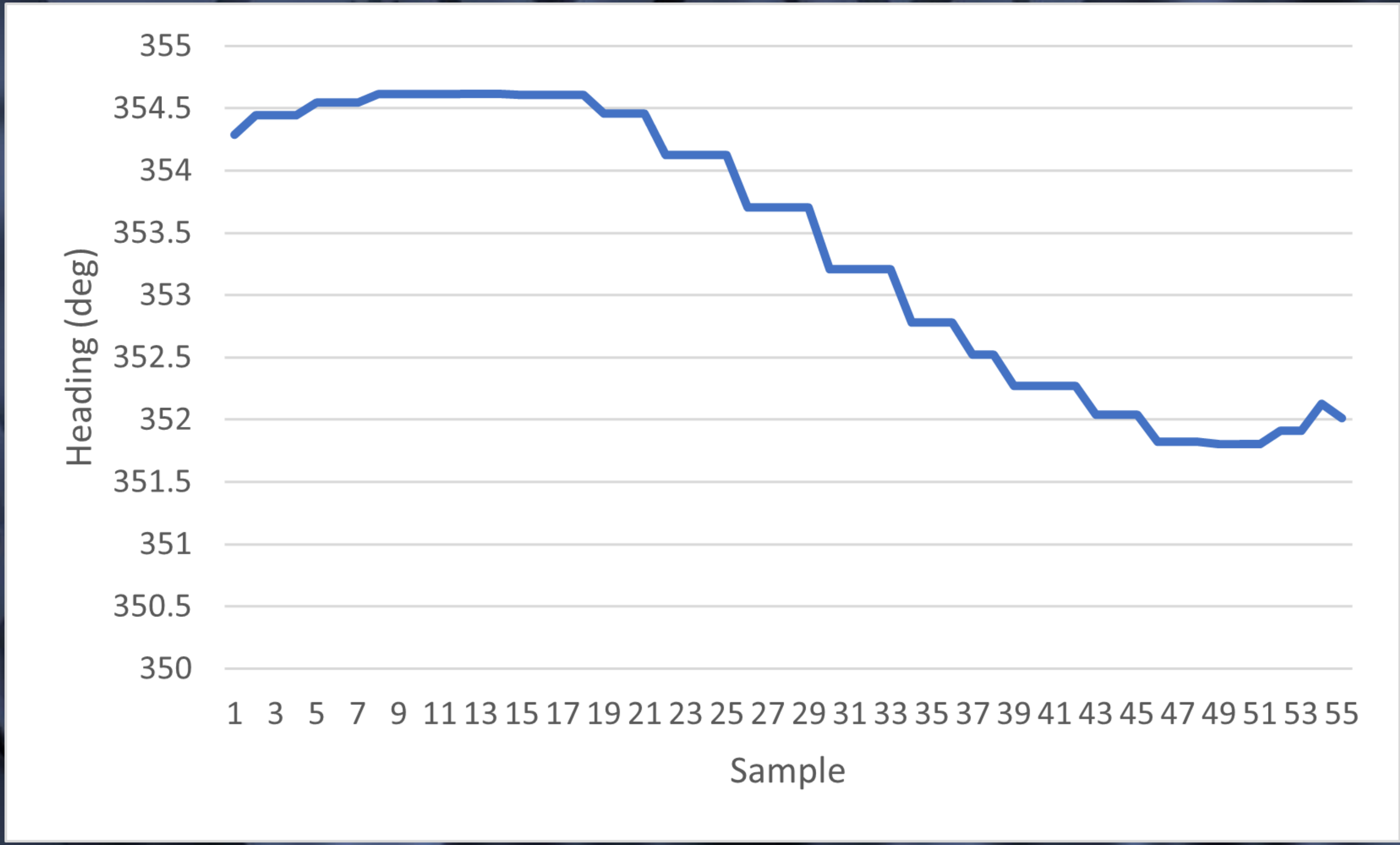
$$\mathbf{A} = \begin{bmatrix} 1 & 0 & \Delta t & 0 \\ 0 & 1 & 0 & \Delta t \\ 0 & 0 & 1 & 0 \\ 1 & 0 & 0 & 1 \end{bmatrix} \qquad (7)$$

where Δt is calculated every loop based on the time between the current and the previous detection. No control input data was used in the prediction step.

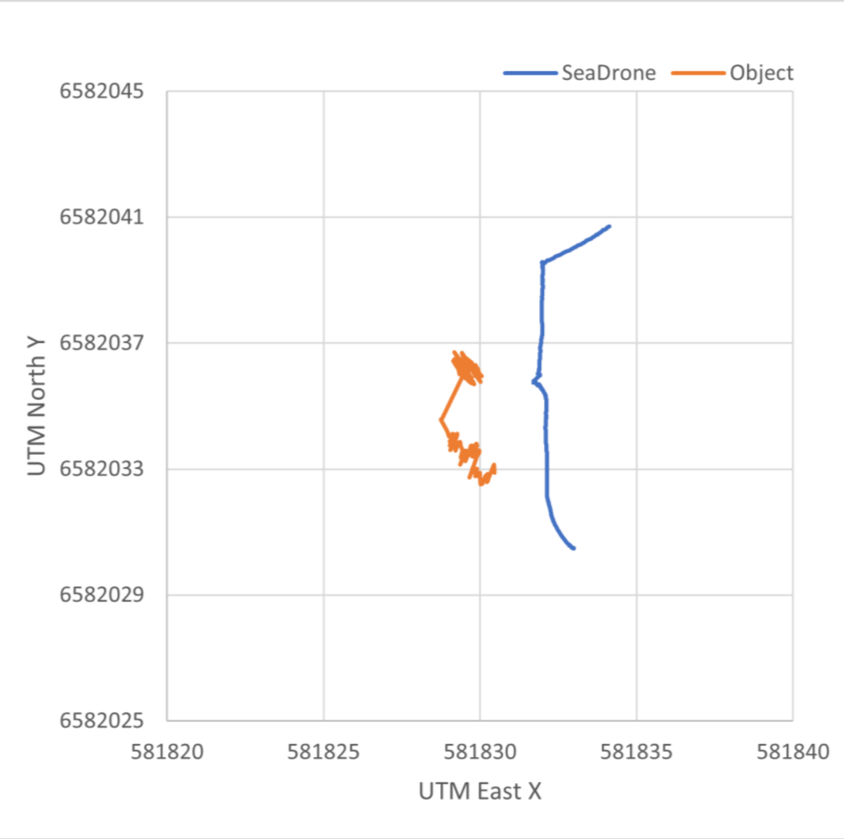
Results

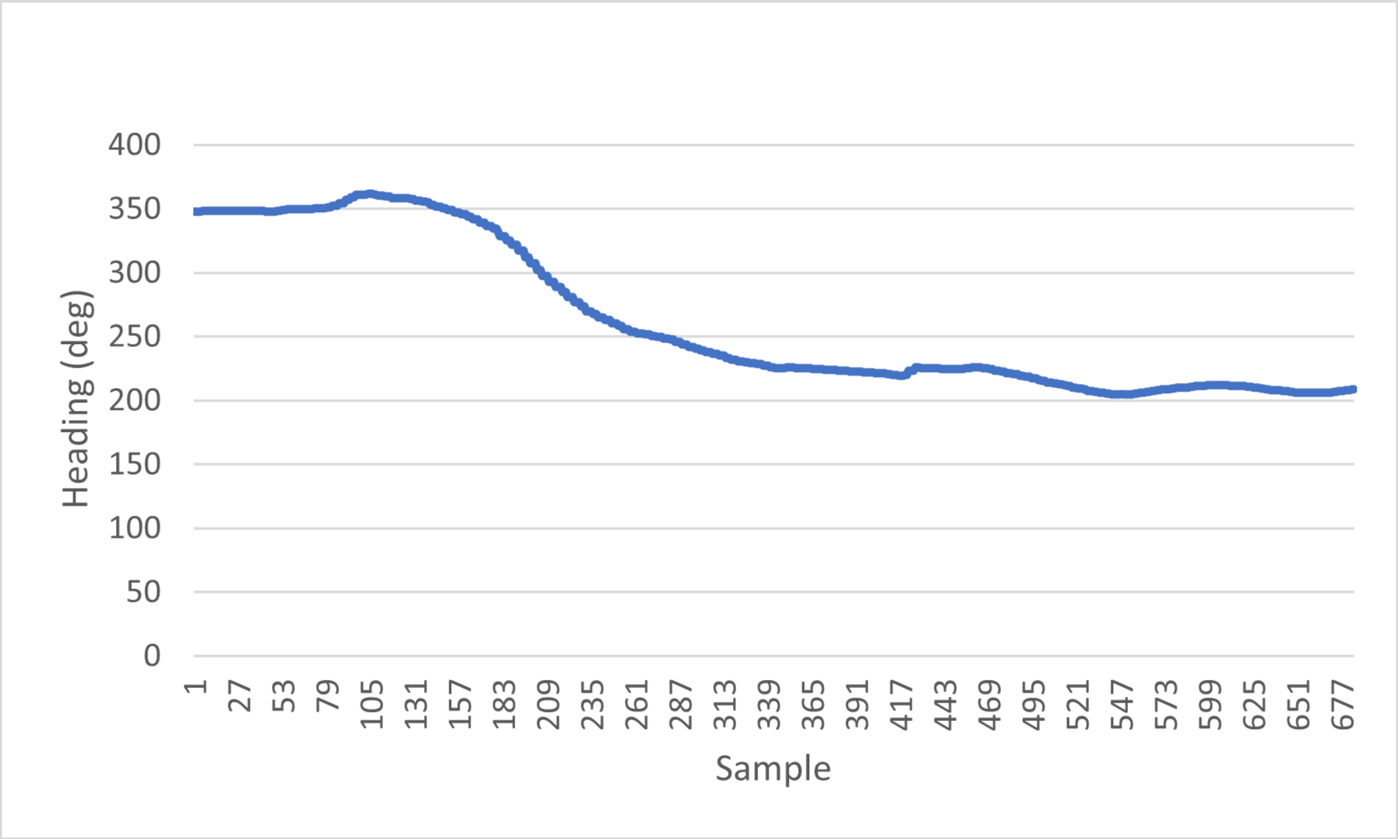
SeaDrone moving straight tracking a steady boat



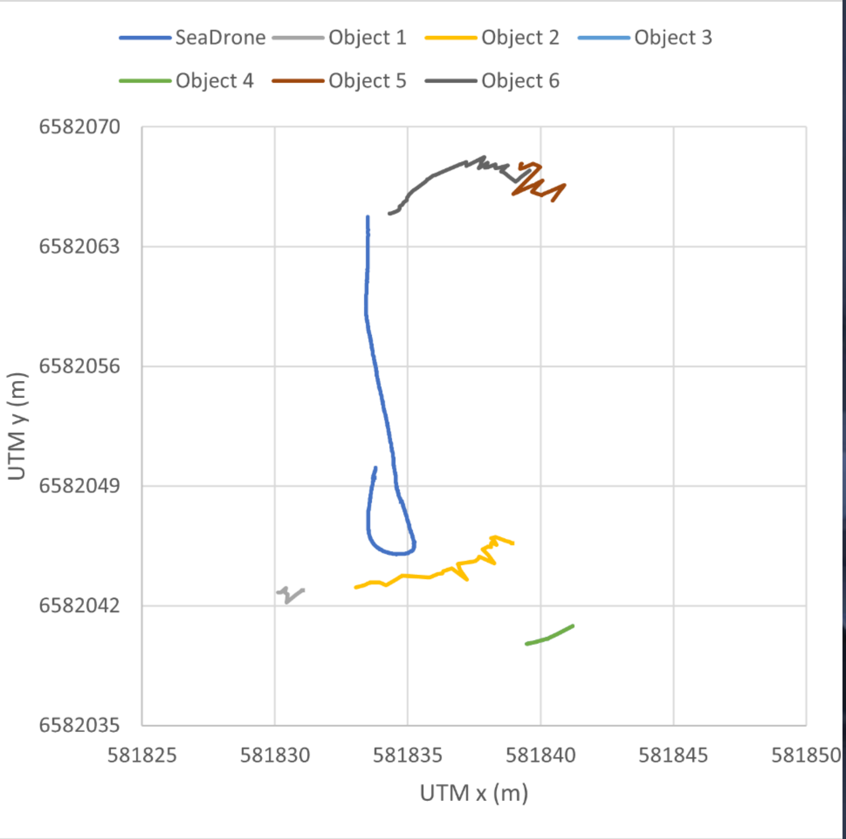


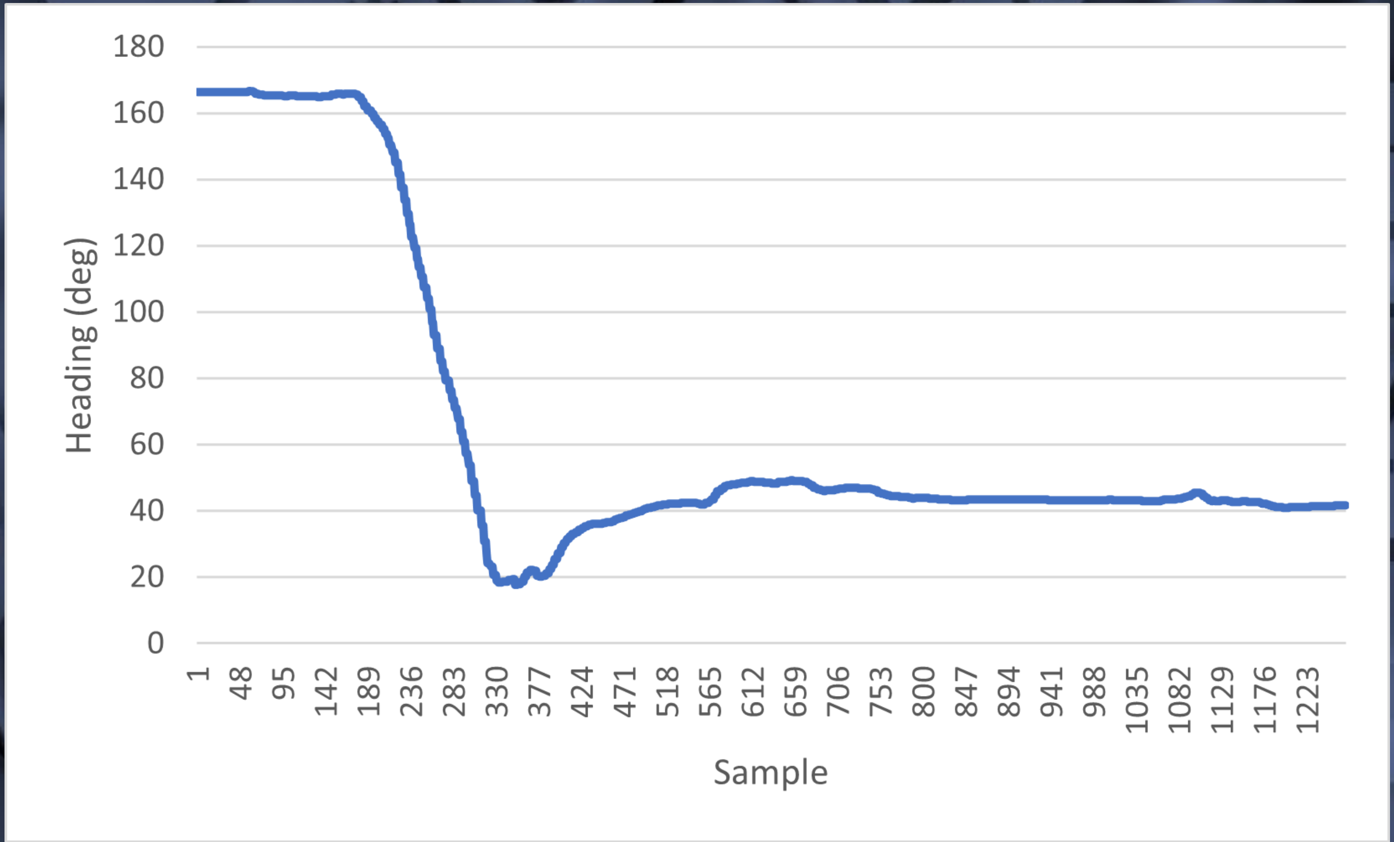
SeaDrone rotating around the tracked boat





SeaDrone moving when tracking multiple moving humans





Future Work

- Make more field tests and improve the Software
- Improve the Kalman Filter
- Test the detection on the sea
- Update the Neural Network with more boat data
- Implement a Model Predictive Control to avoid collision
- Compete in AutoDrone

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Secure distributed systems

The research group develops and teaches courses in additon to research and development related to computations, infrastructure, machine hardware, software and security of these systems.

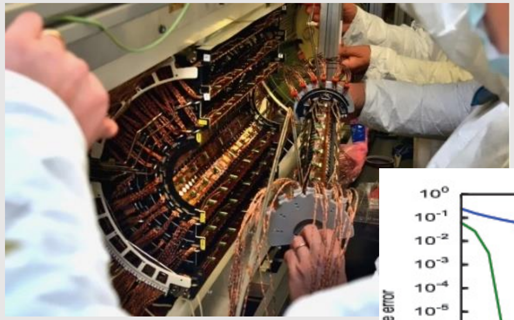
Distributed systems in our context is the combination of computer based systems that appares as one system.

Parts of special interest:

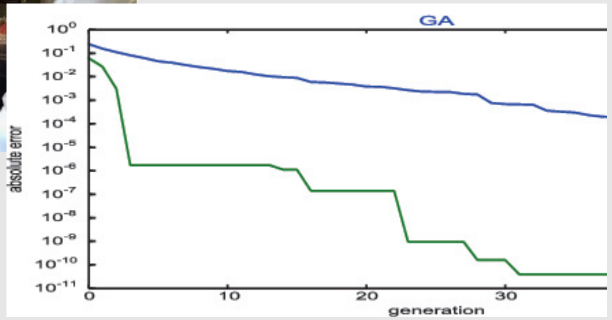
- Big Data
- Cloud Computing
- Cyber Security
- High speed data capture
- Intrusion detection
- Artificial intelligence (AI) and machine learning
- Optimization (performance/precision)
- Internet of Things (IoT)

Members

Geir Myrdahl Køien (lead)
Thomas Nordli
Geir Varholm
Jørgen Lien
Rune Langøy
Noureddine Bouhmala
Roar Georgsen



Pixel Tracker, CERN



Optimization, look-ahead optimizing

BioMEMS

BioMEMS – Biomedical Microelectromechanical Systems – is a subject that combines applied micro- and nanotechnology with biology

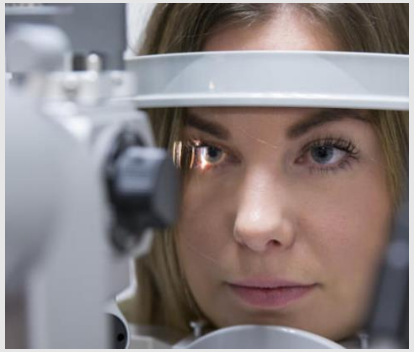
Medicine is one primary application field of BioMEMS platforms, which target:

- Point of care diagnostics
- Therapy and drug handling. It is also used to
- Monitor processes in the body for potential diseases

BioMEMS is an interdisciplinary field that combines natural sciences (physics, biology and chemistry) with electronics, mechanics, biomedical engineering, as well as computer science, materials science, medicine and mathematics.

Members

Lars E. Roseng
Erik A. Johannessen
Tao Dong
Frank Karlsen
Jörn Klein



The Photosense Project

About CtrlAQUA

Centre of Research-based Innovation in Closed-Containment Aquaculture

Closed system aquaculture

Materials and micro-integration

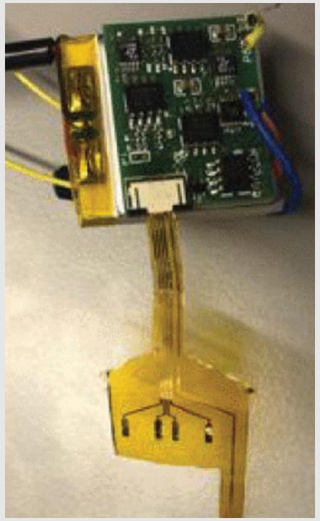
The group of materials and micro-integration performs research on system integration of a wide variety of smart systems, with a particular focus on material-related problems.

Topics:

- Packaging/ systemintegration of microelectronics
- Packaging/ systemintegration of medical devices
- Miniaturization of smart systems and devices
- Bonding technologies for harsh environments
- Intermetallic bonding (SLID)
- Conductive adhesive bonding
- Manufacturing processes for ultrasound transducers
- Integration of functional nanomaterials in microelectronics
- Nanostructures of Wide Bandgap semiconductors for photocatalytic applications

Members

Knut Aasmundtveit (leader)
Kristin Imenes
Kaiying Wang
Hoang-Vu Nguyen
Jan Kåre Bording
Truls Frednes
Bao Quoc Ta
Per Olaf Stensgaard
Ole Henrik Gusland
Anh Tuan Nguyen
Muhammad Tayyib



Implantable Interface for Neuroprosthesis

Micro- and Nanoelectromechanical Systems (MNEMS)

The research group contributes to teaching and academic supervision primarily on research topics related to devices and systems using micro- and nanotechnologies.

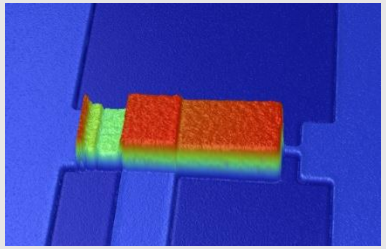
Our main research focus is to use micro- and nanotechnologies for devices and process technologies to advance electronic sensors, actuators and systems used in industrial instrumentation, environment control, health care, maritime and oil & gas applications, e.g.

- Ultrasound applications
- Optics and photonics
- Energy storage and harvesting
- Piezoelectric devices

Members

Ulrik Hanke (leader)
Per Øhlckers (emeritus)
Mehdi Azadmehr
Xuyuan Chen
Einar Halvorsen
Lars Hoff
M. Nadeem Akram
Agne Johannessen
Tung Manh (20%)
Hans J. Alker (emeritus)
Luca Marchetti (20%)
Hamed Salmani

Ultrasound transducers



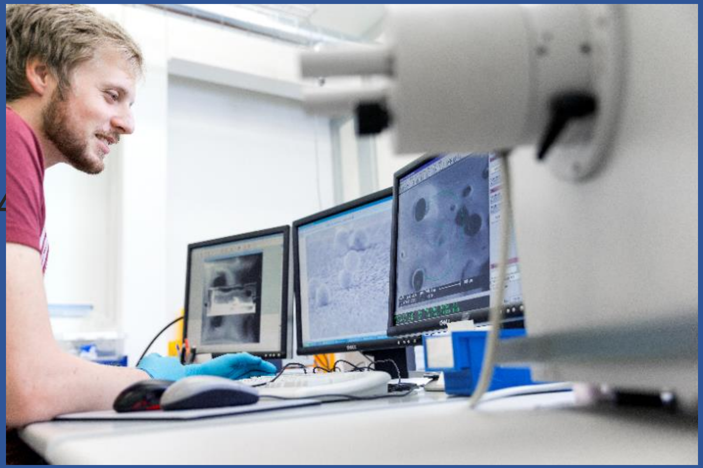
MEMS Microswitch

USN Laboratory facilities

- 1100 m² MST lab in the Vestfold Research Park

<u>Main facts:</u>
Location: Campus Vestfold
Cleanroom Area: 500 m²
Ultrasound/Charact/Biotech Labs: 600 m²
Start: 2002 - New labs 2013
Type: R&D, Education, Industry projects.
130 high tech tools
Staff: 6 Lab Engineers.
14 professors / 4 asc professors

- Medical devices
- Aerospace/space
- Automotive
- Energy
- Climate/Environment



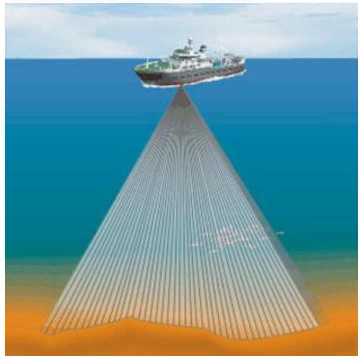
Forskningsrådet

MST-Lab at USN Campus Vestfold–
Systems, Packaging and interconnectivity

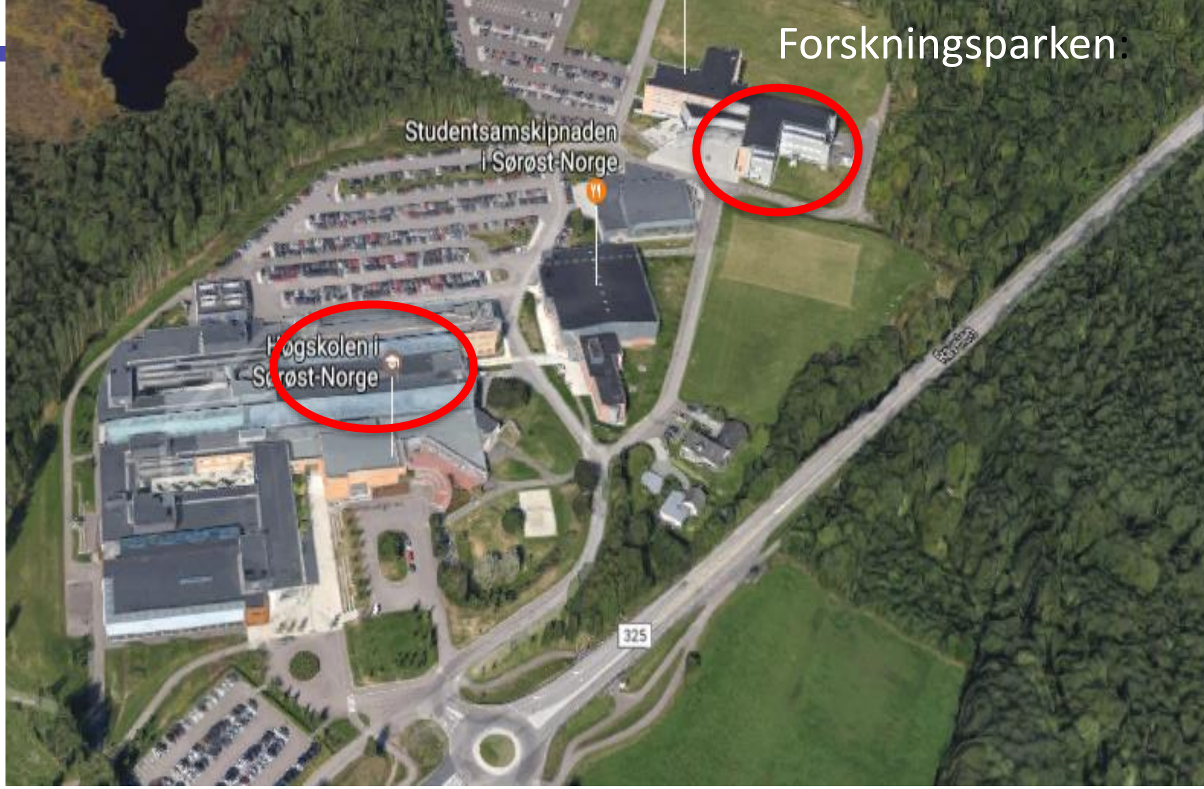
Main competence:
- Packaging of microelectronics
- Characterization SEM
- Sputter/Electroplating
- Chip/Wafer-bonding
- Flip-Chip interconnect
- BioMEMS
- Environmental testing

More than 30 active industry partners,
- Sensonor
- PoLight
- Projection Design - Barco
- Kongsberg NorSpace
- Kongsberg Maritime
- GE Vingmed Ultrasound
- SINTEF
- Jotun
- SensoCure
- Memscap
- CARDIACCS
- Sensocure
- Medistim
- Lærdal
- ++

sensonor norspace KONGSBERG GE Medical Systems SINTEF JOTUN MEMSCAP The Power of a Small World™



IMS MST-Laboratories



Objective:

- **Lab intensive education** Bachelor, Master, PhD (Electronics-El/auto-Data-Product design-Micro/Nanotech
- **BOA projects with industry**
- **Research activities** Nanomaterials- MEMS- Sensors-Bio
- **National/International funded projects**

IMS labs @ Campus Vestfold:

* **Micro/Nanotechnology**, 5 labs, 160 equipment
* **Electronics**, 3 labs
* **Electro/Automation**, 2 labs
* **Product Design,1** lab,1mechanical workshop
* **Data, 1 lab**, 2 server rooms

- Micro/nanofabrication (MEMS) Cleanroom lab
- Packaging semiconductors/sensors, Cleanroom lab
- Material Characterization (2 SEM, AFM, SAM)
- Ultrasound lab
- BiologyMEMS/Biomedical
- Product Design, 3D print lab
- Electronics, 3 student labs
- Electro/automation (incl Maritime) 2 student labs
- Data labs, 1 student lab (30 PC's, 2 server-room)

Technologies

The technologies offered at NorFab are divided in the following nine categories:

- Thermal processes
- Thin film deposition
- Lithography
- Dry etching
- Characterisation
- Bonding and packaging

Lab Facilities

NorFab provides access to state-of-the-art laboratories for Norwegian researchers, independent of their academic, institute or company affiliation. The laboratories include the three nodes NTNU NanoLab in Trondheim, SINTEF MiNaLab and UiO MiNaLab in Oslo, and the University of South-Eastern Norway´s MST-Lab between Tønsberg and Horten.

We offer more than 2000 m² of cleanroom

News

Opening a new window into nature's smallest building blocks

Organic nanomaterials are some of our smallest building blocks. They can change everything from medical treatment to building constructions.

Two engineering positions at NTNU NanoLab

We have currently two open engineering positions at NTNU NanoLab in Trondheim. If you know someone who might be suitable and interested, please do let them know.

Norwegian NanoSymposium October 5-6, 2021

USN MST-Lab

Location: between Tønsberg and Horten, 100 km south of Oslo
Cleanroom size: 400 m²

The MST-Lab is a flexible cleanroom facility for MEMS processes on silicon wafers and other substrates with emphasize on bonding, packaging and Micro-System-Technology. Therefore the laboratory also contains advanced tools for testing, dicing, pick and place, fine-pitch wire bonding and different flip chip methods. In addition, IMST has laboratories for: material preparation and characterization, microsystem measurements (electrically and optically) and BioMEMS research like assembly, packaging and testing of lab-on-chip and microfluidic microsystems.

Website

Technologies and equipment at USN MST-Lab

Thermal processes

- Climate Cabinet (Weiss)
- CNT-reactor
- Oxidation Oven Harmbridge HiTech furnace
- Temp chamber Lenton 202
- Thermal Chamber Heraeus T6200
- Thermal Chamber Lenton WHT6/30
- Thermal Chamber Thermaks TS4115
- Thermal Chamber, Heraeus Wötsch
- Thermoshaker TS-100
- Tube Furnace High Temperature 2"

Thin film deposition

- Au sputter VG Microtech SC500
- Electroplating Ni
- Electroplating of Cu and Sn
- Fume Hood 6- Au electroplating, Ti etch
- Laminar flow bench 4 Metal finger
- Plasma cleaner Addax
- Profilometer DEKTAK 150
- Sputter AJA
- Thermal Evaporator Moorfield MiniLab T25M

Lithography

- Fume Hood 4 for General Solvents
- Fume Hood 5 for corrosive chemicals
- Fume hood 7 – Corrosive
- Mask Aligner – Karl Suss MA56 (new)
- Mask Aligner EVG 620
- Rinse and dry STI Semitool
- Spinner 1 Semitool 1
- Spinner 2 AB Plast Spin 150
- Wet Etching AB Plast

Characterisation

- Acoustic material characterisation
- Acoustic Pulse-Echo measurements
- AFM XE-200
- Elipsometer

Bonding and packaging

- Bond pull tester Micropull
- Die Attach Laurier Inc.
- Flip-chip bonder FinePlacer Pico (Automatic Force 2-700 N)

Chemical and biological methods

- Autoclave
- Biological Safety Cabinet 2 BIO
- Biological Safety Cabinet 3 BIO
- Centrifuge Eppendorf 5702R

cius

Centre for Innovative Ultrasound Solutions

For health care, maritime, and oil & gas

sfi Senter for forskningsdrevet innovasjon

Three application areas

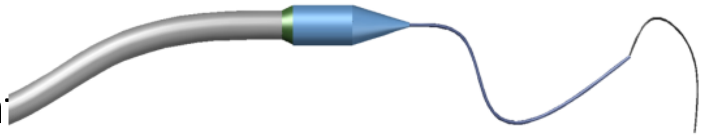
One common technology → *Ultrasound*

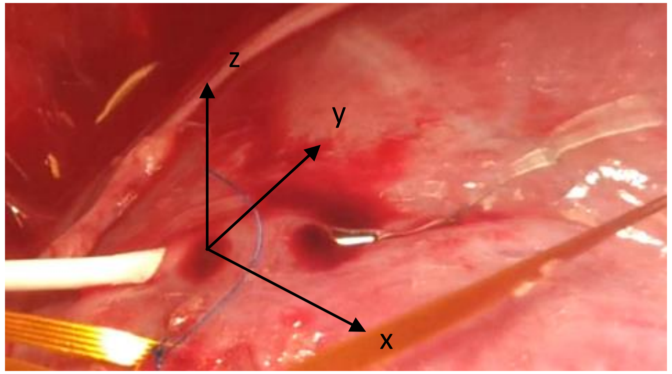
1) **Health**
2) **Maritime**
3) **Offshore oil & gas**

- **World leading industry**
  - Horten cluster: *GE Vingmed, Kongsberg Maritime, FFI(NDRE), Medistim*
- **World leading research centres**
  - NTNU, UiO, USN Vestfold
- **Ultrasound important for Norwegian economy**
  - *Oil, gas, fish, marine resources, health*

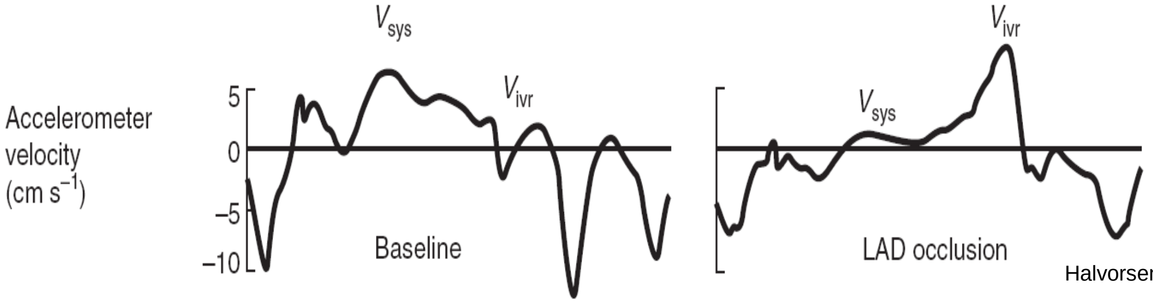
Microsystem for Heart Monitoring

- Detect heart infarction
- Surveillance of bypass operated patien
- Early warning if complications occurs
- Faster and more correct treatment than what is possible today





Sensor implanted in the heart muscle



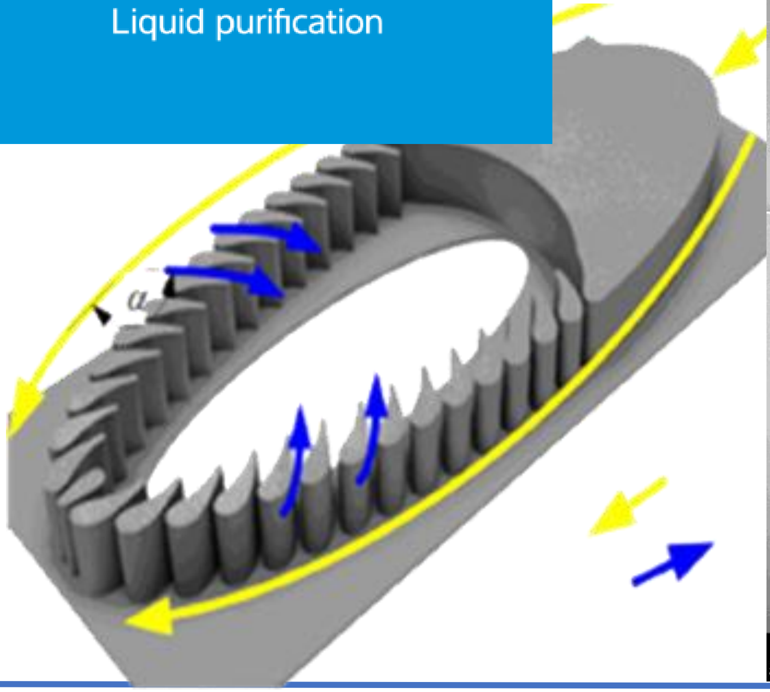
Halvorsen et al, 2009

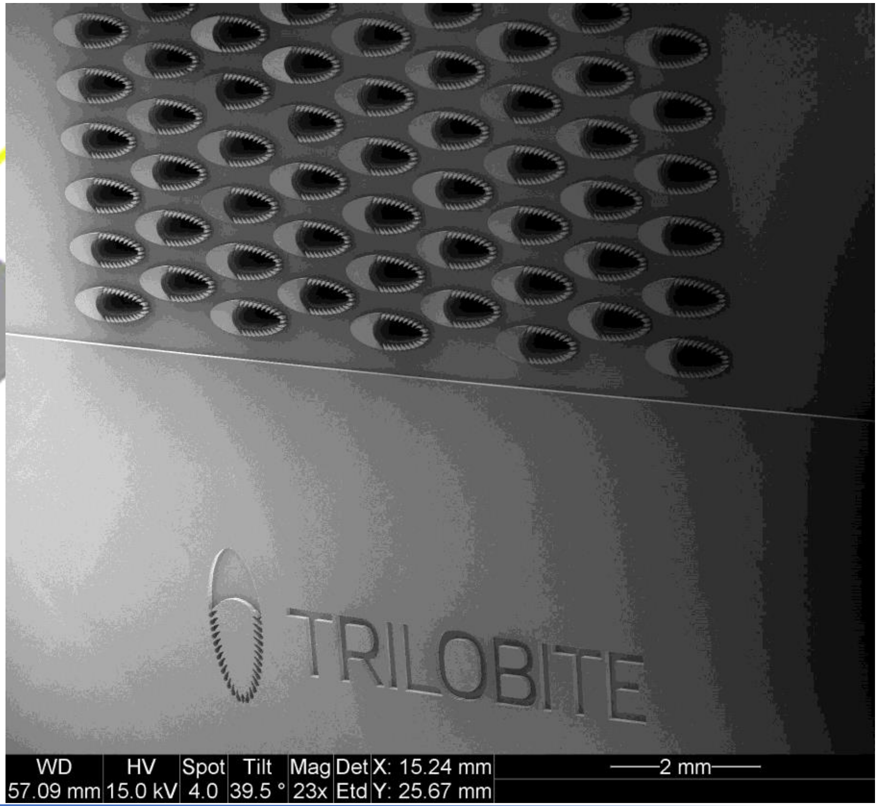
Oslo University Hospital
The Interventional Centre

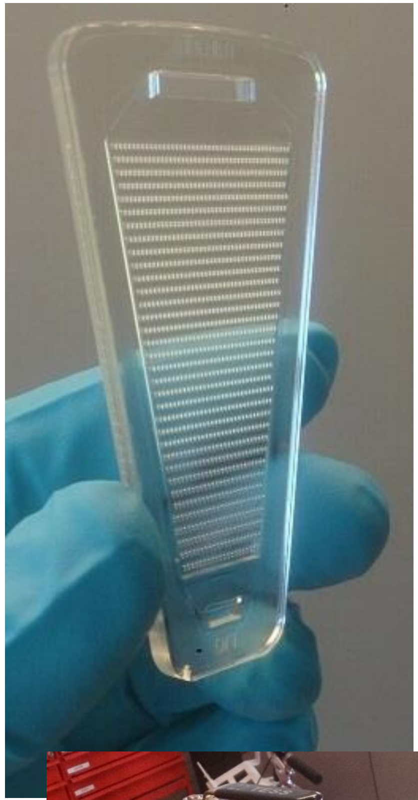
TRILOBITE

Liquid purification

BIOMEDICAL SEPARATION/CONSENTRATION DEVICES
MICROFLUIDICS





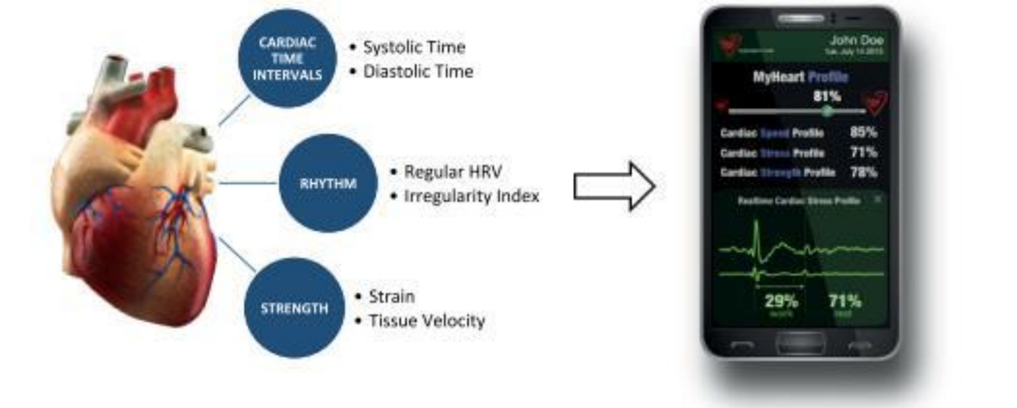


APPLAUSE – (2019-2022)

Title: Advanced packing for photonics, optics and electronics for low cost manufacturing in Europe
Project leader: Professor Per Øhlckers

Project supports building on the European expertise in advanced packaging and assembly to develop new tools, methods and processes for high volume mass manufacturing of electrical and optical components

This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 826588



Cardiac Effectiveness Indicator (CEI) of cardiovascular health

Partners:

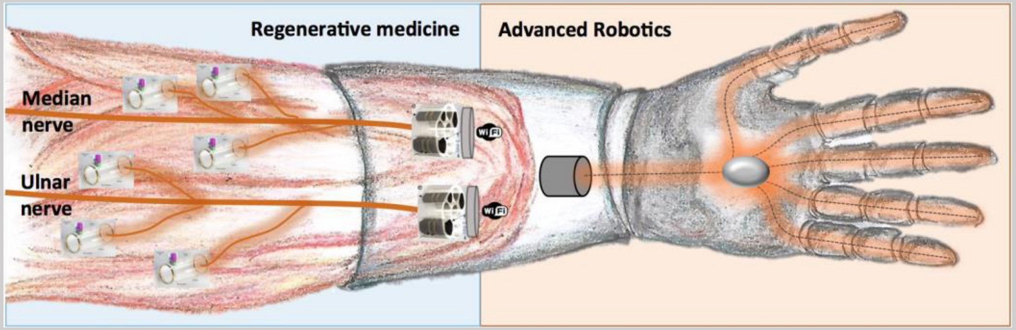
- 8 institutions from Germany
- 8 institutions from Finland
- 3 institutions from Nederland
- 3 institutions from Belgium
- 3 institutions from Austria
- 2 institutions from Switzerland
- 1 institution from France
- 1 institution from Hungary
- 1 institution from Israel
- 1 institution from Latvia
- **3 institutions from Norway**

ARMIN – (2019-2023)

Title: Arm neuroprosthesis equipped with artificial skin and sensorial feedback
Project leader: Professor Lars-Cyril Blystad

This research project aims to develop a personalized arm neuroprosthesis, equipped with artificial skin and sensorial feedback for patients with partially amputated superior limbs, providing the unique capability of bidirectional connect the prosthesis with the peripheral nervous system from the patient stump

This project has received funding from the European Union’s Horizon 2020 research and innovation programme under grant agreement No *[number]*

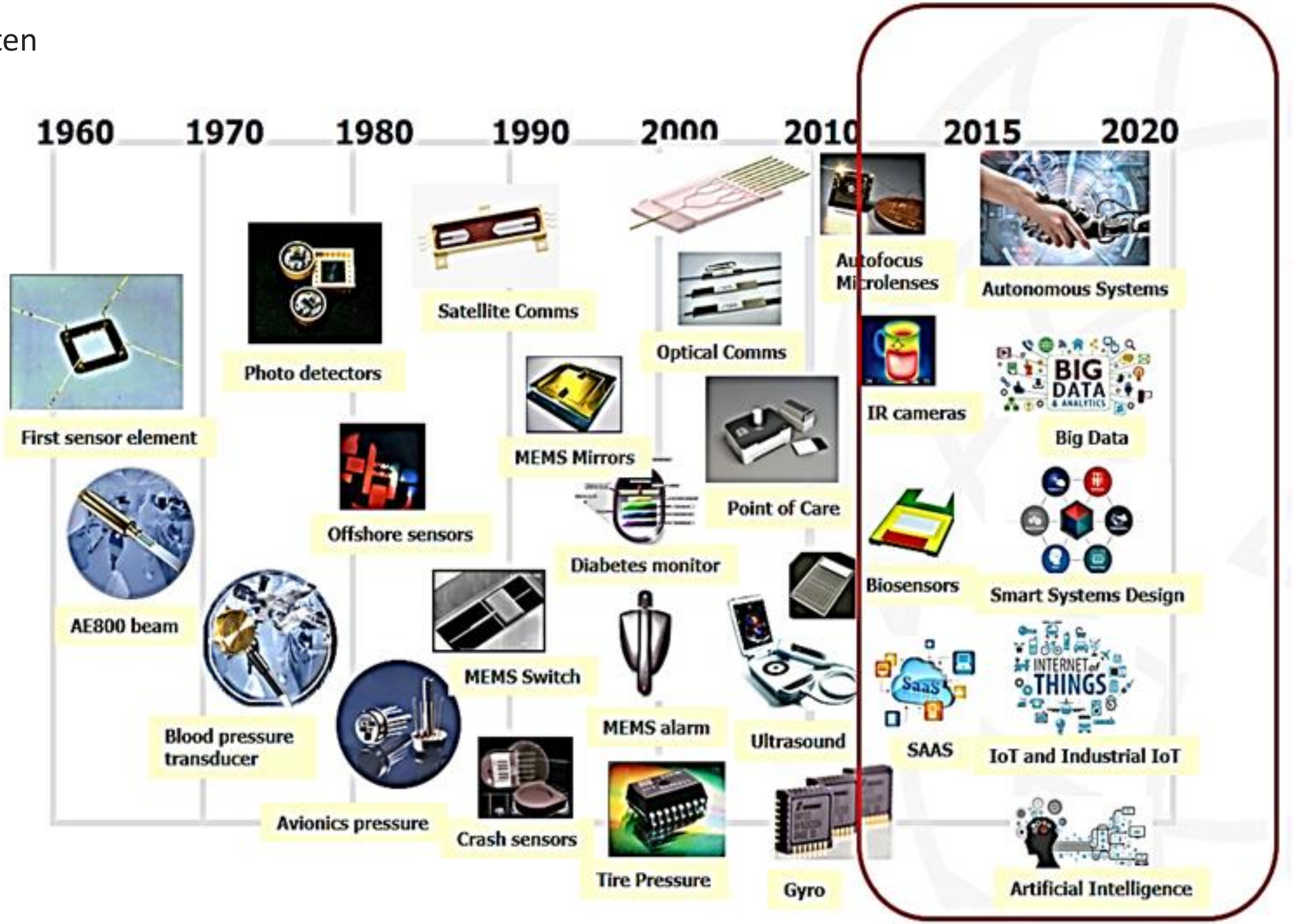


Schematic diagram of the neuro-prosthesis and the targeted call priorities.

Partners:

- University Polytechnic of Bucharest (coordinator)
- Academy of Medical Sciences - Bucharest
- Floreasca Hospital - Bucharest
- National Research and Development Institute for Microtechnology – IMT Bucharest
- Areus Technology SRL – Bucharest
- University of South-Eastern Norway, Department of Micro Systems - Norway

Microtechnology history in Horten




Universitetet
i Sørøst-Norge