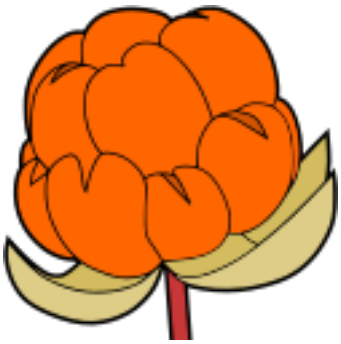
A generic framework for executable modeling

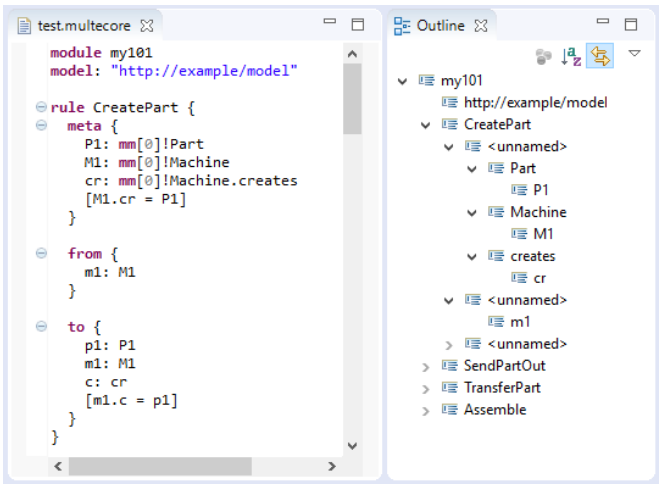
In Model-Driven Software Engineering (MDSE), the increasing complexity of software development processes is tackled through abstractions; i.e., considering abstract models as first-class entities. Using executable models one would expect to gain more from time-consuming modelling efforts, such as simulation, verification and early debugging and analysis. However, due to the lack of mature modelling tools and frameworks that facilitate both definition and execution of models, executable modelling has not gained its deserved popularity and its potentials are not yet unfold. In most cases, the definition of behavioural models for the software system to be developed is a non- trivial task, comprising complex aspects such as time constraints, resource management, failure detection and recovery, etc. Hence, automatic verification of executable models, especially using techniques from runtime verification, would be necessary for any executable modelling framework. This master project will focus on tool support for the metamodelling framework MultEcore (see http://ict.hvl.no/multecore/)

We will use model transformation rules to define the semantics of these languages. For the verification purpose, we define a modelling language for the specification of behavioural properties. These properties are monitored constantly during the execution of the models in order to ensure the expected behaviour. In case failures are detected, or are expected to happen, mitigation procedures could be fired. We will use case-studies from the field of process modelling to ease the development process. There is possibility for a period of research stay at the University of Malaga (Spain).

Supervisors:

• Adrian Rutle (aru@hvl.no) • Volker Stolz (vsto@hvl.no





Master thesis: Asynchronous I/O interface

Software Engineering Research Group

The I/O syscall interface is a possible way to increase concurrent operation in a process.

Linux offers traditional blocking, or synchronous, I/O syscalls. Blocking here means userspace code will not progress and so does no useful work. Linux also offers various non-blocking or asynchronous I/O syscalls such as those defined by the `aio` interface or the newly implemented io_uring interface.

Mode	Blocking	Non-blocking
Synchronous	read/write	read/write (O_NONBLOCK)
Asynchronous	I/O multiplexing (select/poll/epoll)	aio, io_uring

This project may involve:

1) The implementation and application of modeling tools for simulating and analyzing the use of an asynchronous I/O interface.
2) The implementation, practical evaluation, and analysis of asynchronous I/O to a real-world problem.
3) The study of modern language constructs and paradigms that can ergonomically abstract over such operations.

Research questions include:

- can we model the I/O interfaces and make useful predictions about going from one mode to another
- what language constructs or paradigms would enable an ergonomic interface to asynchronous I/O
- develop both qualitative and quantitative measures of the improvements an asynchronous I/O programming model yields

A prospective student should…

- …have an interest in math and computational theory (statistics, logic,...);
- …learn about concurrency and systems programming;
- …like programming and programming languages (Python, C);

Reading material:

- "Asynchronous System Calls Genesis and Status Zach Brown Oracle " (PDF)
- "Efficient IO with `io_uring`". (PDF)

Supervisors:

Volker Stolz (volker.stolz@hvl.no); Ole Jørgen Abusdal (ojab@hvl.no)

Automatic software repairing using Machine Learning

Bug fixing and software repairing are gaining increasing importance since programming environments are becoming more and more complex. The difficulty of keeping programs free of errors grows together with the size of working teams and number of changes during the development process.
To handle this complexity, models are used to support software development. Therefore, the correctness and accuracy of such software models are of the utmost importance to maintain good quality during the development of software systems.
Automation can be an excellent solution to ease the complexity of this process by periodically checking if a model is free of errors and repairing them when they occur.
Machine Learning has already achieved human performance in repetitive tasks and we believe, it could be successfully applied in automatically fixing software errors, both at coding and modelling levels.
The biggest challenge for using Machine Learning in automatic repairing, especially within modeling, is the lack of historical data available publicly. Most ML algorithms need great amounts of datasets in order to achieve high-quality results. Therefore, it would be really interesting to research to what degree Unsupervised Learning and Reinforcement Learning algorithms can be applied in software repair, since this type of algorithms do not need labelled data or even not training data at all.
Therefore, our focus will be on researching how Machine Learning can automatically repair bugs in software models, trying to achieve the best performance posible. For this, we will work with different algorithms, and apply different techniques to boost the algorithms performance. For this we will use Eclipse Modeling Framework.

More information about the project available at https://ict.hvl.no/project-parmorel/

Supervisors:

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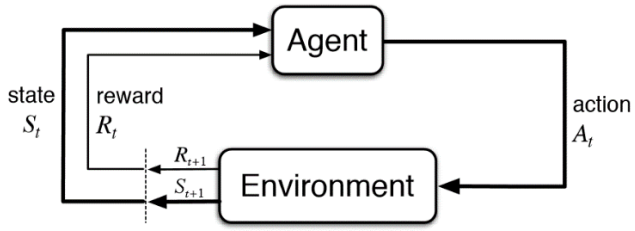

Chatbot generation *for* and *from* Open Data sources

More and more data is published online every day, coming from both the public and private sectors. As an example, the European data portal registers over 400,000 public datasets online.

Most of this data is available via some kind of (semi)structured format (XML, RDF, JSON, etc.) which, in theory, facilitates its consumption and combination. Indeed, the open data movement promises to bring to the fingertips of every citizen all the data they need, whether it is for planning their next trip, or for government oversight.

Unfortunately, this is still far from reality. Our society is opening its data but not building the technology and infrastructure required to empower citizens to access and manipulate it. Only technical people have the skills to consume the heterogeneous data sources while the rest is forced to depend on third-party applications or companies.

This project aims to:

- Validate the use of chatbots as a mechanism for citizens to consume and benefit from open data sources
- Derive a method to automatically generate those chatbots from the definition of the data source itself.

In particular, during the project the student will choose one or more interesting Open Data sources provided by some local/regional/national Norwegian administration and create a chatbot/s for them. From this experience, the student will then aim to derive useful conversation patterns that can then be used to create a chatbot generator that, given a specific open data resource, is able to generate a chatbot to sustain conversations in natural language to query it.

The chatbots will be created using the Xatkit open source development platform (https://github.com/xatkit-bot-platform). Some previous experiments along these lines can be read here: https://modeling-languages.com/a-model-based-chatbot-generation-approach-to-talk-with-open-data-sources/ but this project is not supposed to reimplement that tool but instead come up with an original contribution to the same problem. The actual focus will also depend on the open data sources chosen by the student (e.g. if they are very time sensitive the chatbot should have good support for processing the different wordings users could employ to talk about time/dates).

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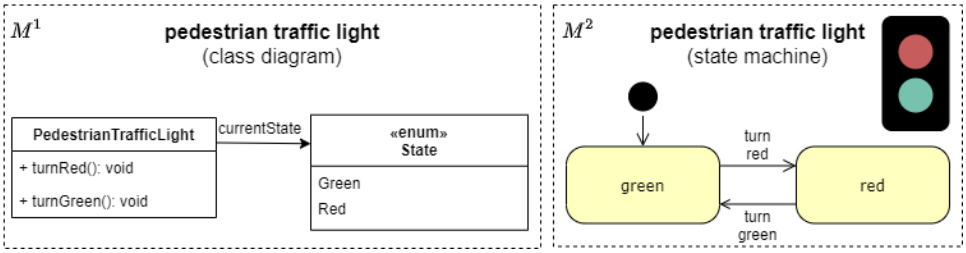
Adrin Rutle (Adrian.Rutle@hvl.no)

Integration of Behavioral Models into Multimodeling

(19.07.2021)

Model-driven software engineering (MDSE) describes a software system with one or more models that focus on various aspects of the system. Models are roughly categorized into behavioral and structural models depending on what they contain: A behavioral model specifies how the system reacts to stimuli (events) of its environment, e.g., human interactions or dispatched by other system components. Typical diagrams to describe behavioral models are state charts. While behavioral models describe how a system changes over time, structural models are irrespective of time: They describe the static relations between objects of the business domain. Typical diagrams are class models created within the Eclipse Modeling Framework (EMF). An example is modelling involved objects at crossroads (traffic lights) together with their behavior (changing from red to green, etc).



Yakindu State Chart Tools (SCT) by itemis AG, located near Dortmund, Germany, provides a family of tools for creating, maintaining, simulating, and testing state charts. For this, events must be defined, which are emitted from or received by objects. Usually, these events arise from methods provided by the classes of the business domain, e.g., *turnGreen()*. Advanced modeling activities in software projects require the creation of well-thought-out class models as well as the specification of the behavior of the objects within these class models. If EMF and SCT are used for this, this leads to a specification overlap of behavioral and structural models: events in state charts, e.g., *turnGreen* must redundantly be modeled in the corresponding classes as methods. In general, models exhibit other structural overlaps or other implicit dependencies amongst each other. While the separation of concerns due to multiple models is a major advantage of MDSE, contradictions between models must be avoided. Moreover, changes in one model must be propagated to other dependent models to restore possibly violated consistency.

The goal of the present project is to design and possibly implement (a prototype of) a tool, which enables consistency checking of EMF class models and depending SCT state charts. The goal is to design a good framework/architecture for consistency checking and maintenance of these heterogenous software models. For this project you will need to be self-driven and have good knowledge within software architecture, good programming skills and preferably a course in reliable software systems. We might divide the project into several parts, and welcome collaboration between two students. The project will have at least one supervisor from HVL (Harald König).

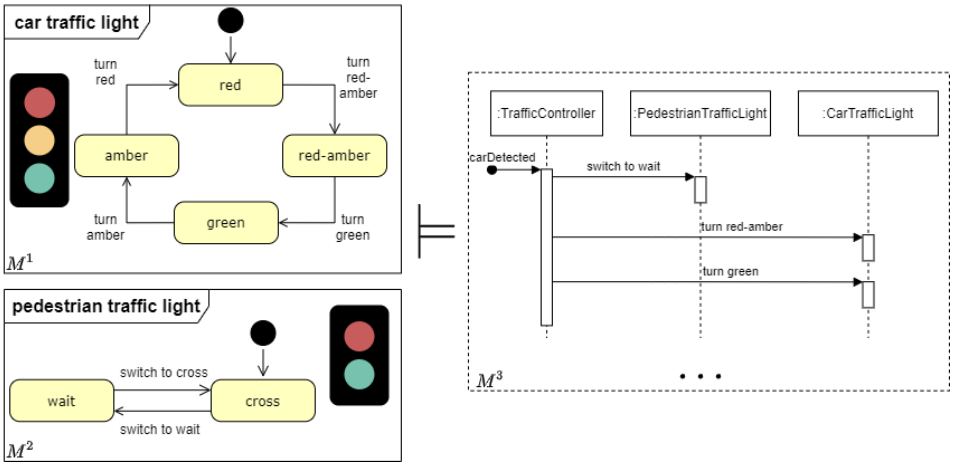
Contacts: Harald König (hkoe@hvl.no) and Tim Kräuter (tkra@hvl.no).

Adrian Rutle (Adrian.Rutle@hvl.no)

Consistency of Behavioral Models in Multimodelling

(19.07.2021)

Model-driven software engineering (MDSE) describes a software system with one or more models that focus on different aspects of the system. Behavioral models specify how the system reacts to stimuli (events) of its environment, e.g., human interactions or dispatched by other system components. Typical diagrams to describe behavioral models are state charts and sequence diagrams.



Yakindu State Chart Tools (SCT) (by itemis AG) and UPPAAL (developed at Uppsala University, Sweden) are tools for creating, maintaining, simulating, and verifying state charts. Advanced modelling activities in software projects require the creation of a well-thought-out set of behavioral models. State charts specify the complete *possible* behavior of objects, sequence diagrams describe *one* special object communication scenario. This leads to a dependency between sequence diagrams and state charts: Sequences of messages must be allowed by the state charts. A typical example is the requirement that at any time an emitted message *m* (causing validity of predicate $sent_m$) should eventually be responded ($resp_m$). While the separation of concerns due to multiple models is a major advantage of MDSE, contradictions between models must be avoided. Moreover, changes in one model must be propagated to other dependent models to restore possibly violated consistency.

A sequence diagram can be translated into a formula of temporal logic, see [1], validity of which can be checked w.r.t. a state chart. In the example above this would be the formula $G(sent_m \Rightarrow F(resp_m))$ ("It is Globally the case that after $sent_m$ one Finally observes $resp_m$."). The goal of the present project is to formalize this translation, then design and possibly implement (a prototype of) a tool, which enables consistency checking of sequence diagrams and state charts created with SCT or UPPAAL by using this translation.
For this project you will need to be self-driven and have good knowledge within software architecture, good programming skills and preferably a course in reliable software systems. We might divide the project into several parts, and welcome collaboration between two students. The project will have at least one supervisor from HVL (Harald König).

Contacts: Harald König (hkoe@hvl.no) and Tim Kräuter (tkra@hvl.no).

Adrian Rutle (Adrian.Rutle@hvl.no)

[1] Kugler, et al.: *Temporal Logic for Scenario-Based Specifications* In: Halbwachs N., Zuck L.D. (eds) TACAS 2005. Lecture Notes in Computer Science, vol 3440. Springer, Berlin, Heidelberg. https://doi.org/10.1007/978-3-540-31980-1_29

Title: A decentralized architecture for data access, security, trust, ownership, and data sharing marketplace for the smartocean (2 students)

Research Group: Software Engineering

Project Description

The smartocean project brings together several actors from different domains with the aim to develop smart sensors, underwater communication systems, and data sharing platforms to better monitor the ocean.

Several challenges exist to build this type of system-of-system. Among them are interoperability, sharing of data, trustworthiness of data, security of data, privacy, ownership of data, and marketplace platform for the ocean data.

This project will investigate a decentralized architecture such as Gaia-X (gaia-x.eu) and blockchain concepts to address the outlined issues. The student (s) will develop a prototype of a marketplace based on e.g., the Gaia-X standard or a custom blockchain standard.

This project can be done by 2 students.

- 1 student can work on building ownership and trust models using smart contracts and cryptography protocols based on data governance plan for the smartocean.
- 1 student can work on building a prototype of a marketplace for sharing data based on different trust and ownership models.

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Elastic Resource Allocation for Cloud Services

Software Engineering Research Group

Project description

Services provided by cloud service providers are in general regulated by a service-level agreement (SLA). Violations of SLA may entail expensive penalties. The service provider needs to ensure that the service is able to meet the SLA, for example, in terms of the end-user response time, by deciding on a resource management policy and determining the appropriate number of virtual machine instances (or containers) and their parameter settings (e.g., their CPU speeds).

To avoid SLA-violation and minimise cost for cloud services, we suggest the following topics:

1. *Elastic resource allocation on the cloud*
   To develop a scheduling framework which can flexibly allocate resources to tasks on the cloud according to dynamic demands
2. *Cost approximation for cloud services*
   To develop a tool which calculates the cost for cloud services depending on the capacity of allocated resources

A prospective student should:

- Like (concurrent) programming;
- Be interested in concurrent programs and verifying their correctness;
- Learn about syntax and semantics of programming languages, grammars, static analysis.

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From Metamodels to Fluent APIs

Domain-specific languages (DSLs) are languages especially designed to perform a task in a certain domain. As such, they outperform General Programming Languages by offering more specific semantics and constructs typically used in that domain. At the abstract / semantic level, DSLs are defined via a grammar or a metamodel where you define the concepts included in the language and the relationships between them. For modeling, the latter is more common.

As a disadvantage, each DSL needs its own specific set of tools to write, read and transform artefacts written in that language. This is why, when implementing the DSL, an important decision is whether to create the DSL as an external DSL or as an internal one. An external DSL is an independent language (with its own grammar, parser, compiler,…). Instead, internal DSLs are embedded in a general-purpose language, typically as a particular form of API, known as a Fluent API or fluent interface.

Clearly, internal DSLs offer several advantages over external ones, including the reusability of the full tooling available for the host language and the capacity to reuse any of libraries and constructs of that same language to avoid reinventing the wheel. As Erik Meijer put it: “External DSLs on the other hand are like puppies, they all start out cute and happy, but without exception turn into vicious beasts as they grow up”.

Right now, the fluent APIs for a given metamodel are manually created. While some best practices for Fluent API do exist, we are lacking of sound and efficient method to derive a Fluent API from an input metamodel.

This will be the goal of this project. More in particular, the project will aim to create a generator that, given a metamodel definition, derives a fluent API definition to create instances of that model. The metamodel definition will be provided as an ecore file and we will use Java as host language on top of which define the Fluent API. Nevertheless, we are open to use another language as target if the student prefers so.

As an example of a Fluent API definition you can take a look at Martin Fowler’s example: https://martinfowler.com/bliki/FluentInterface.html or check the one used to define bots in Xatkit: https://xatkit.com/fluent-interface-building-chatbots-bots/ . Note that this latter one was created after we first tried with an external DSL but ended up realizing that we were mostly reinventing Java.

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Master thesis projects in software engineering

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Fire Risk Mobile Application

Project proposal A

- **Part of the NFR DYNAMIC research project [2019-2023]**

Consumer-grade IoT weather station services

Fire risk indication service as a mobile application

$$C_{in,0} = RH_{inside} * C_{sat,in}$$
$$C_{in,i} = ((1-\beta) * C_{in,i-1} + \beta * C_{wa} * (\frac{T_{out}}{T_{in}}))) + \frac{m_{wall,loss}}{v} + ms * \frac{\Delta t}{v}$$

Fire risk prediction models [Log (2017), Log (2018)]

Meteorologisk institutt Frost

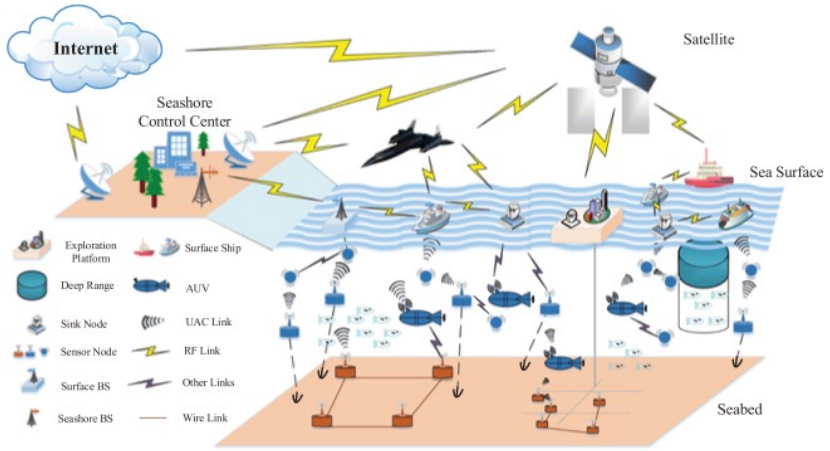
Weather data measurements and forecasting cloud-services

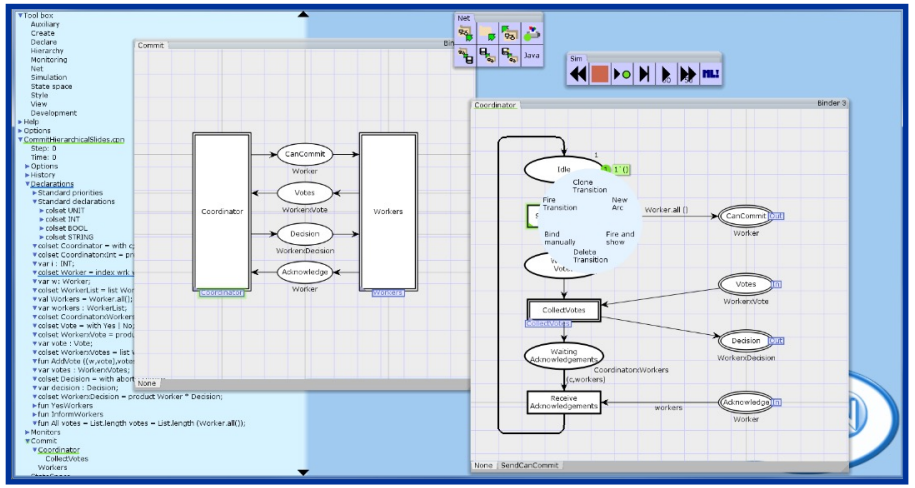
- **Project goal and research questions**
  - **Implementation of fire risk prediction model(s) on mobile devices**
  - **Evaluate implementation efficiency (e.g., computation and storage)**
  - **Continuation of two earlier master thesis projects**

SmartOcean Software Tools

Project proposal B

- **Part of the Centre for research-based innovation (2020-2028) funded by industry partners and NFR [2020-2028]**



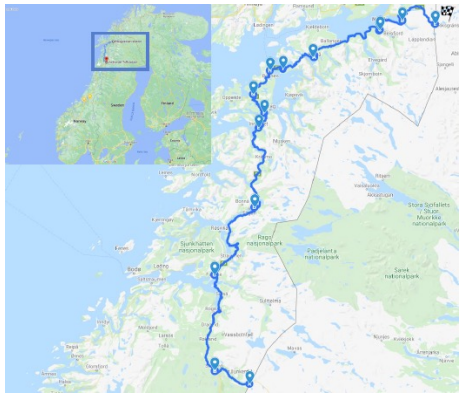


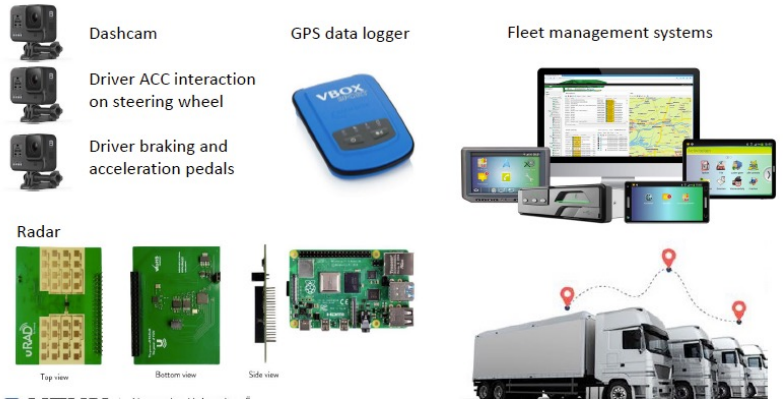
- **Project goal and research questions**
  - **Develop software tools for software systems modelling and validation**
  - **Explore object-oriented (C#) and functional (F#) paradigms on .NET**
  - **Continuation of ongoing master project (to be completed summer 2022)**

Platooning Road Analysis

Project proposal C

- **Part of an ongoing PhD project at NTNU where data has been collected in collaboration with Statens Vegvesen (SVV)**



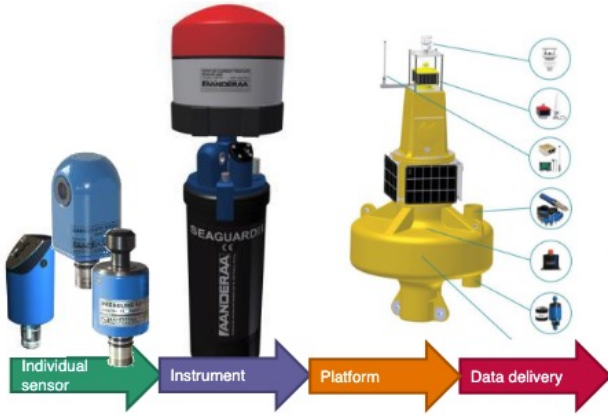


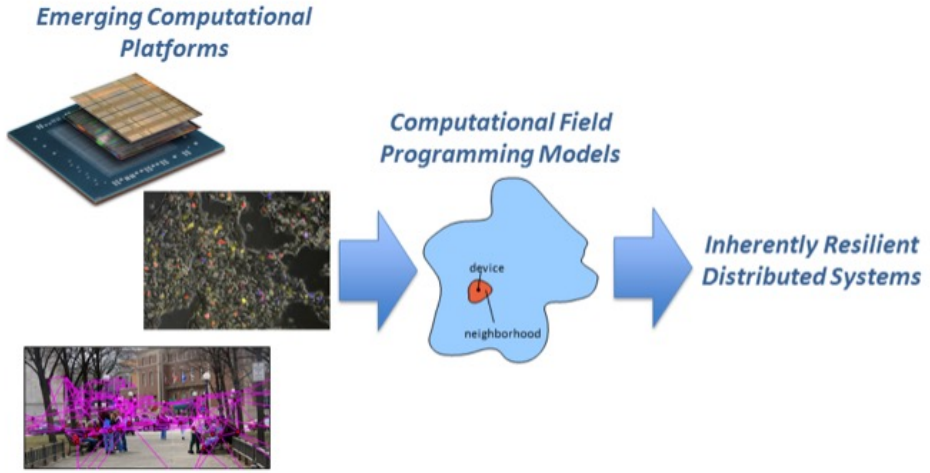
- **Project goal and research questions**
  - **Develop measures to quantify the extent to which road sections are suited to support platooning**
  - **Extract road section information from SVV web services**
  - **Implement data analysis and visualisation pipeline in Python for the collected data (2.6 Tb)**

Aggregate Programming

Project proposal C

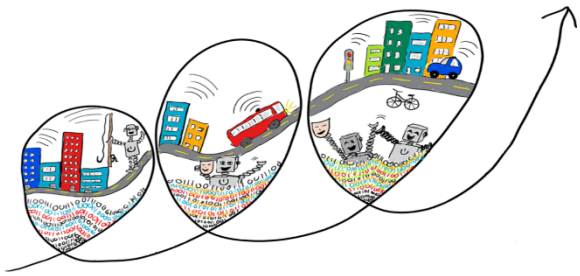
- **Investigate the application of aggregate programming for resillient underwater sensor networks**





- **Project goal and research questions**
  - **How to implement data collection for underwater sensor networks cases studies using the aggregate programming framework**
  - **How to a virtual prototype using simulation tools and supporting assessment of computational and communication costs**

Smart city mobility



How to combine insight and data to come up with smart, innovative and sustainable solutions for smart mobility in Bergen and Norway.

During the last two years an arena has been established in Bergen, where ideas for smarter transport will be created and supported. This mobility laboratory called “MUST” will contribute to innovation and collaboration between public and private sector actors. The core of MUST is focused around three laboratories where the main objective is to help good ideas of to a good start. The innovation-lab, ~~a~~ data-lab and ~~a~~ living-lab, will function as a catalyst and a provider of insight through data and knowledge.

Students choosing this project will contribute to finding good and sustainable solutions for future transportation needs as part of a continuous developing process. In cooperation with MUST, students will have the opportunity to find partners, develop and test ideas in the Innovation-Lab; access, combine and filter large amounts of (mobility) data in the Data-lab and possibly test solutions in a live environment in Living-lab.

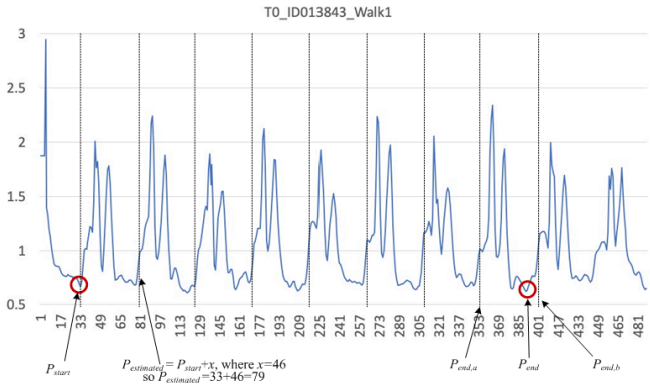
Given the complexity of the modern world mobility challenges a wide range of possible new insight can be extracted from the continuously growing amount of accessible data. Whether this insight comes as a result of applying new analytic models, structuring of data in new architecture or application of AI thru machine learning, is for the students to propose as a thesis. (Students will need to be self-driven and have good knowledge within software architecture, good programming skills and preferably at least one course on machine learning. The students choosing a project within MUST will take part in forming their own project during the Spring of 2022.)

We might offer more than one project, and welcome collaboration between two students. The project will have one supervisor from HVL (Rogardt Heldal) and potentially one supervisor from the industry/Municipality.

Contacts: Rogardt Heldal (rohe@hvl.no)

Real-time On-line Gait Anomaly Detection for Authentication and Authorization (ReGAD)

Software Engineering Research Group



Project description

Human gait sample is a series of gait points generated by human where the gait points are indexed in time order, and this kind of data can be considered as a time series. This kind of time series is referred as *gait cycle time series*. Finding anomalous gaits and abnormal gait behaviors in gait cycle time series has attracted great attentions in recent years since it can be used as an authentication mechanism such as PIN, password, and graphical pattern to protect sensitive information in ubiquitous computing environments.

In the last decade, a number of approaches based on statistics or heuristics have been introduced for gait recognition on a mobile device. However, most approaches require either gait cycle length estimation or gait similarity calculation during template extraction process, which is a traditional offline preprocessing in statistics and heuristics approaches. For instances, they might need to interpolate gait data in equidistant intervals of time for a fixed sampling rate during gait collection, determine appropriate gait cycle length empirically, perform gait cycle detection process, remove unusual gait cycles, and measure similarity of all gait cycles by using dynamic time warping (DTW). These requirements consequently limit the applicability and usefulness of these approaches in practice on mobile devices.

It is therefore desirable to facilitate an on-line and self-adaptive gait anomaly detection approach for gait anomaly detection where the above-mentioned requirements are not needed. Furthermore, it might be also highly valuable to provide a lightweight and real-time human gait anomaly detection approach that is able to be deployed on any commodity mobile device and able to detect gait anomalies in real time.

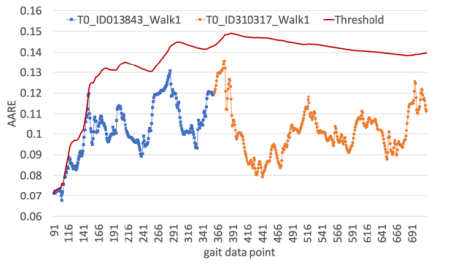
The goal of this project is to investigate and propose a real-time on-line gait anomaly detection scheme, but several challenges exist. Among them are

1. How to use any type of simple neural networks to learn human gait data patterns. Here, a simple neural network means one hidden layer with few hidden units.
2. How to keep computational cost as low as possible to develop a real-time and lightweight gait anomaly detection scheme.
3. How to design a self-adaptive detection threshold without human intervention or domain knowledge.
4. How to recognize human gait data patterns under different human activities based on deep learning and data mining.

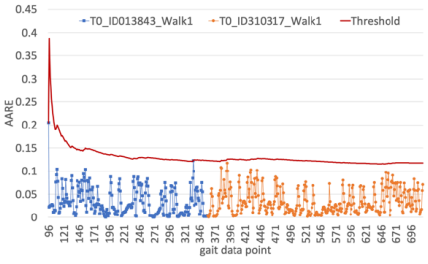
With this scheme, any personal mobile devices, such as smartphone or smart watches, are able to recognize whether they are currently held by their owners. Such a scheme can be used and integrated with a wide variety of services, such as security door access, electric car access, etc., without the requirements of touchpads or touchscreen keypads. One good advantage is that we can reduce the chance that people are infected by COVID-19. The same technique can also be used to continuously monitor patients' health status through real-time gait monitoring.

A prospective student should:

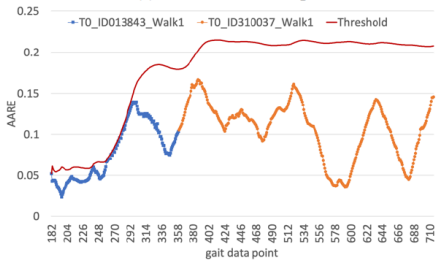
- Like programming, authentication, authorization, artificial intelligence, and gait data analytics
- Be interested in data mining, deep learning, and machine learning;
- Learn about time series data processing, big data analytics, python-based deep learning libraries, and java-based deep learning libraries.

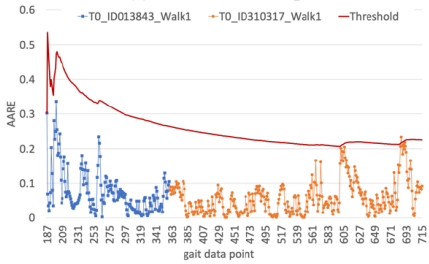


(a) The result of $LSTM_1$



(b) The result of $LSTM_2$





If you are interested in participating in, or if you need more information about the presented project, please contact:

Ming-Chang Lee
ming-chang.lee@ntnu.no; mingchang1109@gmail.com

Volker Stolz (vsto@hvl.no)
Adrian Rutle (aru@hvl.no)

Real-time lightweight unsupervised classification for large-scale time series (ReLUC)

Software Engineering Research Group

Project description

During the last two decades, Time Series Classification (TSC for short) has been considered as one of the most challenging problems in data mining. One important challenge for the TSC community is to provide one large generic *labeled* dataset, which means that all datasets must be classified first by human.

The goal is to automatically classify any real-time time-series data without human intervention whenever encountering an unprocessed time series, but several challenges exist. Among them are

1. How to real-time classify any time-series data.
2. How to propose an automatically classification approach.
3. How to use any type of simple neural networks to classify time-series data. Here, a simple neural network means one hidden layer with few hidden units.

This project will investigate a real-time lightweight unsupervised classification approach for large-scale time series such that this approach does not need offline training in advance and meanwhile is able to classify time-series data in real time based on limited training data.

A prospective student should:

- Like programming, artificial intelligence, and data analytics
- Be interested in data mining, deep learning, and machine learning;
- Learn about time series data processing, big data analytics, python-based deep learning libraries, and java-based deep learning libraries.

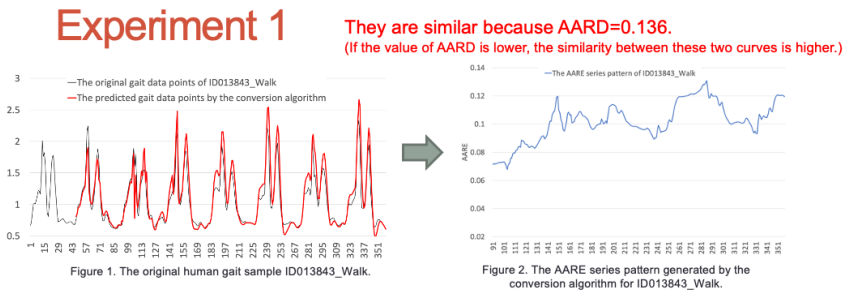


Figure 1. The original human gait sample ID013843_Walk.

Figure 2. The AARE series pattern generated by the conversion algorithm for ID013843_Walk.

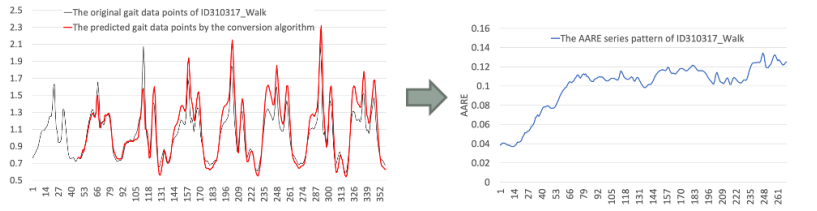


Figure 3. The original human gait sample ID310317_Walk.

Figure 4. The AARE series pattern generated by the conversion algorithm for ID310317_Walk.

If you are interested in participating in, or if you need more information about the presented project, please contact:

Ming-Chang Lee
ming-chang.lee@ntnu.no; mingchang1109@gmail.com

Volker Stolz (vsto@hvl.no)
Adrian Rutle (aru@hvl.no)

Refactoring at Scale

Software Engineering Research Group

Refactoring is an important activity of software developers. It improves code quality and understandability, but can also subtly change the behaviour of your existing program. We have so far tried in two very successful Master theses to make a small number of refactorings for Java *automatic* (website, published in NIK'14), and *safer* (slides, published in ISoLA'16). What is missing now is an experiment *at scale*!

In your thesis, you may either want to implement new refactorings, improve existing ones that we find in IDEs such as Eclipse and IntelliJ, or simply re-use existing refactorings in a new way.

Research questions include:

- can we automate more refactorings (beyond Extract-and-Move-Method)?
- can we do so at scale (incremental or concurrent processing of large code bases)?
- can we integrate automated refactorings into code review systems like Gerrit?

A prospective student should…

- …like programming and programming languages;
- …have an interest in software quality metrics (coupling, cyclomatic complexity,…);
- … learn about grammars, programming language semantics, types/static analysis;
- …independently set up and run experiments (e.g. check out open source-projects from GitHub, apply automated refactoring, collect results e.g. in Jenkins/Sonar/…).

Related research projects:

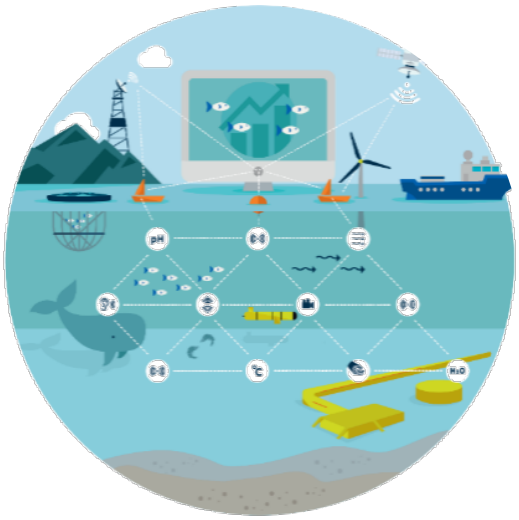
- Modern Refactoring (2017-21, SIU/CAPES)

Some results so far:

- Master thesis Ringdal "Automated Refactoring of Rust Programs" (UiO, 2020)
- Master thesis Eilertsen "Making Software Refactorings Safer" (UiB/HiB, 2016)
- Anna Maria Eilertsen, Volker Stolz, Anya Helene Bagge: Safer Refactorings. LNCS Vol. 9952, Springer, 2016.
- Erlend Kristiansen, Volker Stolz: Search-based composed refactorings. NIK 2014
- Master thesis Kristiansen "Automated Composition of Refactorings" (UiO, 2014)

Supervisor: Volker Stolz (vsto@hvl.no)

Smart Ocean



How to use the resources of the ocean will become more and more important in the future due to scarce resources and climate impact.

We have received funding to start an SFI (Centre of Research-based Innovation) project in 2021 here in Bergen. The goal of the Smart Ocean SFI is to strengthen the leading position of Norwegian ocean industries and increase value creation by filling gaps on sensor technology and connectivity to enable safe, cost-effective, and sustainable operations in the marine environment.

This is a collaboration among leading research institutes such as The Institute of Marine Research and The Nansen Environmental and Remote Sensing Centre, industrial partners such as Aker Solutions and Kongsberg Maritime, and academia partners (HVL and UiB). HVL together with Bouvet and NORCE will play a key role in the overall software and systems architecture and its implementation. If you care about the environment and also want to work with the newest technology regarding software architecture, sensor technology and data analysis this project is for you. The project will give the opportunity to work both with industry and academia.

Students picking this project will be part of the start-up of the SFI project, and the work might have an important impact on the rest of the SFI project. In this initial state, we will in particular focus on the current software framework and platforms that exists today such as Microsoft Azure and Web-of-things, but also proprietary frameworks developed by partners of the project. The goal is to find and develop a good framework/architecture for collecting data and provide the data to stakeholders, based on several pilots that exist in the project. Machine learning will play a role as well in how such a framework should work.

Given that this is a research project, it will put a high demand on the students that will undertake a master's thesis in the context of the project. You will need to be self-driven and have good knowledge within software architecture, good programming skills and preferably at least one course on machine learning. The students choosing a project within this SFI will take part in forming their own project during the Spring of 2022.

We might offer more than one project, and welcome collaboration between two students. The project will have at least one supervisor from HVL (Rogardt Heldal or/and Lars Michael Kristensen) and potentially one supervisor from the industry.

Contacts: Rogardt Heldal (rohe@hvl.no) and
Lars Michael Kristensen (lars.michael.kristensen@hvl.no)

TEKNOTHERM

Project descriptions

Teknotherm Marine
(https://www.teknotherm.no/marine/)

Heating Ventilation Air Conditioning Refrigeration

Introduction

In TEKNOTHERM's "Marine Business Unit" you will find one of the most competent HVAC & Refrigeration teams in the world.
Our focus is to provide a good system functionality along with compliance to applicable regulations and relevant international standards. We are continuously working to develop systems with better energy efficiency, improved functionality, easier operation and low maintenance cost – in combination with cost efficiency for equipment delivery and on-board installation.

We can provide you with detailed information of any HVAC products or systems and any Refrigeration products and systems. We have in-house all the competence you need, and the main products are manufactured in our 12 factories around the world.
We have close contact with yards, designers and ship owners to learn about what they need now and in the long run. Our experienced engineers use all this information to engineer tailor made systems and products to provide state-of-the art functionality and quality for our ongoing projects. Our R&D department also receive this information and are continuous thinking "out-of-the-box" to be one step ahead of the market, and release regularly innovative and attractive new products to the market.

The Teknotherm service organization is integrated with HEINEN & HOPMAN's service organization, and from 32 locations we are ready to serve our clients wherever they take their ships.

Contact

For further questions/discussion, don't hesitate to contact us

Topic: Digital twin for predicting energy consumption

Chris-André Larsen
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cla@teknotherm.no

Topic: Automation and industry 4.0
Anders Lekve Brandseth
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alb@teknotherm.no

Internal HVL supervisor

Adrian Rutle (Adrian.Rutle@hvl.no)

Topic: Digital twin for predicting the energy consumption of a HVAC system

Software development/digital twin for predicting the energy consumption of a HVAC system based on external and internal conditions.

During operation a Heating, Ventilation and Air-Conditioning (HVAC) system is exposed to different internal and external loads, resulting in a varying energy consumption. Moving towards a greener future, and in accordance with the UNs sustainable development goal 12 “Responsible consumption and production”, being able to predict the total energy consumption of different HVAC solutions prior to production would represent a significant step towards this goal.

A HVAC system is comprised of several different parts, with Air Handling Units (AHU), chillers, heat pumps, Fan Coil Units (FCU) and several fans and pumps. All of these consume energy and are interconnected in different ways. These different components can be viewed as separate building blocks, which in the end makes up the entire system. The software should be able to take user input in the form of design outside conditions (temperature/relative humidity), air demand, filter type, chiller/refrigerant type, heat sources/sinks, fan type, location etc.
A good scope for the project could be;

- review the literature for previous energy prediction models, and what tools/programming languages are suggested for building such a software. Give an evaluation of the pros and cons with different tools/programming languages and suggest how to best develop the software/digital twin.
- Based upon the evaluation, build two of the “blocks” i.e an AHU and a chiller. Or a chiller connected to a pipe system with a set of pumps.

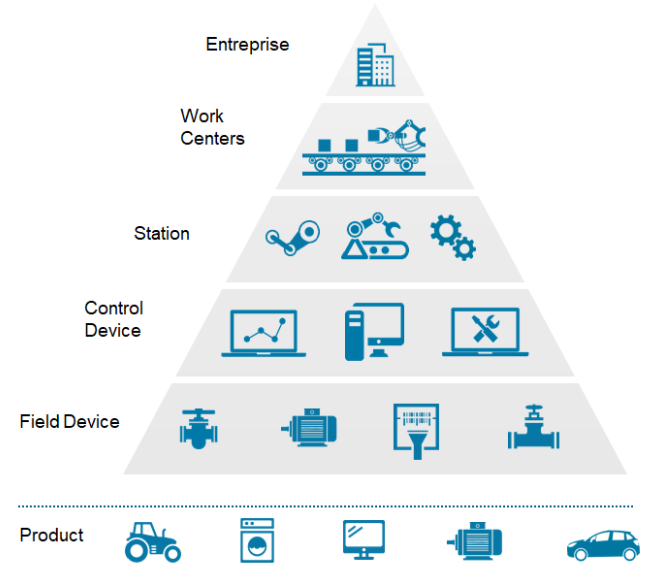
Building a database of different smaller system components (filters, fans, valves etc.), and a database of weather data could also be part of the project.

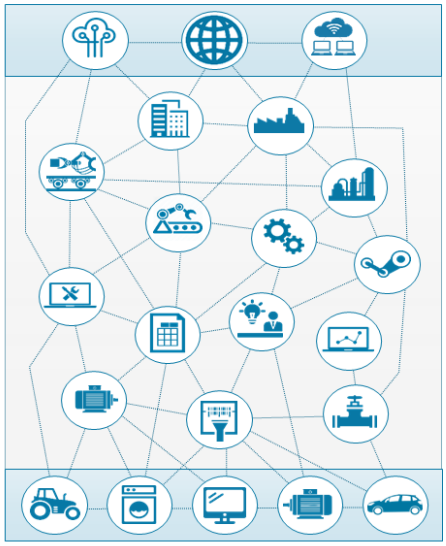
The student is encouraged to take part in defining the final scope of the project.

Topic: Automation and industry 4.0

Background

Automation systems are traditionally built as a monolithic system following the automation pyramid where layers are strictly coupled to underlaying layers with specific information about the systems like register addresses, metadata etc. This leads to inflexible systems and low reusability between projects. Industry 4.0 concepts are breaking this pyramid and enabling communication across layers in a web of smart equipment that complies to the same information models.

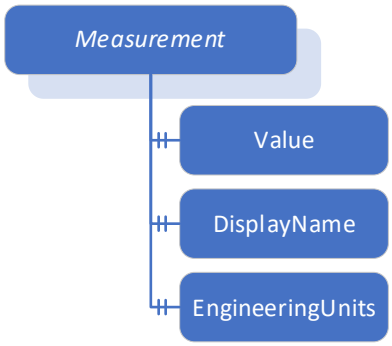




Grafik © Anna Salari, designed by freepik

Opc Ua

Agreeing on an information model and what the data means is the key to achieving the concepts of Industrie 4.0. Opc Ua is the only recommended standard for implementing the communication layer in the “Reference Architecture Model for Industrie 4.0” (RAMI 4.0). The information modelling capability is the key concept of Opc Ua that separates it from other protocols. Machines and devices can now expose and describe their information in a browsable object-oriented manner instead of a flat register/value only server where the client needs to be aware off all metadata. Opc Ua defines a graphical notation (Stereotyped UML) to describe information models. The following simple example could represent a measurement type.



More information

There Is No Industrie 4.0 without OPC UA – OPC Connect (opcfoundation.org)

How OPC UA complements our open IIoT approach - Microsoft Industry Blogs

AutomationML-Brochure.pdf

What do we want to achieve?

The project tasks should lead us closer to meeting one or more of the following goals

- Less hours on project-specific engineering while staying flexible to meet customer requirements
- Less hours on commissioning
- More advanced functionality
- Better user experience
- Easier changes and expansion of systems

We see modularizing our system in to self-contained “smart” components as a promising path. By complying to the same information model, different components can be put together in “puzzle” that meets the specific project specification.

- Reusable components lead to less engineering hours
- Reusability also implies that our components have been used and tested before. Components can also be tested stand-alone and tested for compliance to our information model thus reducing errors during commissioning.
- Loose coupling and reusability between the different system components greatly simplifies continuous improvement of user experience and functionality

Task suggestions

The student is encouraged to take part in defining the final scope of the project. The following three topics are suggested, but the final description could include subjects from all topics on a higher level or dig deeper into parts of the suggested tasks.

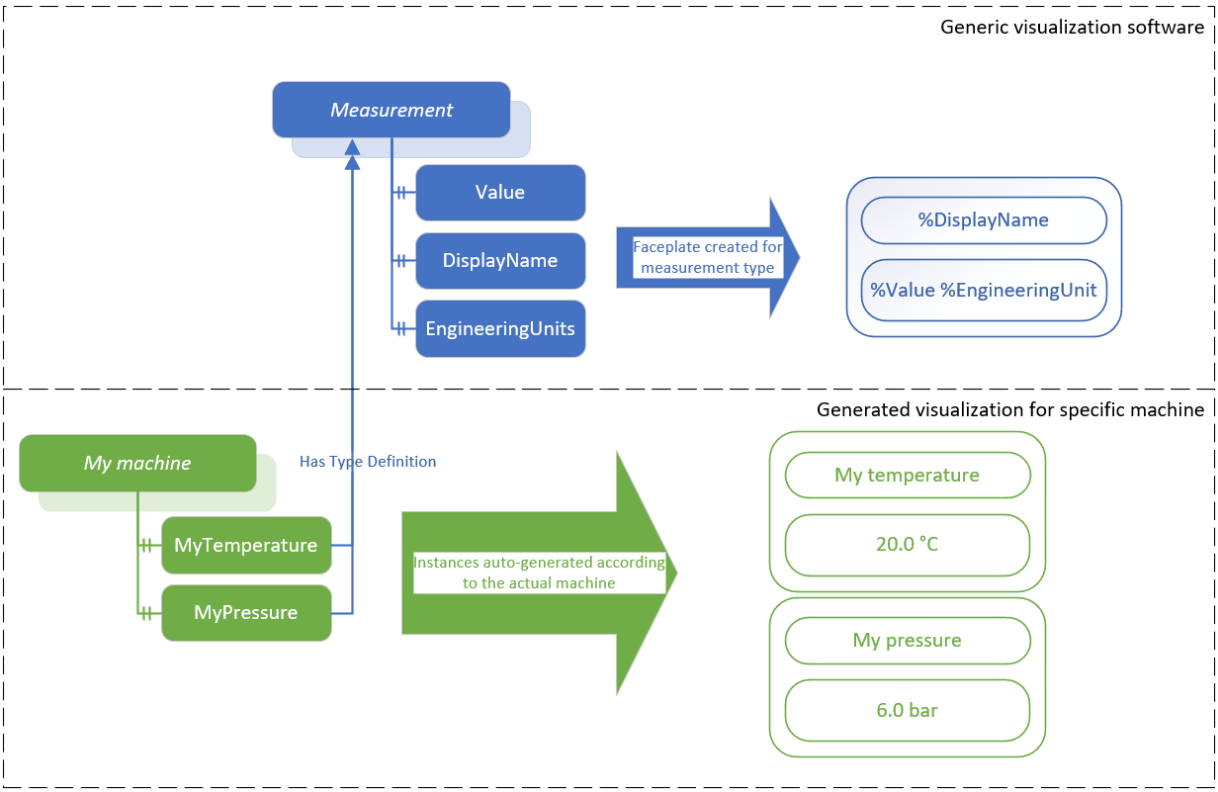
Information modelling and server development

Opc Ua provides the information modelling language but there is still substantial work in finding the best solution for how to model the components in our HVAC system. There are many “companion specifications” released that describes ways of modelling various industry segments. Currently there are none available for HVAC or marine installations.
The student could:

- Research existing companion specifications and literature describing information modelling in Opc Ua.
- Create information models for a limited set of Teknotherm components
- Evaluate Opc Ua SDKs
- Implement the information model

Generic visualization

When the information in the system components is described in standardized way. The visualization can be programmed towards the types of the information model. This enables a visualization solution that adapts to the specific system where it is installed.



The student could:

- Evaluate if available technology (ie. Component based frameworks like react, blazor) meets the requirements of an industrial visualization
- Design user interface / user experience
- Implement solution for a limited part of Teknotherm equipment

Model based engineering using AutomationML

AutomationML is a modelling language using existing XML-standards like CAEX for hierarchical object information and PlcOpenXML for plc-programming. AutomationML offers a loss-less description of automation systems that can be used for generation of relevant documents and diagrams.

From: AutomationML-Brochure.pdf
The life cycle of production systems is and will be more and more digitalized, independent of the invention of the „Industrie 4.0“. Data has been playing an important role within the life cycle of production systems for ages.

AutomationML integration in OPC UA: Combining AutomationML and OPC UA offers the possibility to communicate and operationalize AutomationML by means of OPC UA. It is possible to simplify the creation of OPC UA information models based on existing AutomationML data. AutomationML models can be exchanged and managed by OPC UA which makes an up-to-date description of the as-is state of the system possible.

OPC UA integration in AutomationML: Another possibility is the lossless exchange of OPC UA system configuration within AutomationML models. The manual exchange of OPC UA server configuration data will be replaced by standardized/specified description in AutomationML. Parameters used to set up OPC UA communication between tools can be exchanged by using AutomationML. This creates consistent data, leads to less errors and results in an easier and faster configuration of UA servers and clients.

The student could:

- Research AutomationML and evaluate how it may be used to improve the automation engineering work process.
- Especially investigate the relationship between automationML and Opc Ua
- Create a complete system description of a small example system and demonstrate how this simplifies changes by updating examples of relevant documentation.

Workflow Planning and optimisation for Business and Healthcare Services

Software Engineering Research Group

Project description

Workflow planning is needed everywhere and is a critical activity in domains like healthcare service (e.g., workflows in hospitals). Optimal planning is particularly important in these domains to handle operational risks and coordinate all actors on a facility, such as surgery, medical equipment. In these domains, errors in planning decision can entail not only substantial financial loss, but also loss of life. Therefore, such errors should definitely be avoided.

Executable languages, e.g., BPEL and YAWL, have typically been used to model business process and workflows. However, it can be challenging to develop such models correctly when the quality of the existing documentations of the modelled process is questionable. Another technique, process mining, allows for the analysis of business processes based on event logs. Analysing event logs can help understand trends, patterns and details of a business process, and derive the corresponding model.

To facilitate planning for operations and understand the workflows in industry and healthcare domain, we suggest the following topics:

1. *Transforming workflows into executable models*
   - To develop a transformation algorithm that translates workflows represented in graphical notations (e.g., in UML) into executable models.
2. *Scheduling and allocation of healthcare resources* (e.g., doctors, operating rooms and medical devices)
   - To develop a prototype to model the scheduling of a pending operation, considering the availability of the operating rooms and medical devices
3. *Process mining for workflows in industry and healthcare services*
   - To study the techniques of process mining and combine them with machine learning to apply to process planning in healthcare domains and industry.

A prospective student should:

- Like programming and programming languages;
- Be interested in language parsing and/or optimisation;
- Learn about syntax and semantics of programming languages, grammars, static analysis.

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Yngve Lamo
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MSc projects in machine learning and medical AI

@ MMIV

allu@hvl.no

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mmiv.no, github.com/mmiv-center, github.com/mmiv-ml

v. 14.12.2021

The latest version of the catalog is at all times available here

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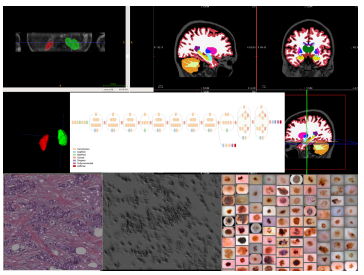


Western Norway University of Applied Sciences

HELSE BERGEN Haukeland universitetssjukehus

About MMIV and the machine learning group

Bringing technology and medicine together to advance the state of the art in medical imaging and visualization

The Mohn Medical Imaging and Visualization Centre (MMIV) was established at the Department of Radiology at Haukeland University Hospital in 2017 as a collaboration between Helse Bergen, UiB and HVL. Medical doctors, natural scientists and engineers work side-by-side to do research and to develop and evaluate new solutions aimed at the future of patient care. The center is a vibrant hub for the exchange of ideas and expertise.

MMIV is very lucky to be an integrated part of the Dept. of Radiology at Haukeland University Hospital, making it close to the patients and the factors that impact patient care: precise diagnosis and staging, accurate prognostication, and the development of tailored and targeted treatment strategies.

There are currently more than 40 researchers associated with MMIV, and since March 2019 the center has been located on the top floor of the new building at Haraldsplass, with an excellent view of Bergensdalen.

Since the center's inception, machine learning and artificial intelligence has been a core focus area. As is well-known, recent years have seen a surge of interest in machine learning in medicine, caused by breakthroughs in artificial neural networks over the past 10 years. Significant progress has been made in enabling computers to extract meaningful, actionable information from complicated heterogeneous data sets, leading to astonishing results in computer vision, natural language processing, analysis of structured data, and more.

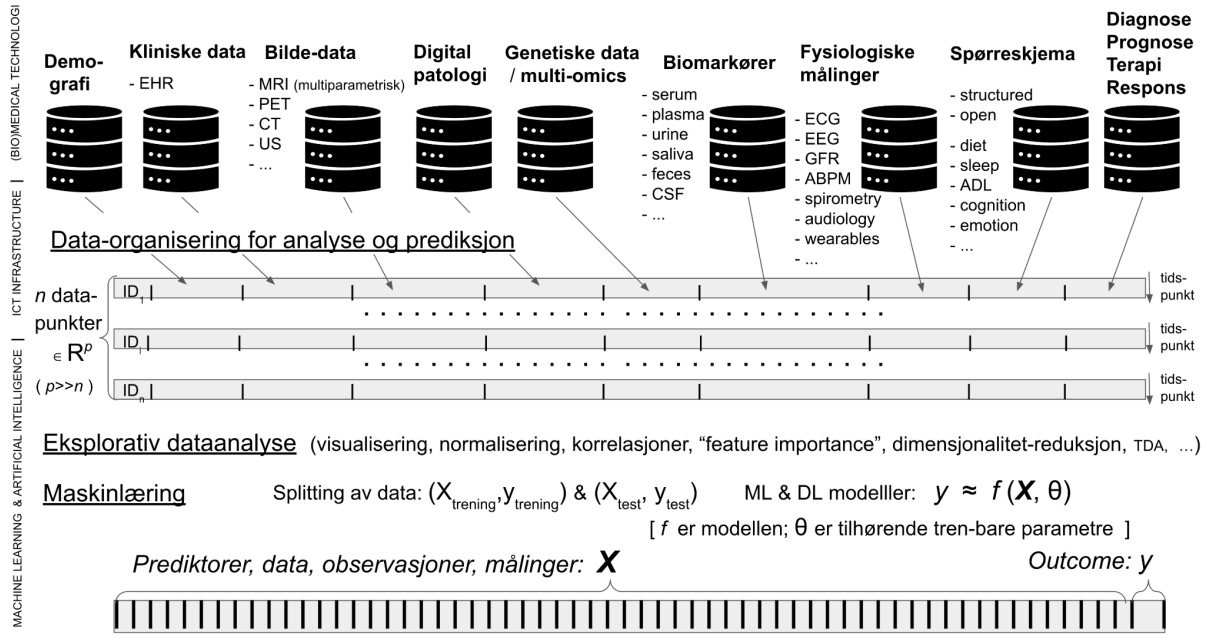
As the new techniques are broadly applicable, these developments have had and are having a huge impact on medicine and medical research, enabling improved detection, diagnosis, treatment and therapy. This is illustrated by the enormous amounts of research results from a broad set of medical areas: imaging diagnostics, electronic health records, sensor-based analysis, administrative tasks in health-care facilities, and much more.

The MMIV machine learning group's main research activities are related to image diagnostics, i.e. involving radiological images and image-related information, but we have multiple projects from other medical disciplines: analysis of electronic health records data, AI support for emergency medicine (AMK), machine learning in drug discovery, and more. We are also working to introduce modern techniques and tools based on machine learning and visualization into the clinical workflow, where real impact can be made (see e.g. https://mmiv.no/wiml).

At all times, there are several MSc students from the HVL-UiB HVL Joint Master's Program in Software Engineering program working at the center, doing important work on problems related to machine learning in medical data analysis (see below for a list of ongoing and previous MSc projects).

At MMIV, the Software Engineering MSc students have their own lab, access to powerful computational resources, and are embedded in an exciting medical research environment.

See mmiv.no, https://mmiv.no/wiml, https://digitallifenorway.org/prosjekter/medimml-computational-medical-imaging-and-machine-learning, github.com/mmiv-center, and github.com/mmiv-ml for more about the center and our activities.



Projects currently offered (updated continuously)

Note: The below projects are only described very briefly. Feel free to contact us at allu@hvl.no for more details. We're also open for your own project suggestions.

The below projects are all related to software engineering and medical data analysis. The techniques and tools used in the projects are however very general, and widely used in research and industry. Completing any of these MSc projects will give you a solid basis for a variety of areas and careers.

Note: If you select one of these projects you are *strongly* encouraged to follow the course DAT255 during your MSc studies. A look at that course may help you decide whether these projects are of interest to you. You should also consult the list of recent projects below.

User-friendly software for Bayesian data analysis

Supervisors:

Piero Mana, HVL, MMIV
Alexander S. Lundervold, HVL, MMIV

Several statistical methods are used in Medicine and other fields for making important inferences, for example to predict the effect of a drug or treatment, or to assess whether one treatment is better than another. These inferences typically use data from a small sample of cases and try to extrapolate them to future cases. Researchers in medicine use various kinds of software that easily allow them to input the data, choose which method to apply, and get numerical results out.

Many of these statistical methods have been criticized since their introduction 80 years ago, and an increasing amount of evidence has shown that they in fact have built-in flaws and inconsistencies, or that they implicitly use assumptions that are not valid in many medical situations. Often they are also misapplied. In 2016 and 2019 the American Statistical Association finally gave an official warning against their use, and recommended the use of different methods.

There are indeed other methods, belonging to so-called Bayesian probability theory, which are known and proven to be free from inconsistencies, and routinely used in fields such as astrophysics. Why aren't they routinely used in Medicine then? One reason is that their mathematics is more complex and numerically more difficult to implement. Therefore there is no user-friendly software available to medical researchers to apply it. The only available software is written for professional statisticians and requires the user to have in-depth knowledge of the maths and numerics.

The goal of this MSc project is to write a prototype version of a user-friendly app for applying Bayesian theory in typical medical research problems. The core code for the mathematical computations is already available in the R programming language and is used at MMIV (https://github.com/pglpm/bayes_regression/blob/main/code/mcmc4.R). The focus of the project is to put such code into a "container", for example an R package, with a user-friendly interface. The interface will allow the users to input their data and specify what kinds of inferences they want to do, internally transform the data into a format usable by the "numerics part", and output the results of the latter as informative plots and numerical tables. The users won't have to worry about the numerics taking place under the hood. The student working on the project is not expected to have or acquire in-depth knowledge about the maths, but only a general understanding of what it's doing.

Other programming languages such as Python, Octave (Matlab), Fortran, C variants, or Julia could of course be used, but this would require the development of the numerical part as well (currently unavailable in most of those languages).

Technologies:

- R-software ecosystem
- Database management
- ...and much more

Other projects (currently not on offer)

Self-supervised learning for computer vision and medical imaging

Supervisor: Alexander S. Lundervold, MMIV, HVL
Co-supervisor: Satheshkumar Kaliyugarasan, MMIV, HVL

Supervised learning, i.e. learning from labelled data, provides a mechanism to construct predictive models that can perform exceptionally well on specific tasks. However, the massive amounts of labelled data often needed to train accurate models means that there many applications are in practice out-of-reach for supervised learning.

Self-supervised learning provides ways to use the vast amounts of *unlabelled* data one can typically get hold of to construct representations of underlying structures in the data. More specifically, ways to use labels that are somehow part of the input data rather than solely labels introduced in a separate (and costly) extra step.

Self-supervised learning has seen great success in natural language processing (NLP), where e.g. the approach of constructing *language models* (models tasked with e.g. predicting the next word of a given sentence—a task which can be set up with built-in labels

by collecting vast amounts of texts and deleting words to construct model inputs) as backbones for e.g. text classification models has had a profound impact (see e.g. ULMFiT, BERT, RoBERTa, GPT-3, etc).

This approach hasn't seen much use in computer vision, but that seems to be changing. Several recent results have shown that it is possible to construct self-supervised setups able to make use of unlabelled data, ending in image classifiers that outperform models trained in a standard supervised learning fashion. There are indications that this can cause a small revolution in deep learning for computer vision in the coming years, in particular for the many application areas for which it is inherently difficult to produce large amounts of labelled data. One such field in medical imaging: there are vast amounts of unlabelled medical image data out there, but producing accurate and medically interesting labels is difficult and costly (caused by, among other things, issues related to privacy and the expertise required to assign labels).

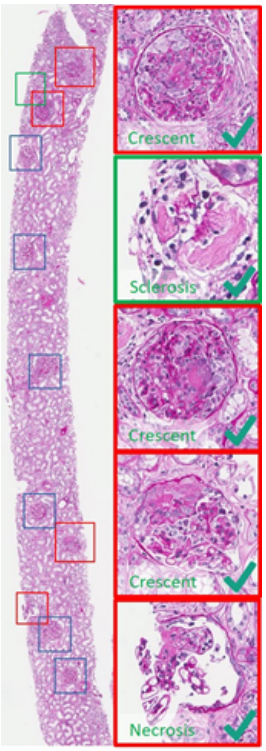
The proposed MSc project will construct, evaluate and apply state-of-the-art self-supervised learning techniques to real medical images, aiming to highlight strengths and weaknesses of this exciting technology.

Technologies:

- Python data science ecosystem
- PyTorch
- Fastai, fastMONAI
- Medical imaging
- ...and more

Deep learning in pathology

Supervisor: Alexander S. Lundervold, MMIV, HVL
Co-supervisor: Sabine Leh, Dept. of pathology, Haukeland University Hospital



Every treatment and cure begins with a diagnosis. Pathology laboratories and pathologists in Norway make several hundred thousand diagnoses on tissue samples – every year. The pathology reports are a prerequisite for treatment and cure in almost all cancers and many other diseases.

Pathology is currently undergoing digital transformation: rather than inspecting samples on glass slides using conventional microscopy, the slides are digitized, and the microscope turned into a virtual microscope. This leads to easier management and sharing of pathology information and opens the door to a more computer-driven interpretation process. In fact, a whole new field "computational pathology" is emerging, enabling large-scale computer-aided diagnosis.

This MSc project will focus on the pathology of kidney diseases. Chronic kidney disease is one of the most underrated chronic diseases expected to be the fifth leading cause of death above all cancer types in 2040. Aggregated health care costs for chronic kidney disease are in the same range or even higher as the costs for cancer and diabetes.

Since 2012, the pathology department at Haukeland University Hospital has built an image database of digital slides from medical kidney biopsies. These biopsies are taken from patients with kidney dysfunction in order to classify the present kidney disease, to give an estimation about prognosis and to guide treatment decisions. Kidney biopsy diagnostics is a highly subspecialized field in pathology and evaluation of a kidney biopsy is a time consuming process.

An annotated, publicly available image data set will be generated from the image database of medical kidney biopsies. Machine learning methods assisting the pathologist in detection and quantification of kidney structures as well as classification of pathological changes will be developed based on this image data set. The MSc students connected to this project will work with these different aspects of computer-assisted diagnosis in medical kidney biopsies. The recently funded innovation and research project "Pathology services in the Western Norway Health Region – a centre for applied digitization" will be a partner to the MSc work.

Technologies:

- Python data science ecosystem. PyTorch and TensorFlow.
- fastai
- Medical imaging
- ..and more

`fastMOMAI`: Deep learning for for 3D medical images

Supervisor: Alexander S. Lundervold, MMIV, HVL
Co-supervisor: Satheshkumar Kaliyugarasan, MMIV, HVL

Our research group we are currently developing an extension of the powerful `fastai` deep learning library (https://github.com/fastai/fastai) to support tasks related to three-dimensional imaging (classification, regression, segmentation), also incorporating elements from the MONAI library (https://monai.io).

Such a library combining the best parts from fastai and MONAI is extremely useful in a wide variety of medical imaging settings, as it's very common to work with 3D imaging. E.g. in magnetic resonance imaging (MRI) and computerized tomography (CT). We have already successfully used our library in multiple projects: pulmonary nodule classification in lung CT in relation to lung cancer, skull-stripping in 3D MRI, and estimation of "brain age" directly from MR images.

The student in the proposed MSc project will join the development, aiming to create a clean, modular, efficient, well-documented, and widely tested `fastai`-based Python library.

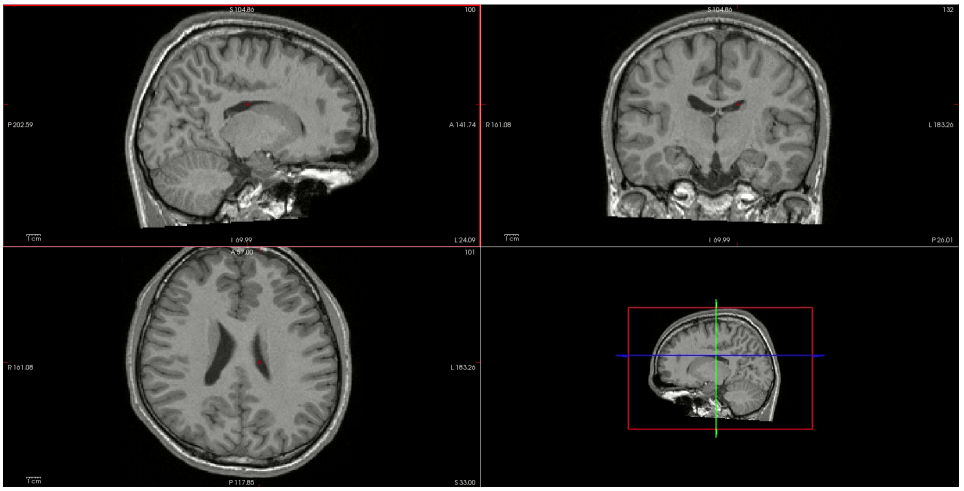
Technologies:

- Python data science ecosystem. PyTorch and TensorFlow.
- fastai
- Medical imaging
- ..and more

Deep learning for fast skull stripping in brain imaging

Supervisor: Alexander S. Lundervold, MMIV, HVL

Skull stripping is the removal of parts of images corresponding to non-brain tissue. Fast and accurate skull stripping is crucial for numerous medical brain imaging applications, for example *registration*, *segmentation* and *feature extraction*.



In recent work we've done in our group at MMIV (*"2D and 3D U-Nets for skull stripping in a large and heterogeneous set of head MRI using fastai"*) we have constructed and trained a three-dimensional convolutional neural network that can perform skull stripping quickly and accurately.

2D and 3D U-Nets for skull stripping in a large and heterogeneous set of head MRI using `fastai`

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[2]Dept. of Computer Science, Electrical Engineering and Mathematical Sciences, Western Norway University of Applied Sciences, Bergen, Norway
[3]Dept. of Biomedicine, University of Bergen, Norway
[4]Institute of Electronics, Lodz University of Technology, Poland
[5]All authors contributed equally to the work

[**] Data used in preparation of this article were obtained from the Alzheimer's Disease Neuroimaging Initiative (ADNI) database (adni.loni.usc.edu). As such, the investigators within the ADNI contributed to the design and implementation of ADNI and/or provided data but did not participate in analysis or writing of this report. A complete listing of ADNI investigators can be found at: http://adni.loni.usc.edu/wp-content/uploads/how_to_apply/ADNI_Publication_List.pdf

[***] Data used in the preparation of this article was obtained from the Australian Imaging Biomarkers and Lifestyle flagship study of ageing (AIBL) funded by the Commonwealth Scientific and Industrial Research Organisation (CSIRO) which was made available at the ADNI database. The AIBL researchers contributed data but did not participate in analysis or writing of this report. AIBL researchers are listed at www.aibl.csiro.au

Abstract

Skull stripping in brain imaging is the removal of the parts of images corresponding to non-brain tissue. Fast and accurate skull stripping is a crucial step for numerous medical brain imaging applications, e.g. registration, segmentation and feature extraction, as it eases subsequent image processing steps. In this work, we propose and compare two novel skull stripping methods based on 2D and 3D convolutional neural networks trained on a large, heterogeneous collection of 2777 clinical 3D T1-weighted MRI images from 1681 healthy subjects. We investigated the performance of the models by testing them on 927 images from 324 subjects set aside from our collection of data, in addition to images from an independent, large brain imaging study: the IXI dataset ($n = 556$). Our models achieved mean Dice scores higher than 0.978 and Jaccard indices higher than 0.957 on all tests sets, making predictions on new unseen brain MR images in approximately 1.4s for the 3D model and 12.4s for the 2D model. With further research aimed at increasing the models' robustness, such accurate and fast skullstripping methods can potentially form a useful component of brain MRI analysis pipelines.

1 Introduction

Magnetic resonance imaging of the brain

Magnetic resonance imaging (MRI) is a medical imaging technology (modality) used in radiology to acquire information in space and time about structure (anatomy) and function (physiology) of tissues and organs in the body. MRI scanners use a combination

This paper was presented at the NIK-2020 conference; see http://ojs.nik.no

The project will be closely related to the above *fastai for 3D MRI* as it will use and develop our combination of the MONAI and fastai deep learning libraries. It will also have a

significant component of *model deployment*, as the project will aim to put the method into a imaging workflow framework currently being created at MMIV. There will be multiple interesting software engineering and machine learning engineering challenges in the project. The recently funded, large innovation and research project *Workflow-integrated machine learning*, run by MMIV researchers, will form a natural partner project to the MSc work.

Federated learning for medical imaging

Supervisor: Alexander S. Lundervold, MMIV, HVL
Collaborators from Stavanger University Hospital and Oslo University Hospital

Enabling learning across different hospitals without exchanging data.

As privacy and data protection is often a requirement when dealing with medical data, new techniques for training models without exposing the underlying training data to the user of the model are necessary. It is not enough to merely restrict access to the training set used to construct the model, as it is easy to use the model itself to discover details about the training set. Even hiding the model and only exposing a prediction interface would still leave it open to attack, for example in the form of model-inversion and membership attacks.

Most current work on deep learning for medical data analysis uses either open, anonymized data sets, or locally obtained anonymized research data, making these issues less relevant. However, the general deep learning community is focusing a lot of attention on the issue of privacy, and new techniques and frameworks for federated learning, split learning and differential privacy are rapidly improving. See here for a survey. There are a few examples of these ideas entering the medical machine learning community, where the distribution of deep learning models among several medical institutions are investigated, but typically without considering the above privacy issues.

As machine learning systems in medicine grow to larger scales, perhaps even including computations and learning on the “edge”, federated learning and differential privacy will likely become the focus of much research in the medical AI community.

In this project you will explore how useful medical imaging tasks can be learned across different sites without exchanging sensitive data.

Have a look at https://www.tensorflow.org/federated and https://devblogs.nvidia.com/federated-learning-clara for an indication of what the project might entail.

Technologies:

- Python data science ecosystem, PyTorch
- Tensorflow Federated
- Medical imaging
- ...and much more

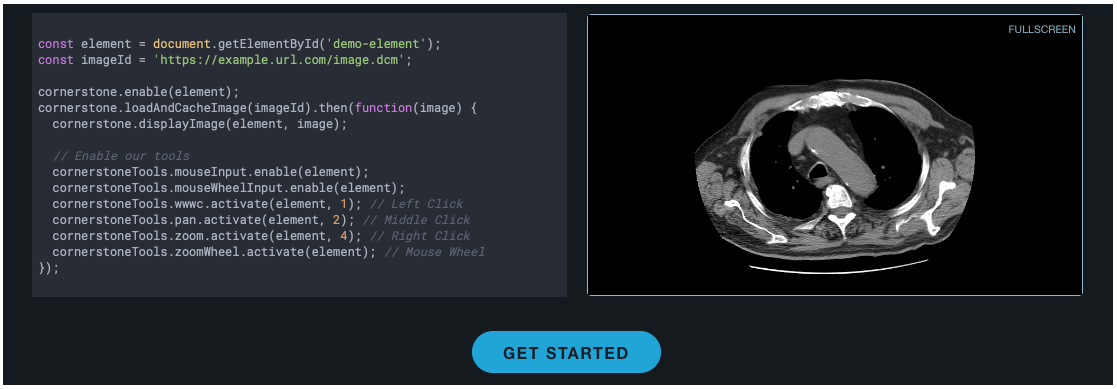
We need a different PACS!

Supervisors:

Main supervisor: Hauke Bartsch, MMIV, Haukeland University Hospital
Co-supervisor: Alexander S. Lundervold, MMIV, HVL

Picture Archive and Communication Systems (PACS) are widely used in clinical settings. But, they are slow, depend on specific monitors and screen layouts and they are expensive. Alternative mini-PACS software is now available as open source and can be used to implement all those features that are missing in the established PACS systems (see https://cornerstonejs.org).

What we want is a high performance data import from millions of small files with convenient access to machine learning algorithms for classification of body parts and clustering of scan types based on image and image meta-data. We need a nice graphical interface that provides easy to understand access to all the data. The system should be web-based using JavaScript and a JSON-API style access to its database. You might want to think about using *Electron* to make the system run from a USB stick, *ThreeJS* to provide 3D rendered overview graphs, *nltk* to provide useful freeform search capabilities in the annotated structures and *GraphQL* to support complex queries with knowledge discovery. We welcome and support all your ideas to make this MMIV project a useful research tool for everyone.



Ongoing HVL MSc projects

> *Here's a list of ongoing MSc projects involving students from our HVL-UiB MSc program, giving you a taste of what's going on. See also the list of completed MScs below, including links to the student's MSc theses.*

Speech-to-text models to transcribe emergency calls (113)

Who: Øyvind Grutle and Jens Thuestad
Supervisor: Alexander S. Lundervold, MMIV, HVL
Co-supervisors:

- Prof. Guttorm Brattebø, Head of the Norwegian National Advisory Unit on Medical Emergency Communication (KoKom) and consulting physician at Kirurgisk Serviceklinikk, Haukeland Universitety Hospital
- Emil Kristoffer Iversen, consulting physician and PhD-candidate, KoKom

The project also involves collaborators from Helse Vest IKT and the national emergency communication centers.

Norway has a unique national system for handling medical emergencies, and there are 16 emergency medical communication centres (AMK-sentraler / 113) spread throughout the country. The proposed MSc project is connected to a larger research project led by KoKom; *"AI-supported decision making in emergency medical calls using speech recognition and structured hospital data"*. This research project is aimed at improving the quality of 113-call handling, using audio recordings from emergency calls in combination with historical patient record data. This combination will form the basis for developing a machine learning system, which will give the 113-operators valuable decision support within seconds / minutes when talking to a 113-caller about a medical emergency.

The MSc-project focuses on the unique and valuable task of getting accurate text transcripts of the emergency calls, a task that is crucial for success in the larger context of the *"AI-supported decision making in emergency medical calls"*-project. For developing the speech-to-text models, historical 113-calls will be used.

Technologies:

- Python data science ecosystem
- Audio processing and speech analysis (e.g. LibROSA and Surfboard)
- State-of-the art deep learning approaches to speech recognition (e.g. Transformers)
- ...and much more

Machine learning for drug discovery

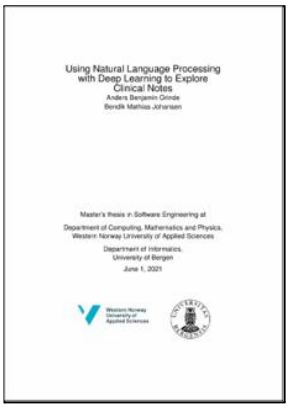
Who: Kjetil Dyrland
Supervisors: Alexander S. Lundervold, Piero Mana

Software for brain tumor segmentation

Who: Jostein Digernes and Carsten Ditlev-Simonsen
Supervisors: Alexander S. Lundervold, Sathiesh Kaliyugarasan (HVL), Anders Rodell (Siemens)

Recent MSc projects supervised by our group

Using Natural Language Processing with Deep Learning to Explore Clinical Notes (2019-2021)



Who: Anders Grinde and Bendik Johansen
Supervisor: Alexander S. Lundervold
Keywords: deep learning, language modelling, ULMFiT, BERT, text analysis

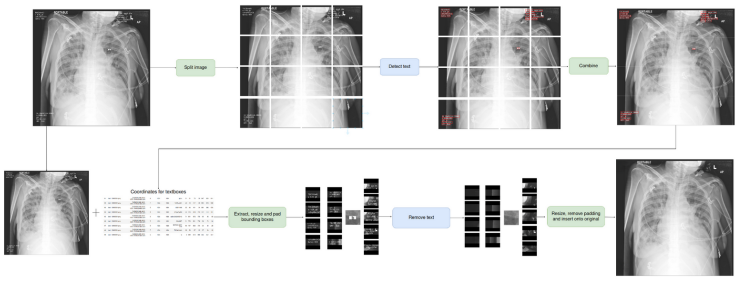
Link to thesis: https://bora.uib.no/bora-xmlui/handle/11250/2770432

By training a so-called language model on a large collection of clinical notes, the students investigated whether using the model as the basis for text classification models would enable the extraction of useful and actionable information from clinical notes.

De-identification of medical images using object-detection models, generative adversarial networks and perceptual loss (2019-2021)

Who: Malik Aasen and Fredrik Fidjestøl Mathisen
Supervisor: Alexander S. Lundervold

Link to thesis: https://bora.uib.no/bora-xmlui/handle/11250/2770435



Trajectories from Mild Cognitive Impairment to Alzheimer's Disease: A machine learning approach in the context of Precision Medicine (2019-2021)

Who: Ingrid Rye
Supervisors: Astri Lundervold (UiB), **Alexandra Vik** (HVL/MMIV)

Link to thesis: https://bora.uib.no/bora-xmlui/handle/11250/2760024

Medical image synthesis using generative adversarial networks (2018-2020)

Adrian Storm-Johannessen and **Sondre Fossen-Romsaas**
Supervisor: Alexander S. Lundervold

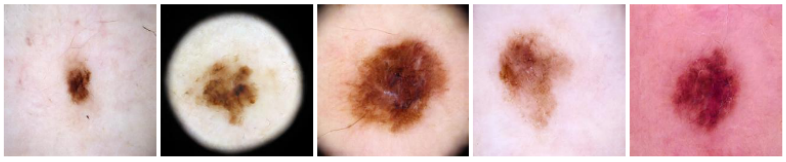
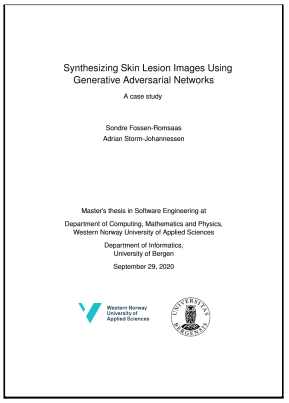


Figure 1: Examples of synthetic images of skin lesions generated by our models. From left to right: *Nevus*, *Melanoma*, *Nevus*, *Melanoma*, *Nevus*

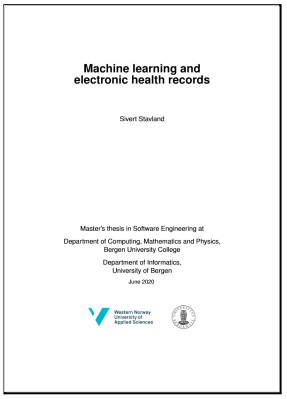


Link to thesis: https://bora.uib.no/bora-xmlui/handle/1956/24108

Their work resulted in the following scientific publication: https://ojs.bibsys.no/index.php/NIK/article/view/837

Machine learning and electronic health records (2019-2020)

Sivert Stavland
Supervisor: Alexander S. Lundervold


Machine learning and electronic health records

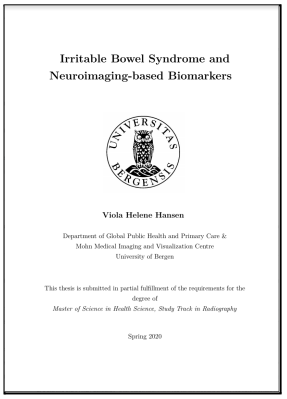
Sivert Stavland

Master's thesis in Software Engineering at
Department of Computing, Mathematics and Physics, Bergen University College
Department of Informatics, University of Bergen
June 2020

Link to thesis: https://bora.uib.no/bora-xmlui/handle/1956/24107

Irritable Bowel Syndrome and Neuroimaging-based Biomarkers (2018-2020)

Viola Helene Hansen
Supervisor: Arvid Lundervold


Irritable Bowel Syndrome and Neuroimaging-based Biomarkers

Viola Helene Hansen

Department of Global Public Health and Primary Care & Mohn Medical Imaging and Visualization Centre
University of Bergen

This thesis is submitted in partial fulfillment of the requirements for the degree of
Master of Science in Health Science, Study Track in Radiography

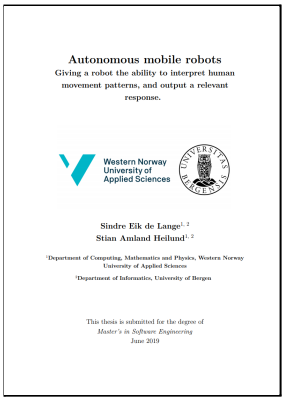
Spring 2020

Link to thesis: http://bora.uib.no/handle/1956/23933

Autonomous mobile robots (2017-2019)

Sindre Eik de Lange and Stian Heilund
Supervisor: Alexander S. Lundervold

Using advanced computer vision techniques (graph convolutional neural networks), and the Robot Operating System, the project investigated the potential of constructing robotic physical therapists


Autonomous mobile robots
Giving a robot the ability to interpret human movement patterns, and output a relevant response.

Western Norway University of Applied Sciences

Sindre Eik de Lange[1, 2]
Stian Amland Heilund[1, 2]

[1]Department of Computing, Mathematics and Physics, Western Norway University of Applied Sciences
[2]Department of Informatics, University of Bergen

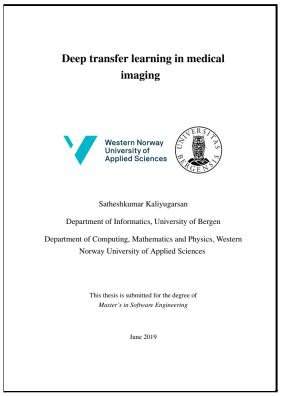
This thesis is submitted for the degree of
Master's in Software Engineering
June 2019

for patient rehabilitation. They presented part of their work at EHiN 2018 in Oslo Spektrum, and at Christiekonferansen 2019

Link to thesis: https://bora.uib.no/handle/1956/20845

Deep transfer learning in medical imaging (2017-2019)

Sathiesh Kumar Kaliyugarasan
Supervisor: Alexander S. Lundervold


Deep transfer learning in medical imaging

Western Norway University of Applied Sciences

Satheshkumar Kaliyugarsan

Department of Informatics, University of Bergen

Department of Computing, Mathematics and Physics, Western Norway University of Applied Sciences

This thesis is submitted for the degree of *Master's in Software Engineering*

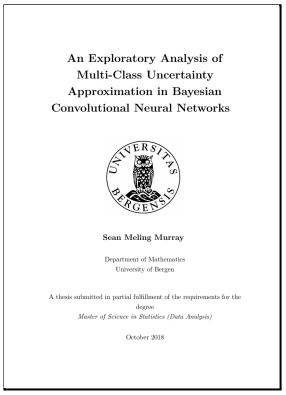
June 2019

A study of how to use transfer learning when training deep neural networks for biomedical image analysis. Sathiesh presented part of his work at NVIDIA's GTC Europe 2018 in Münich, at EHiN 2018 in Oslo Spektrum, and at Christiekonferansen 2019

Link to thesis: https://bora.uib.no/handle/1956/20849

An Exploratory Analysis of Multi-Class Uncertainty Approximation in Bayesian Convolutional Neural Networks (2017-2018)

Sean Meling Murray
Supervisor: Hans J. Skaug (UiB), Alexander S. Lundervold, Erik Hanson (UiB)


An Exploratory Analysis of Multi-Class Uncertainty Approximation in Bayesian Convolutional Neural Networks

Sean Meling Murray

Department of Mathematics
University of Bergen

A thesis submitted in partial fulfillment of the requirements for the degree
Master of Science in Statistics (Data Analysis)

October 2018

Sean developed and explored new techniques for obtaining robust uncertainty estimates for deep neural networks. This is a highly important research area for *Explainable AI*, particularly crucial for applications of deep neural networks in medicine, where uncertainty and explainability are key issues.

Link to thesis: https://bora.uib.no/handle/1956/18735

Exploring the IBS Brain: Resting State Functional Connectivity and Machine Learning (2017-2019)

Peder Lillebostad
Supervisor: Arvid Lundervold


Exploring the IBS Brain: Resting State Functional Connectivity and Machine Learning

Peder August Gudmundsen Lillebostad

Link to thesis: https://bora.uib.no/handle/1956/20486

MSC PROJECTS

SEP 2021

HVL DATA SCIENCE & AI GROUP

WHO WE ARE?

- The HVL Data Science & AI research group focuses on a branch of Computer Science that studies computational models of reasoning, action, learning, and perception for different applications including healthcare, energy, environment, etc.
- VISIT US: hvl.no/ai

MASTER PROJECTS 2021

- Arghandeh, Satellite based artifactual intelligence for infrastructure's 3D monitoring.
- Arghandeh, Artifactual intelligence for hydropower forecasting
- Landschulze, Robot based interaction between remote caretaker and patient
- Landschulze, Development of a human body communication network device
- Lin, Pattern analytics and prediction, recommendation
- Lin, Data security and privacy preservation
- Lin, Ocular Motor Dysfunction Detection
- Meric, Medical (DICOM) Image Processing
- Meric, Modeling of a Treatment Verification System in Particle Therapy for Cancer Treatment
- Meric, Measurements and Analyses of Heart Rate Variability
- Høyland, Categorization and interpretation of emails
- Høyland, Using NLP for interpreting invoices
- Lundervold, multiple projects from Medical AI @ MMIV

SATELLITE BASED ARTIFACTUAL INTELLIGENCE FOR INFRASTRUCTURE'S 3D MONITORING

Objective: developing machine learning algorithms to combine and analyze different satellite images (SAR, Optical, or Laser), and create 3D model of vegetation and buildings around powerlines, pipeline, or roadways.

Reza Arghandeh
Professor
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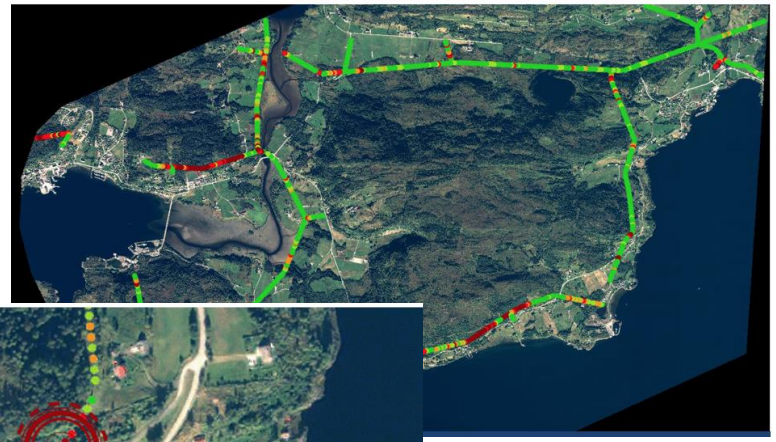

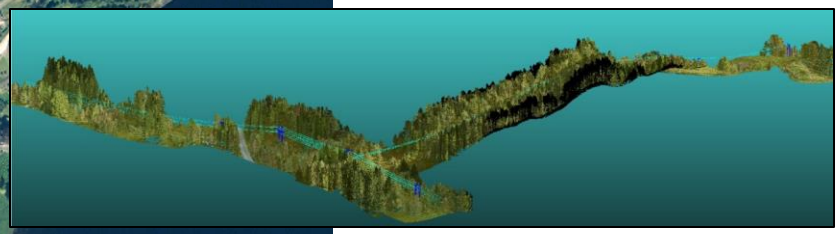

Research Questions:

- What are proper deep learning architectures for satellite image analysis?
- How can we combine optical and radar satellite images?
- How can we create 3D images from 2D satellite images?
- How to characterize impact of climate change on powerline, pipeline, or roadways?

In a collaboration with:

KSAT KONGSBERG SATELLITE SERVICES

StormGeo Freedom to Perform

esa European Space Agency

ARTIFACTUAL INTELLIGENCE FOR HYDROPOWER FORECASTING

Objective: developing machine learning algorithms to forecast inflow, water value, power generation, or electricity price for hydropower systems in Norway. The outcomes of our research is essential for improving hydropower scheduling and electricity market regulation.

Reza Arghandeh
Professor
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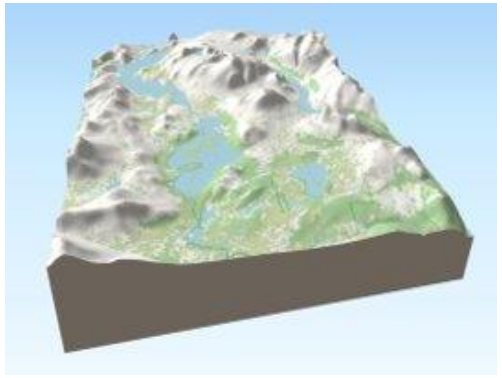
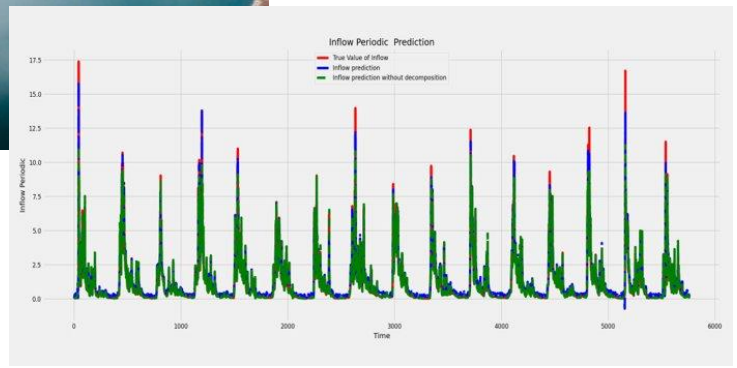




Research Questions:

- What are proper deep learning architectures for time-series forecasting problem?
- What types of feature extraction methods are more suitable for studying spatial and temporal dependencies within different hydropower data?
- How to combine meteorology and hydrology data to improve inflow forecasting?

In a collaboration with:

SMART INNOVATION NORWAY

NTNU

ROBOT BASED INTERACTION BETWEEN REMOTE CARETAKER AND PATIENT

Objective: For many years are robots around hospitals and give surgeons steadier hand for delicate medical procedures or help nurses in their daily work. Today are robots finding their way into healthcare-technology and will interact with patients in new or different ways. Robots act as an around-the-clock sitter, assist frail and elderly patients out of bed or chair or provide entertainment.

In this master project you will investigate the feasibility whether it is possible to connect a distant caretaker or doctor via the robot to a patient or someone with special needs. The focus is to build an interface where the caretaker verbally interact with a patient via the robot and simultaneously controls emotional movements (body language) of the robot with a web-interface.

Research Questions: In this thesis you will develop a software interface/program to provide verbal communication from the caretaker to the patient via the robot. In the second step you will program a Pepper robot via Choregraphe which allows you to control the robot in a virtual environment. The final step will be to build a web-interface where a caretaker can control the robot movements of Pepper by pressing e.g. emoticons and test it under “real” conditions possibly at Haukeland hospital/Alrek.

Marcus Landschulze
Associate Prof.
mlan@hvl.no

DEVELOPMENT OF A HUMAN BODY COMMUNICATION NETWORK DEVICE

Marcus Landschulze
Associate Prof.
Room: E403
mlan@hvl.no

Objective: Human body communication (HBC) is a relative new research area in healthcare and fitness technology. HBC uses the human body tissue as the transmission medium to transmit sensor information to processing device close to the body (see first figure 1, YouTube video). It also serves as a promising physical layer solution for the body area network (BAN). The human centric nature of HBC offers an innovative method to transfer the sensor data with low interference and reliable data link (see second YouTube video).

Currently, most of the used sensors (e.g., heartbeat-, O2- and insulin-measurements) are using wireless technologies like Bluetooth to communicate between the sensors and a communication hub (e.g. mobile phone). Using wireless technologies provide a standardized communication interface which make it simple to communicate, but with three major drawbacks when it comes to health and fitness care: 1. power consumption, battery lifetime is hours instead of days or weeks. 2. signal transmission up to several meters around the body which may interact with other devices or persons. And 3. eavesdropping of sensitive healthcare data as a security risk.

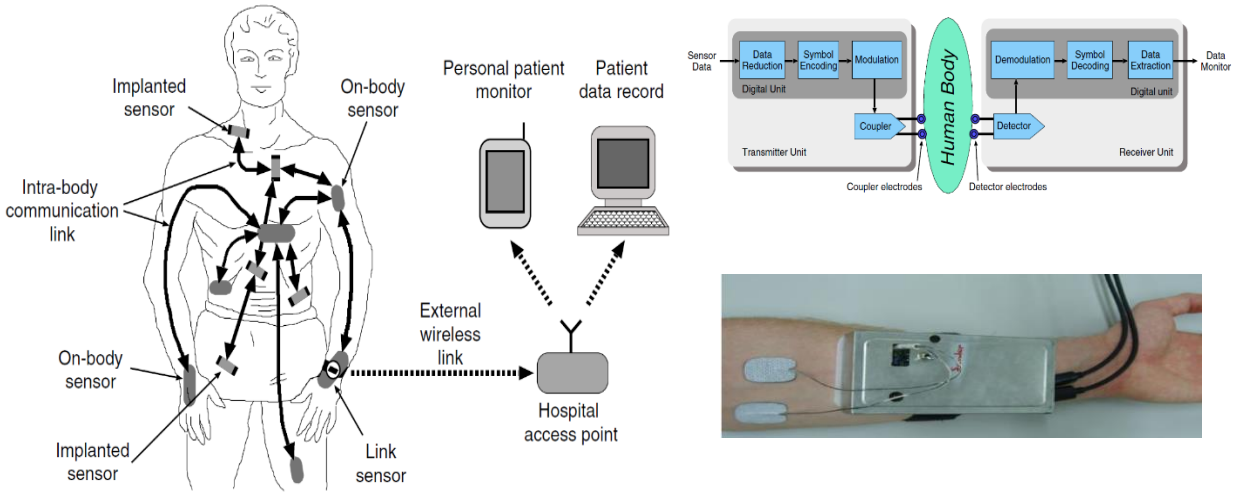


Figure 1: schematic of the HBC, device workflow and example. Source: PhD Thesis, Wegmüller, M. S., 2007

Further information:

YouTube: 1. https://www.youtube.com/watch?v=NHqfT1vle6E
2. https://www.youtube.com/watch?v=ZzmMxpR4T5c

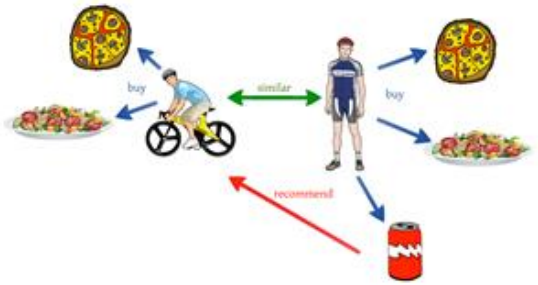
PhD Thesis, Wegmüller, M. S., 2007, https://doi.org/10.3929/ethz-a-005479240

Research Questions: In this project two or three master students will develop a sensor device prototype using capacitive coupling for data communication. The main objective will be to build a sensor device which can send the sensor data via the human body to a micro-controller (hub) by using standard medical electrodes. This objective includes programming the firmware for the sensor device and micro controller (hub). Furthermore, the signal processing methods and visualization for the hub or PC.

PATTERN ANALYTICS AND PREDICTION, RECOMMENDATION

Objective: pattern analytics and prediction, recommendation is used for different application for retail companies including basket-market, user behaviors, financial data, stream data, and sequence data

Models: pattern mining and ML/DL models



Jerry Chun-Wei Lin
Professor
chun-wei.lin@hvl.no

Research Questions:

- What type of pattern analytics methods can be used for and prediction, and recommendation for different applications (i.e., basket-market)?
- What types of data structures can be designed and implemented for different analytics and mining tasks?
- What theorems can be designed to efficiently reduce the search space for the pattern mining tasks?

- http://ikelab.net
- Email: jerrylin@ieee.org (E417)

DATA SECURITY AND PRIVACY PRESERVATION

Objective: Hiding sensitive and confidential information in data sharing situations, ensuring the data security and privacy preserving

Models: optimization, anonymity, ML/DL models

Jerry Chun-Wei Lin
Professor
chun-wei.lin@hvl.no

Research Questions:

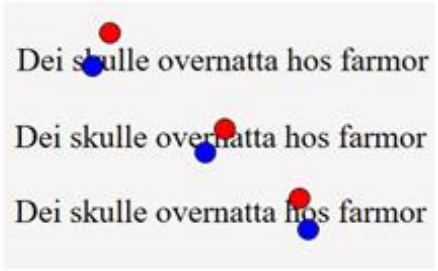
- How to design a sanitization models to keep data privacy with minimal side effects?
- How to design federated learning model to secure data in the distributed environments
- How to handle the imbalance data issue in data anonymity?

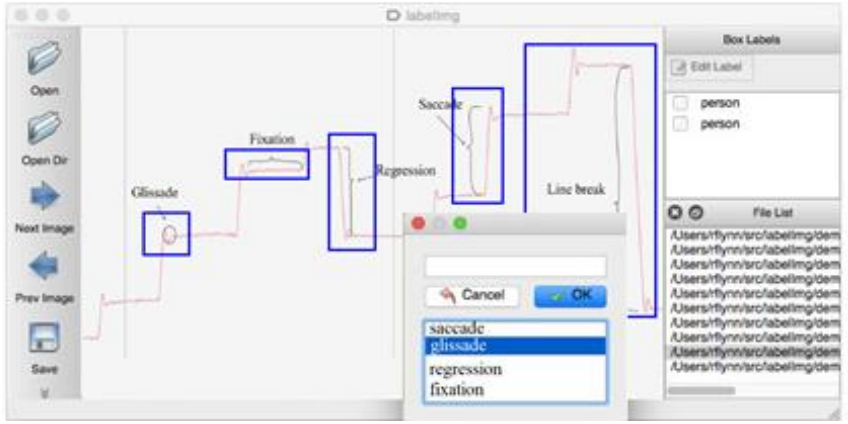
- http://ikelab.net
- Email: jerrylin@ieee.org (E417)

OCULAR MOTOR DYSFUNCTION DETECTION

Objective: detecting several vision problems by ML/DL models for OMD diagnosis and rehabilitation

Models: ML/DL models





Jerry Chun-Wei Lin
Professor
chun-wei.lin@hvl.no

Research Questions:

- How to design a AI model to diagnosis the OMD vision problems effectively.
- How to design a rehabilitation model for OMD vision problems (i.e., personalized)
- How to improve the accuracy for test designation?

- http://ikelab.net
- Email: jerrylin@ieee.org (E417)

MEDICAL (DICOM) IMAGE PROCESSING

Objectives:

(1) Process medical CT images in DICOM format using the python library pydicom. (2) Convert DICOM images to voxel geometries for use in computer simulations of radiotherapy treatments. (3) Develop and test a DICOM-Voxel parser software and make this available to the radiotherapy community at large. The project will be part of the NOVO project funded by the Research Council of Norway and the candidate will be able to interact with PhD and postdoctoral candidates in the project.

Ilker Meric
Associate Prof.
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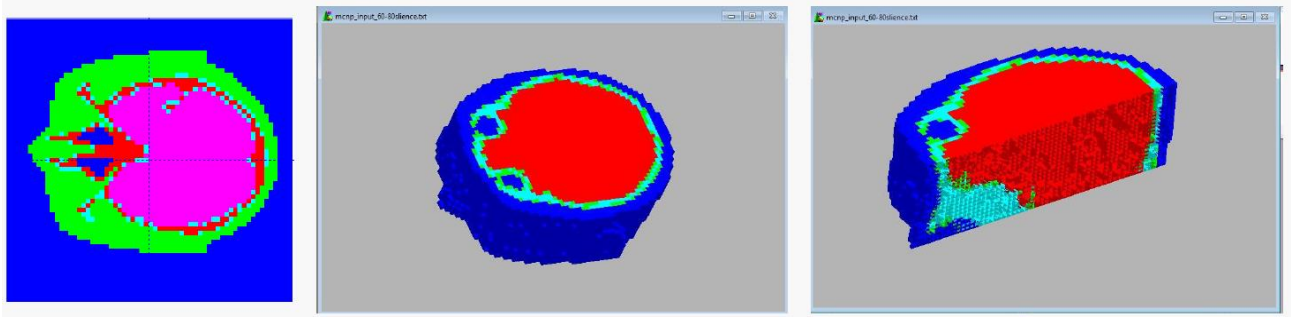


Research Questions:

- How can we most efficiently convert CT images in DICOM (Digital Imaging and Communications in Medicine) format to a format usable by mainstream radiotherapy simulation tools?
- How can we ensure the development of a parser-software that is sufficiently robust and safe to allow for distribution to the radiotherapy community at large?

Partners:

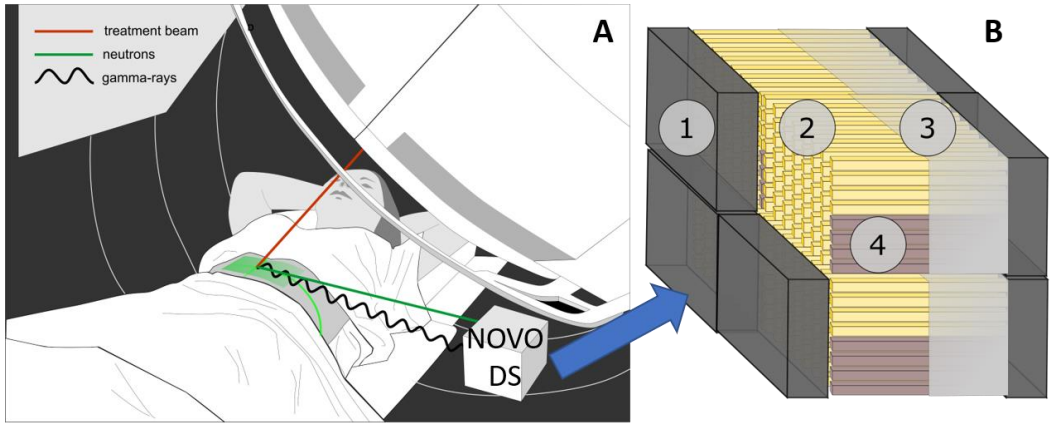
KU LEUVEN
MANCHESTER 1824 The University of Manchester
UNIVERSITAS BERGENSIS
HELSE BERGEN Haukeland universitetssjukehus
NC STATE UNIVERSITY
OncoRay National Center for Radiation Research in Oncology Dresden
RB
Institut Ruđer Bošković

Funding:
Forskningsrådet
The Research Council of Norway

MODELING OF A TREATMENT VERIFICATION SYSTEM IN PARTICLE THERAPY FOR CANCER TREATMENT

Objectives:

(1) Develop computational models of a quasi-monolithic organic particle detector array (QuDA) to study their properties in particle beams used for cancer treatment. (2) Develop a generic reconstruction framework for the QuDA system using simulation tools and experimental data. The project will be part of the NOVO project funded by the Research Council of Norway and the candidate will be able to interact with PhD and postdoctoral candidates in the project.



Ilker Meric
Associate Prof.
ilme@hvl.no

Research Questions:

- Can computational models reliably determine the achievable performance parameters of QuDA systems for treatment verification in particle therapy?
- Can we use machine learning techniques to improve on parameters such as spatial resolution?
- Can machine learning techniques improve the signal-to-noise ratio of QuDA systems?

Partners:

KU LEUVEN
MANCHESTER 1824 The University of Manchester
UNIVERSITAS BERGENSIS
HELSE BERGEN Haukeland universitetssjukehus
NC STATE UNIVERSITY
OncoRay National Center for Radiation Research in Oncology Dresden
RB Institut Ruđer Bošković

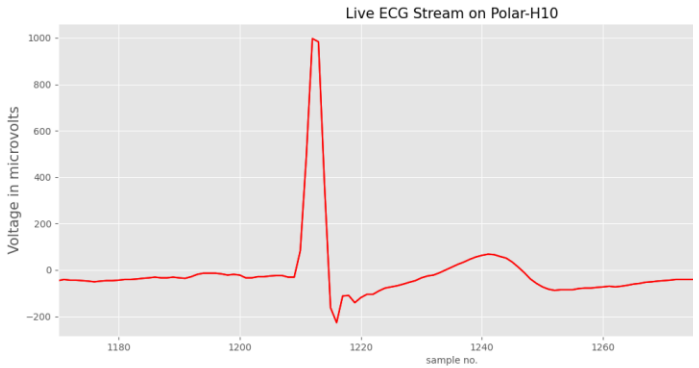
Funding:
Forskningsrådet
The Research Council of Norway

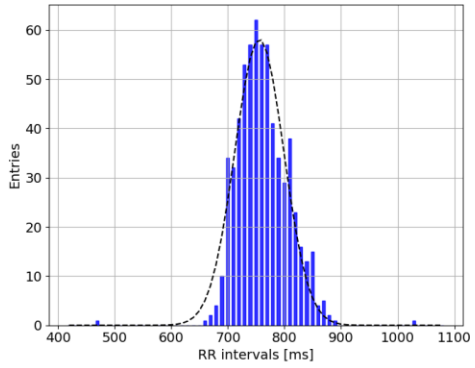
MEASUREMENTS & ANALYSES OF HEART RATE VARIABILITY

Objectives:

SenSe (Sensor technology, visually impaired and stress) is a newly initiated project @ HVL. The main objective is to study stress levels in the blind and visually impaired and compare these to the stress levels of people with normal vision in everyday situations. The objectives specific to this MSc project are:

- Collect data from a control / test group of 15-20 participants each using heart rate sensors
- Study HRV (Heart Rate Variability) in both groups using classical statistical methods as well as machine learning techniques
- Develop a mobile application (using sensor SDKs) for real-time data acquisition from heart rate sensors





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Research Questions:

- Can we use HRV and associated data such as RR-intervals to conclude facts about the stress levels of blind and visually impaired individuals versus individuals with normal / unimpaired vision?
- Can machine learning methods help identify patterns in HRV data that would allow easier interpretation of the collected data?
- Would HRV alone be a sufficient indicator of stress levels?

Partners:

- Department of Computer Science, electrical engineering and mathematical sciences, HVL
- Department of Welfare and Participation, HVL
- University Hospital in Oslo
- University of Oslo
- Alrek Health Cluster

Funding:

Norges Blindeforbund
Synshemmedes organisasjon

CATEGORIZATION AND INTERPRETATION OF EMAILS

Objectives:
Classify and interpret free text emails that are sent to Frende Forsikring. Use sentiment analysis to analyse if emails are positively or negatively charged.

Models:
State of the art NLP models

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Anders Dræge
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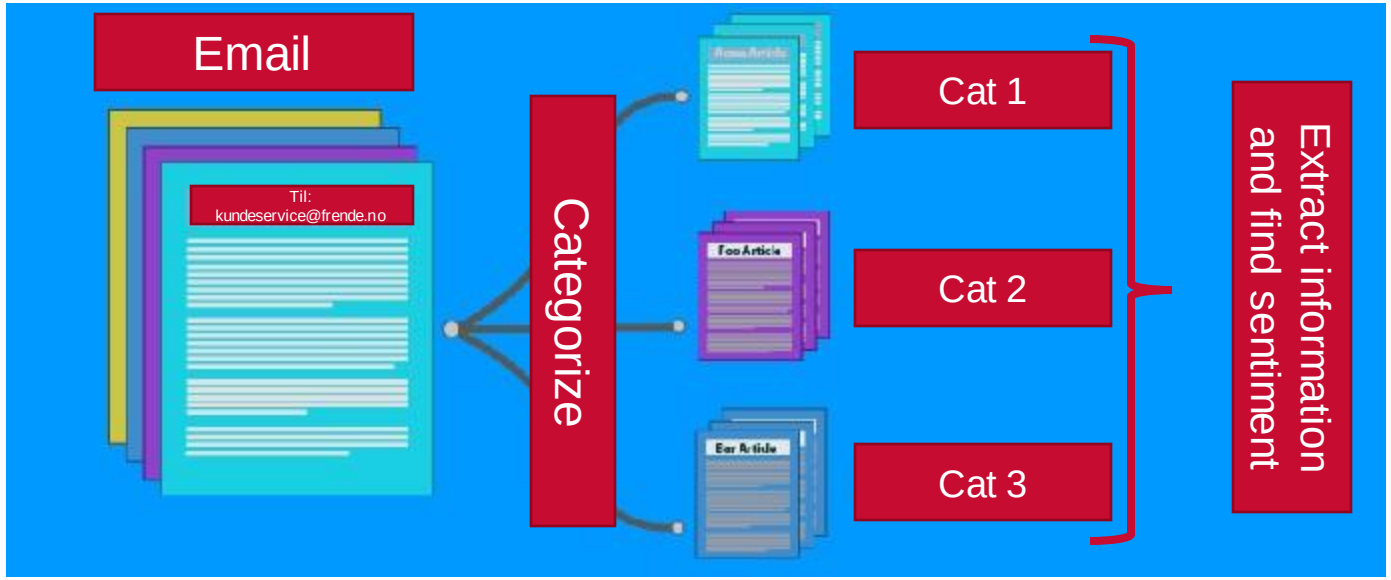

Research Questions:

- Can free-text emails sent to Frende be categorized properly by NLP models?
- Is it possible to extract relevant information from different email categories?
- Can we identify positively and negatively charged emails by sentiment analysis?

FrendeForsikring

USING NLP FOR INTERPRETING INVOICES

Objectives:
Frende receives many invoices from customers and partners. These come as both image and pdf files. As of today, a large proportion of these are read and processed manually. Conversion of image files into text, and extraction of relevant information from the invoices enables automatic invoice handling. The work will be focusing on identifying standard information such as customer id, organization number, amount, account number, in addition to looking at the potential for extracting more specific information such as what it is invoiced for.

Models:
State of the art NLP models

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Anders Dræge
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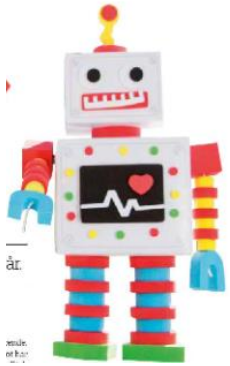
Invoice

NLP

Automatic processing



Research Questions:

- What kind of information can be recognized from invoices?
- Is it possible to convert manually scanned invoices to text with satisfying quality.
- Can invoices be interpreted with high enough precision to allow for automatic handling?

FrendeForsikring

MEDICAL AI @ MMIV

Alexander S. Lundervold
Associate Prof.
allu@hvl.no

The MSc project catalog for medical AI is available at
https://tinyurl.com/HVL-MMIV-MSc

Machine learning based search for Dark Matter using data from the ATLAS experiment at CERN

Research group: CERN related physics and computer science

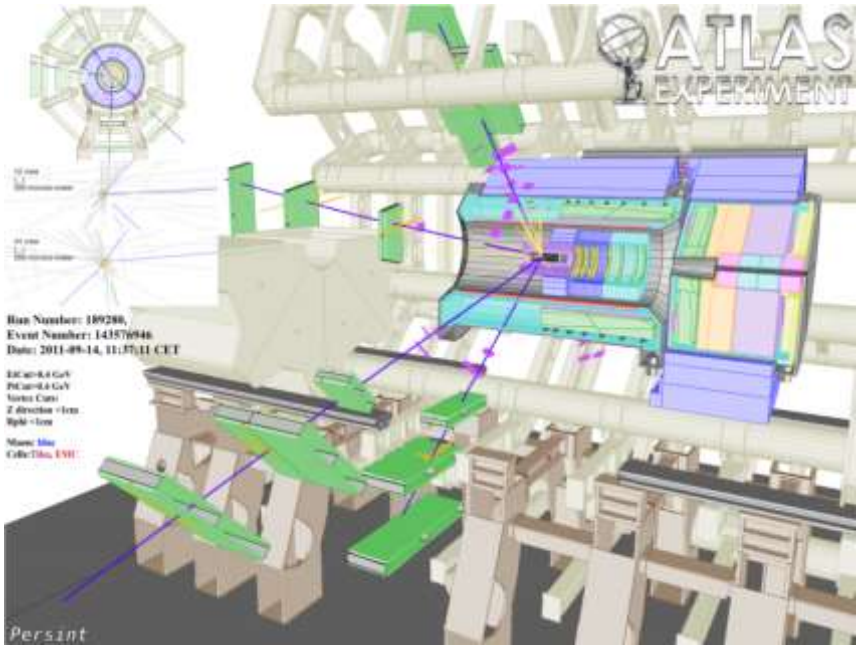
The ATLAS experiment at CERN in Switzerland is one of the largest and most complex experiment in particle physics ever built. By colliding protons from the accelerator the Large Hadron Collider, we recreate the conditions of the early universe - corresponding to a millionth of a millionth of a second after The Big Bang. Through analysis of large and complex data sets recorded by the ATLAS detector we hope to address one of the major mysteries of our universe: the nature of Dark Matter.

If you are curious about the universe and want to take part in one of the world's largest research projects, you are very welcome to join our research group. As a master student in our group you will work together with master students and researchers at HVL, UiB, UiO and at CERN analysing data to search for Dark Matter. Knowledge about particle physics is not required before starting the project (*"Curiosity is more important than knowledge"* A.E.). Your work will be to apply different machine learning techniques to improve upon existing analyses developed to search for "New Physics" in data from the ATLAS experiment. The data which you will be analysing is being recorded at the moment, and has never been looked at before. Thus, you will be working at the frontier of particle physics research.

Working on this project you will have to possibility to visit CERN, and you are encouraged to spend some of your time there.

Supervisors

- Therese Sjursen, Therese.Sjursen@hvl.no, D407
- Trygve Buanes, Trygve.Buanes@hvl.no, D410



«Grid Computing» -- distributed processing on a global scale

Research group: CERN-related physics and computer science

Project description:

The ALICE experiment records data from heavy ion collisions at CERN in Switzerland. Offline processing of experiment data takes place using Grid technology. This technology may also be used for other compute-intensive research and industry. The group at HVL takes part in the operation of the Nordic Tier1 centre, which is one of the primary computing centres with storage resources and direct connection to CERN. Grid research work includes testing and development of different middleware technologies, and commissioning, monitoring and development of tools for efficient Grid operations.

The projects are conducted as a cooperation between Høgskulen på Vestlandet, Universitetet i Bergen, Nordic e-Infrastructure Collaboration, CERN and several member institutes of the ALICE collaboration.

The ALICE experiment uses the AliEn grid middleware to coordinate its offline analysis. AliEn is now being replaced by a new version, basically written in Java and named JAliEn. The system also include several components in Python. JAliEn is being finalised and prepared for production. HVL has 2 PhD students active in this work. Max Storetvedt currently works at CERN, and Haakon André Reme-Ness is based in Bergen.

We can offer 1-2 master projects with more specific tasks related to release of JAliEn. Detailed project definitions will be made in cooperation with the prospective student. You must be prepared to take part in travel to CERN during your master project period.

Contact persons:
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Kristin Fanebust Hetland, email Kristin.Hetland@hvl.no, office E437
Max Storetvedt, email Maksim.Melnik.Storetvedt@hvl.no
Haakon André Reme-Ness, email Haakon.Andre.Reme-Ness@hvl.no, office R235-2

Simulation and readout of ALICE FoCAL (CERN) or proton CT (medical physics)

Research group: CERN-related physics and computer science

Project description:

Modern silicon pixel detectors produce data at very high rates, due to high density of sensitive points and very short time to produce a single readout. In order to cope with these data rates, special electronics is developed to control physical signals from the sensitive elements and package and deliver digitalised data to computing infrastructure through dedicated communication lines.

The microelectronics group at the Department of Physics and Technology at UiB is currently involved in two different projects involving the ALPIDE monolithic pixel detector devloped by the ALICE experiment at CERN.

The Forward Calorimeter (FoCAL) is a new detector element to be added to the ALICE experimental setup in the late 2020s. The detector will consist of ALPIDEs as the sensitive elements, and the group in Bergen will have responsibilities in the development of readout electronics and software.

Proton CT is a completely different project using the same technology. It has recently been decided that Norway will offer particle therapy as cancer treatment. Proton CT is a method to use the particle beam itself (which is also used for treatment) to produce position measurements. The detectors and readout electronics to be used for the proton CT prototype will be based on the ALPIDE chip developed for the ALICE experiment at the CERN LHC accelerator.

We can offer programming tasks both within modelling/simulation of the readout chain, and readout/monitioring of the measured data. Prototype detectors will be installed at UiB and/or Haukeland University Hospital. The development will also take place in close collaboration with developers in the ALICE collaboration.

Master projects can be offered in simulation of the readout system, in development and monitoring of the readout, and in control software and monitoring of the registered data. The tasks will be done in close collaboration with the ALICE activities and the pCT project at IFT/UiB, including the nuclear physics and microelectronics groups.

Contact persons:
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Kristin Fanebust Hetland, email Kristin.Hetland@hvl.no, office E437 (HVL/Kronstad)
Johan Alme, email Johan.Alme@uib.no, office 435 (UiB/Allégaten 55)

Project “pust”-
Development of technologies to prevent child death

Sudden Infant Death Syndrome (SIDS) and Sudden Unexpected Infant Death (SUID) are among the major reasons for infant death globally. SUID is a term used to describe the sudden and unexpected death of a baby less than 1 year old in which the cause was not obvious before investigation. These incidents often happen during sleep or in the baby’s sleep area. Sudden unexpected infant deaths include sudden infant death syndrome (SIDS), accidental suffocation in a sleeping environment, and other deaths from unknown causes. Note that accidents with kids that is more than one year old also occur when they are not under direct supervision. In recent years, SUID deaths have accounted for about 40% of sudden and unexpected infant deaths up to 4 years.

“The death mechanism pre-SIDS is yet to be known, but it is believed that a downscaling of respiration and/or heart function initiates it, which in turn leads to lack of oxygen, coma and death” - Landsforeningen uventet barnedød(LUB)

The initial ambition was to explore and substantiate opportunities for applying acoustic technologies to detect deviations in breathing patterns, and as such pre-empt and prevent fatalities due to respiratory failure of children. Throughout the exploration phase and testing it was discovered that acoustic sensors needed to be combined with other sensor technologies to meet the criteria given by the project. We want to investigate if inclusion of short distance radar and thermal imaging data could be used to improve the detection and ensure the data quality needed to provide real time warning in a non-intrusive matter.

The first goal is to build the ecosystem needed to develop, test and validate a device that will use synthetic data to warn when respiration deviates from the normal and gives a warning when respiration fails. The device should function as an advanced “baby-call”.

Findings done with acoustic sound beam testing, gave good results in certain sleeping phases, but could not give good enough data to analyse it with AI techniques when the kids were in deep sleep. Infants and small kids breathe extremely silently during deep sleep, hence other sensors need to be combined and tested in the project to meet the goal of the project, which is to ensure security. It is likely that the project would need cross-sensor/multiple sensors to accurately monitor breathing without falling out during the monitoring period. Testing done with short wave radar indicates that this technology has big limitations when it comes to distance.

We believe that it will be much easier to first develop the technologies needed for monitor healthy grownups since they breath heavier (more acoustic sound), has bigger movements in the chest (short wave radar) and gives a bigger heat signature when breathing. Evidentially the long-term ambition is to develop technologies to collect data on infant respiratory patterns, and from there apply IOT and data from respiration to pre-emp and prevent fatalities with machine learning-artificial intelligence. The overshadowing long-term goal is to collect data from infants with the vision to shed new light on SIDS.

Project “Pust” represents an idea that is relevant and innovative. The product we outline represents something completely new in the market and has the potential to change how we monitor our infants, children and grown-ups with special needs, people in prison, at healthcare institutions, the elderly etc. in a user friendly and reliable package.

As an example, a colleague from the naval officer school managed to commit suicide inside a psychiatric institution June 2021. These kinds of deaths can potentially be avoided by applying new technology that can lower the risk of human error.

The technologies are changing rapidly and gives us further motivation to explore the potential that lay within monitoring of respiratory patterns and vital signs. For example, Somnofy has started to sell their sleep monitor product, that uses a short-wave radar sensor produced by a Norwegian company, and recently Google released their google nest sleep monitor.

Project “pust” is funded by a grant from Innovation Norway and is connected to a network of relevant experts from the academic sector, healthcare sector and commercial actors.
The project aims to cooperate through open innovation to create the synergies needed to realize the product. The project represents a complex system under development and is looking for 1-2 master students that will:

- Investigate how different sensor data (thermic capacities, short distance radar, acoustics data or combination of these) could be used to monitor respiration and investigate how different AI techniques could be used to detect changes in respiration for different groups of people, e.g., children, adults, healthy and non-healthy persons

Development of services for a quality register for tooth implants

Together with the Department of Odontology at UiB and NORCE (Norwegian Research Centre) we are developing a prototype for a quality registry for tooth implants to demonstrate the possible functionalities of a quality registry based on the requirements and standards of "tomorrow".

A health quality register is an interactive database with the capability to collect, organize and display healthcare information. The purpose of a quality registry is to evaluate and improve outcomes for a population defined by a particular condition, disease, or exposure. Specifically, registries use observational study methods to collect and harmonize data about the treatment, outcomes, and well-being of patients who receive care over time. They aggregate large data sets and analyze trends or patterns in treatments and outcomes.

Registries can serve many purposes and provide value for a variety of healthcare stakeholders e.g.:

- Researchers, clinicians and other healthcare professionals/administrators use registries to evaluate and improve available treatments, procedures, implants, devices and equipment.
- Patients can use registries to get informed about clinic, type of treatment and/or implants to choose depending on various quality ratings and length of waiting lists.

Modern quality registries will address all the referred purposes and challenges by going beyond data collection and data warehousing. They will help in establishing standards for representation and communication of medical data, and they will include advanced analytics and data science to transform data into meaningful insights that are useful, usable, and used by a variety of stakeholders to achieve a desired outcome.

The future quality registry for tooth implants prototype will collect various patient data, data about the implants and the clinical procedures performed, data from patient satisfaction forms reported both just after the operation and later, as well as data collected from regular dental check-ups.

As of today, there are no quality registries for tooth implants implemented anywhere in the world. Also, there are yet no registries related to odontology in Norway.

Previously, we have had two master students working on the development of the backend and a prototype frontend for registering the data. Currently, we have one master student working on populating the quality register DB with synthetic data, which will be followed up by development of visual analytics to demonstrate future use (and possibilities) of such a quality register.

We would like to welcome two (2) more students onboard the project. Available projects are:

a) **Design and develop a good frontend solution for entering data to the quality register**
   - Will build on previous work.
   - To be done in accordance with accepted principles for good UX design.
   - The project will include a formal evaluation of the solution.

b) **Design and development of schemas for patient follow-ups w/data collection and integration**
   - Schemas to collect various data from patients at various times and treatment situations.
   - Schemas/data collection to be done by input through cell phones.
   - Including data model extension and logistics for data collection and integration.
   - Possible extension of analytics services (currently being developed) with new follow-up data.

Contacts:
- Yngve Lamo: F511, yla@hvl.no
- Svein-Ivar Lillehaug: E415, sil@hvl.no

Tool support for interoperability among heterogenous software

Software interoperability is achieved when different software systems are seamlessly cooperating to execute tasks or exchange information. In theory this should be easy to implement, but in practice it is one of the most challenging software engineering problems in domains where one has many heterogenous systems, such as the health care domain.

To solve this problem Patrick Stünkel, as part of his PhD work at HVL, has developed a tool (CorrLang) based on a domain specific language (DSL) allowing to combine multiple heterogenous software systems into one federated system, reason about them and check whether they have the desired behaviour. The figure below is a highlevel description of the workflow in the CorrLang tool.

Today's version of the CorrLang tool is supporting technologies such as GrapQL, Eclipse Modelling Framework (Ecore) and Epsilon EVL. The proposed master project will be to extend the tool concerning additional technologies, e.g., XML-based languages (WSDL web services), Open API (REST web services), Ontology languages (SNOMED CT, ICD 10 etc.).

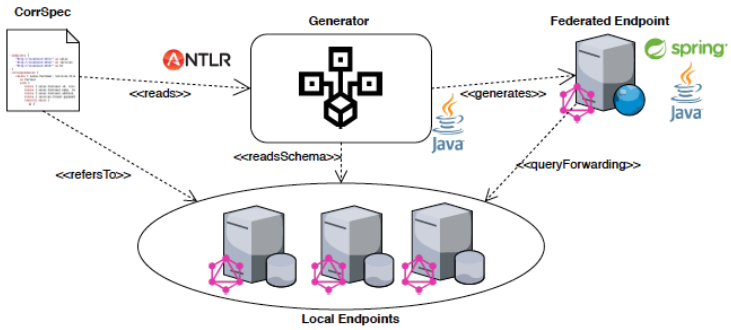
It would also be possible to

- implement editor support for writing configurations in the CorrLang DSL, e.g., by building on existing IDEs such as Visual Studio Code and Language Server Protocol or IntelliJ Plugins, or
- evaluate the tool with respect to examples and real-word use cases from the health care domain.

See https://github.com/webminz/corr-lang for the source code of the CorrLang tool.

Supervisors: Patrick Stunkel, Yngve Lamo, Adrian Rutle

Implementation



Towards a unified workspace for emergency response centres

Two master thesis projects available:
- Backend/integration
- Frontend

Today personnel working at the alarm central in the municipality emergency response centre need to follow about five (5) different monitors at the same time, each monitoring their own set of patient variables for the same set of patients receiving home care services. This increases the risk of certain alarm situations not being identified, others being identified too late – and that the actions taken are not appropriate. In addition comes the problem of storing the log data in appropriate formats for later use.

The centre for care research at HVL (https://www.hvl.no/om/senter-for-omsorgsforskning/) has installed a fully functional version of the emergency response centre used in the municipalities in the western region of Norway.

We have two master thesis projects available within this project:

1. **Develop a technical integration of the various monitor/alarm systems of today – delivering the data for a unified workspace:**
   - Design and develop a backend for the new integrated system.
   - Develop APIs for the various systems needed to deliver data to the new backend system.
   - Might include an integration towards the municipality EPJ (electronic patient journal).
   - Make use of standards to promote interoperability.

   The project might result in well-defined APIs as requirements for vendors and business delivering monitoring solutions to municipality emergency response centres.

   This is a suitable project for a smart student with interests in data modelling, API/interfaces, integration, interoperability/standards, backend/data bases – all important parts of developing good e-health applications.

2. **Develop a unified workspace for the response centres.**
   - Design and develop a good user interface for the unified workspace at the response centres.
   - To be done in accordance with accepted principles for good UX design.
   - Will require cooperation with project 1 on the development of a new data model for the project

   This is a suitable project for a smart student with interests in frontend design and development in accordance with principles of good UX design – and that finds it challenging and interesting to work within the interdisciplinary field of e-health.

The work will be done in cooperation with the centre for care research at HVL. It will be beneficial if the chosen students can work part time as lab engineers to support the lab at the centre.

Project 2 is dependent on someone choosing project 1, whereas the development of a more simple frontend could be included as a part of project 1 if there is no student to do project 2.

Contacts:
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- Svein-Ivar Lillehaug: E415, sil@hvl.no

Helse Vest IKT - AR/VR-prosjekt i Helse Vest – 2021

Figur 1 VR-rommet for barn og unge, Energisenteret for barn og unge, Helse Bergen

Vi leverer alt av IKT tenester til Helse Vest, vår innovasjonsseksjon jobber med ny teknologi som kan være relevant for våre pasientar og ansatte på sjukehusene. Blant våre fokusområder nå er bruk av VR/AR og spillteknologi for å lage opplevelser vi kan bruke for å tilby enda bedre pasientbehandling. Haukeland har eget VR-rom for aktivisering, behandling & trening som brukes aktivt i dag, de andre regionene bygger opp simuleringssenter med VR, og ellers er vi langt framme innen bruk av VR.

I våre prosjekter vil de gjøre ein direkte nytte for våre pasientar, sammen med helsepersonell & teknologar.

https://helse-vest-ikt.no/seksjon/vrlab

Kontaktperson for alle prosjektene er Håkon Garfors i Helse Vest IKT, som også koordinerer med aktuell enhet på aktuelt sjukehus/klinikk: haakon.garfors@helse-vest-ikt.no, tlf: 97014605.

Eksponeringsterapi fobi/angst - Valgfritt fobiscenario

VR-rommet for barn og unge er i dag allerede i bruk til trening, aktivisering og spilling, i både somatikk og psykiatri. Potensialet for nye behandlingsmetoder er stort, og kapasiteten er fortsatt god. Her ønsker vi derfor aktiviteten til å inkludere VR-basert fobitrening, i første omgang knyttet til barn og unge ved Klinikk Psykisk Helsevern for barn og unge (PBU).

En aktiv tilnærming til personer med fobier er eksponeringsterapi, at pasienten utsettes for sin fobi i trygge rammer. Her kan det være sosial angst, presentasjonsangst, fobi for edderkoppar, frykt for mørke, trange rom, brann, flyskrekk m.m. Bruk av VR-teknologi gir en unik mulighet til å effektivisere denne behandlingen betraktelig gjennom direkte eksponering med tilknyttet samtaleterapi.

Vi ønsker over de neste årene å etablere et repetoar av eksponeringsarenaer, og dette arbeidet får nå en boost gjennom en veldig spennede masteroppgave gjennom eksterne samarbeidspartnere ved

Høgskulen på Vestlandet. Her inviterer vi inn studenter til å selv velge egne fobier som de vil lage eksponeringsterapi for i VR.
Veiledere: Harald Soleim, Atle Birger Geitung.

AR-vitals-HUD ambulanse

For videooverføring og medisinske vitale data frå ambulanse til legevakt/akuttavdeling, her har vi fleire pågåande initiativ/prosjekt. Robust mobilt helsenett (nasjonalt prosjekt der vi er først ut med å teste løsningar) der vi kombinerer 4/5G frå Telenor, ICE og Telia og vi jobber med ulike løsningar for å understøtte ein bedre kommunikasjonsmåte fra ambulansen og inn til lege, der lege kan gjøre ein vurdering på pasientar med gul/oransje på video for å avklare alvorlighetsgrad på ein bedre måte og få pasienten til riktig instans raskare. Vi kan også overføre prosedyrer til ambulansearbeider på direkten.
Her samarbeider vi med Universitetet i Stavanger og andre helseregionar (Innlandet), og har god kontakt med ambulansemiljøene og akuttavdelingar. Her kan oppåva være f.eks å lage HUD i AR for å understøtte ambulansearbeider og gi info om pasienten, vitale data frå måleutstyret, medisinliste, pasienthistorie, fargekodar for risiko m..m. Her er eit hav av mulighetar.

Pasientkonsultasjon psykiatri

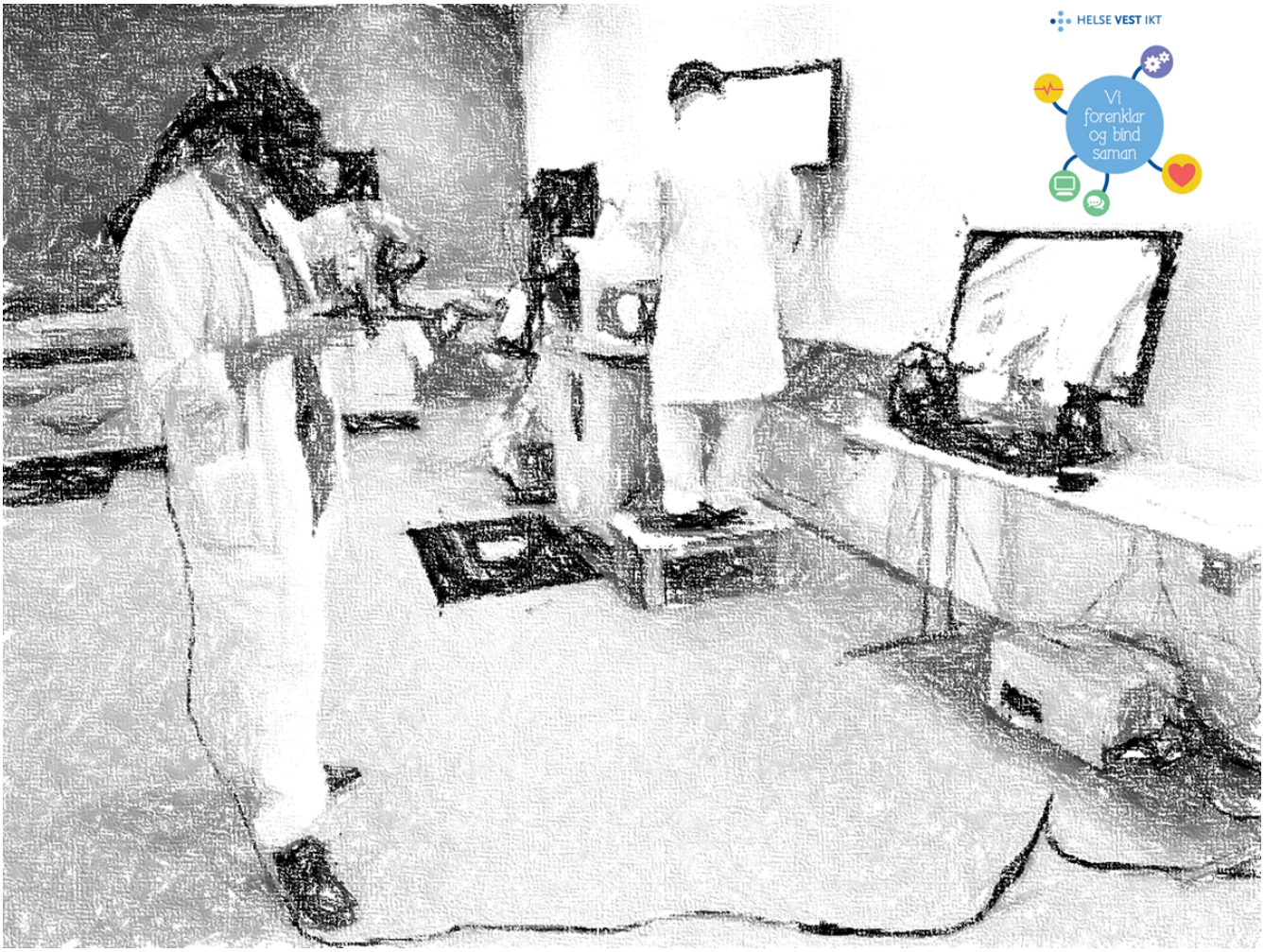
Bruk av Hololens/VR for pasient som er heime i dialog med terapeut på sjukehuset der vi vil ta terapeuten inn i AR som eit Hologram ved å bruke Holocap (transporterer vha Kinect ein live-video av ein 3D-modell av ein person inn i AR/VR). Virtuell terapi der ein bruker ein kombinasjon av VR og AR, eventuelt alternativt mobil/PC.

Psykoedukasjon

Bruk av AR-briller der samme terapeut kan snakke foran fleire barn samtidig (psykoedukasjon), der alle barna blir anonyme for hverandre. Dette er altså fjernundervisning for grupper der terapaut vil kunne holde felles opplæringssesjonar for fleire barn (m/foresatte) samtidig.

Bruk av AR for pasientundersøkelse sengepost Helse Stavanger

Her har vi eit innovasjonsprosjekt der vi har prøvd ut visning av ultralyd i Hololens i sanntid, dvs når undersøkelsen av pasient pågår med ultralyd, får lege opp ultralydbildet i sanntid i Hololens som ein video over pasientområdet som blir undersøkt. Altså ultralydbilde i sanntid i AR som vises over pasienten (røntgensyn).


HELSE VEST IKT
Vi forenklar og bind saman

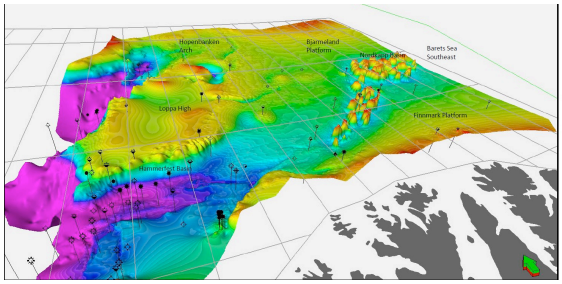
BARENTSHAVET I 3D: BRUK AV VR-TEKNOLOGI I EN ØKOLOGISK SAMMENHENG

Research group: Collaboration, Interaction and Graphics
(https://www.hvl.no/forsking/gruppe/samarbeid-interaksjon-og-grafikk/),
(https://ict.hvl.no/research/computer-graphics/)
Internal supervisors: Harald Soleim (harald.soleim@hvl.no), Atle Geitung (atle.geitung@hvl.no),
(Daniel Patel (daniel.patel@hvl.no)).
External supervisor: Sam Subbey (samuels@hi.no)

Mål

Målet med denne oppgaven er å bygge en VR (3D modell) av deler av Barentshavet, for å demonstrere hvordan bruk av VR-teknologien kan være behjelpelig med forståelser av fiskeadferd. Det er derfor ønskelig med å kunne følge en, eller flere fisk i den VR-verdenen.

Bakgrunn og problembeskrivelse



Vi ønsker å sammenstille data fra forskjellige kilder for å bygge en verden, sett fra fiskens ståsted. Det endelige verktøyet skal brukes til å besvare en del økologiske spørsmål om fisk i Barentshavet. Som et eksempel, ønsker forskere bedre forståelse om effekten av temperaturendringer (som skylder globaloppvarming) på fiskeadferd (vandringsmønster, og valg av vandringsruter). For å besvare slike spørsmål ønsker vi å:

1. lage en 3D topologisk beskrivelse av en utvalgt del av Barentshavet
2. lage en VR-fiskeverden v.h.a. den topologiske beskrivelsen og andre databaser som gir informasjon om temperatur-dybde fordelinger, havstrøm, osv.
3. legge til observasjonsdata fra havmiljøet for å danne en virtuell virkelighet

VR-verktøyet skal være et viktig forskningsverktøy for havforskere, og skal også kunne brukes i undervisning (ungdomsskoler/universiteter) om fiskeadferd.

TILLEGGSINFORMASJON

- Oppgaven passer bra for to (2) studenter som ønsker å jobbe i lag
- Studentene får kontorplass ved HI (Nordnes) i forskningsgruppen «Fiskeridynamikk»
- Samarbeid med forskere (oseanografer, biologer, økologer og dataingeniører) blir sentral

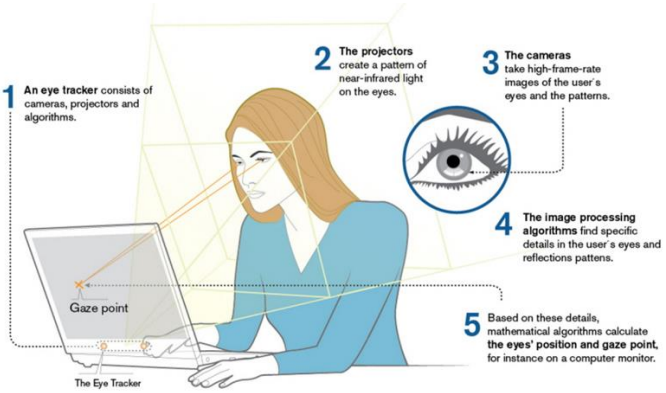
Detecting Eye Problems via Games

Collaboration Interaction and Graphics

Contact: *ilona.heldal@hvl.no;*

gasim.ali@hvl.no;

carsten.gunnar.helgesen@hvl.no



Some eye problems influence the quality of life and causes poor physical and mental health in children. 17-25% of school-aged children may have undetected functional vision problems. Our group, *Collaboration Interaction and Graphics*, has four MSc project suggestions focusing on detecting eye problems with new technologies.

Imagine: One can play an arbitrary game with an associated eye tracker and a program running in the background which can:

1. Recognize functional eye problems via structured exercises
2. Make an analysis report that can be checked after the exercises
3. Point to the identified problems (visualizing the analyses from (2) on the screen)
4. Suggest training exercises/games for the eyes based on the detected problems

Having an MSc project in our group, you can learn to design and develop programs with new technologies and help people with eye problems. You will have contact with engaged people, great earlier project results, and collaborate with PhD projects. You will become familiar with a range of tools and technologies such as Unity, Visual studio, C#, and PostgreSQL. We have modern technologies and programs for structured exercises and training. These must be improved and extended to work with *arbitrary games* and have better analyses and training applications. We have four ideas for MSc projects:

- **Front-end applications.** This MSc idea is focusing on developing an interface that suggests games (tailored to one's eye problems) for training.
- **AI and new technologies.** This work focuses on mapping data collected from the eye-tracker and the program from free screening (arbitrary games, not structured exercises) to eye-problems.
- **Designing games**. This MSc is focusing on improving the structured exercises for eye-tracker-based screening to suit specific age groups and including new games for this.
- **Modelling and programming** is an ambitious MSc idea that can extend the current functionalities of our program to additional vision problems (detect Nystagmus and Strabismus). In this case, our software needs to be modified to integrate more modules for capturing other parameters of vision, such as the x-axis or y-axis in real-time, parameters that can be recorded with modern eye-tracking technologies today. This project requires collaboration with optometrists from Latvia.

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Games Supporting Fire Safety Training

Collaboration Interaction and Graphics

Fire Safety Engineering

Contact: *Cecilia.Hammer.Wijkmark@hvl.no;*

Ilona.Heldal@hvl.no

This MSc project will be within the Collaboration, Interaction and Graphics research group. It is associated with a PhD project focusing on design, development and use of virtual reality, serious games and simulation for training fire safety at the Software Engineering in Bergen, and at the Fire Safety Engineering Departments in Haugesund. You can be located in Bergen or in Haugesund, but you may need to travel (if it is possible, otherwise we plan online demonstrations) to Fire stations in Norway and Sweden to demonstrate training with games.

At CIG, research is performed into different aspects of gamification, Human-Computer Interaction (HCI), Virtual Reality (VR), Augmented Reality (AR), and sensor networks. There is a focus on desktop technologies and games for learning procedural skills, as well as more immersive experiences that allow learning specific skills.

The suggested MSc work focuses on**:**

- Understanding the VR programs used for training and adjusting it to local needs
- Setting up VR tests in Norway.
- Work with further adjustment/development of our existing games enabling training
- Working with data (and the data already collected from a large number of tests)
- Collect data from different sources (sensors, films, etc.)
- Developing recommendations for virtual, game-based training places

This work enables possibilities to further develop games (you will have access to our actual games and technologies), utilize sensors in training contexts and work with game engines such as Unity or Unreal Engine. The project heavily utilizes gamification, simulations, and evaluations. This work incorporates possibilities to work with a company developing game environments.

Interested? Contact: Cecilia.Hammar.Wijkmar@hvl.no; ilona.heldal@hvl.no

Games Supporting Biomedical Scientists

EduGameLab

Collaboration Interaction and Graphics

Contact: *Tord.Hettervik.Froland@hvl.no;*

Ilona.Heldal@hvl.no

This MSc project will be associated to EduGameLab. This is a collaboration project between the Collaboration, Interaction and Graphics research group from the Software Engineering and the Biomedical Laboratory Scientists (BLS). EduGameLab investigates how we can use Serious Games and simulations to improve education for BLS students. Research is done into different aspects such as gamification, Human-Computer Interaction (HCI), Virtual Reality (VR), Augmented Reality (AR), and sensor networks. There is a focus on both simpler 2D games for learning procedural skills as well as more immersive experiences that allows for learning specific skills and experiencing simulated experiences.

There are possibilities to join this project by a MSc work focusing on **Interactive multiplayer game for learning and increased inter-student relations**

During the current pandemic, there have been many challenges in education on all levels with a large pivot from physical to virtual education. One aspect that many students struggle with is the loss of human contact and closeness to their fellow students. The goal of this work is to investigate how we can develop a learning experience that has a particular focus on creating and maintaining inter-student relations for the BLS students using serious games. The vision is an interactive multiplayer experience that allows the incorporation of a wide range of material, which makes it possible for it to be used throughout the students' semester.

Are you interested in working with sensors, augmented or other immersive virtual reality technologies? This MSc can be extended to using these technologies.

This MSc requires working with game engines such as Unity or Unreal Engine, gamification, simulations, and evaluations.

Interested? Contact: Tord.Hettervik.Froland@hvl.no; Ilona.Heldal@hvl.no

Ring nødnummer

Research group: Collaboration, Interaction and Graphics
(https://www.hvl.no/forsking/gruppe/samarbeid-interaksjon-og-grafikk/),
(https://ict.hvl.no/research/computer-graphics/)
Internal supervisors: Harald Soleim (harald.soleim@hvl.no), Atle Geitung (atle.geitung@hvl.no),
(Daniel Patel (daniel.patel@hvl.no)).
External supervisor: Eva Cathrine Backer (eva.cathrine.backer@helse-vest-ikt.no)
Software development tools: Unity, Mobile, (VR), …

Bakgrunn

Når skal du ringe 113 – medisinsk nødtelefon og når skal du kontakte fastlegen eller kanskje legevaktene på nasjonalt, gratis nummer 116 117? Om det dreier seg om forgiftning kan man kanskje heller ringe giftinformasjonen 22591300? Når skal man kontakte de ulike ressursene? Hvor alvorlig skal det være for å ringe 113?
Et kjent problem i helsevesenet og andre nødetater er utfordringen med å lære befolkningen hvilket hjelpenummer som finnes og når de skal ringes. Problemstillingen er aktualisert ved innføring av et nytt nummer, legevaktsnummeret, i 2017. Det har vist seg svært utfordrende å innføre dette nye nasjonale nummeret i Norge, samtidig som feil bruk av andre nødnummer medfører ressurstap i allerede pressede tjenester og fare for forsinkelser av kritisk hjelp.

Oppgave

I samarbeid med relevante aktører ønsker vi å lage et læringsspill for hele Norges befolkning der man skal trenes i å vurdere situasjoner og kontakte riktig hjelpesentral. Spillet bør:

- Kunne spilles både av voksne og barn
- Lages med «mobile first» teknologi, 2D, og kunne spilles gjennom alle vanlige nettlesere for å nå fleste mulig
- Bruke humor og overraskelser for å skape fenge spilleren og skape oppmerksomhet rundt tema (se www.stoppsepsis.no som eksempel)
- Inneholde «husketeknikker», elementer som hjelper spilleren med å huske rett nødnummer senere, eksempelvis rimsystemet e.l.

Forslag til master-prosjekt fra Institutt for byggfag ved HVL:

1) I kva grad klarar me å lage ein virtuell opplæringsmodul for landmålarar? Dette vil vera ein modell som krev terreng, eigedomsgrenser og ein case kor studentane skal lære seg intuisjonen med tanke på god plassering av grensa mellom partane og grensemerker. Dette kan anten vera i form av eit fiktiv scenario, men det hadde kanskje vore enno kulare om ein kunne tatt eit reelt case, og så kunne ein også få lagt inn matrikkelgrensene? Slik kan studentane sjå korleis dei ville vurdert det ut frå dokumentasjonen/partane sine påstandar, lage ei skisse til korleis dei meiner grensene skal vera og så kunne ein trylla fram matrikkelgrensene og sett i kva grad det samsvarar? Her finst det ein million måtar/problemstillingar, utfordring nr. 1 er å samkjøre terreng og matrikkelgrenser i VR.

2) Me har to studentar på masterstudiet som har undersøkt og kategorisert knappe 500 eigedommar som har høyrt til Baroniet i Rosendal. Dei ulike kategoriane syner særs viktige bestanddelar av godset, t.d. var det nokre eigedommar som ikkje kunne avhendast, nokre som høyrte til kyrkjene som igjen høyrte til godset, nokre som finanserte prestane som hadde embete i kyrkjene som høyrte til godset etc. etc. Dei har koda dette inn i ei kml-fil. I fyrste omgang skal dei lage ein presentasjon som skal gå i ei større presentasjons via skjermar-satsing på Baroniet. Dette er ganske stas å vera med på. Men så er spørsmålet korleis ein eventuelt kunne ha nytta fila vidare. Her er det mange løysinga, Ringheim på Medielab meinte det enkelt kunne brukast til ein app t.d. Eg personleg tenkjer at ei profilering som kan verta meir ynskja framover er interaktive modular til museum/VilVite (museum 3.0 sett i høve til det me vaks opp med), og kanskje er dette ein prosjekt som kunne brukast som ein showcase kring dette? Kart er jo alltid veldig illustrerande, og ingen dum ting å ha kunnskap kring koding av?

Forslag til masteroppgaver

Aldersbestemmelse:
Fisk aldersbestemmes ved å telle ringene på øresteinen (otolitten) på samme måten som på trær. Det er stor forskjell på utformingen av øresteiner mellom arter, og derfor også stor forskjell på hvordan øresteinen skal behandles i forkant av aldersleing. Noen otolitter leses hele, andre knekkes på midten, og enkelte må også brennes før de kan leses. Prinsippet bak alderslesing er det samme for alle arter, men vanskelighetsgraden varierer stort. Hvordan definerer man en falsk sone? Hvordan ser man at fisken har gytt?

Artsbestemmelse:
Vassild eller strømsild? Lyr eller sei? Snabeluer eller vanlig uer? Det er ikke alltid enkelt å se forskjell på artene vi fisker, og det er enda vanskeligere når de er små.
Vi har tokter som går langs Afrikas kyst og i det Indiske hav, og det er vanskelig å øve på artsbestemmelse av disse artene hjemmefra.
Hva er de spesielle kjennetegnene som definerer de forskjellige artene? Kan du hjelpe oss med å lage en VR-artsbestemmelsesmetode?

Prøvetaking:
Hvor sitter leveren? Hvordan tar vi ut øresteiner fra fisken? Hva kjønn har egentlig denne umodne fisken? Når vi står på forskningsbåten, skal vi ta diverse prøver fra hver fisk. Lengde, vekt, kjønn, modningsstadium, levervekt, gonadevekt og øresteiner.
Kan du hjelpe oss med å lage et VR-oppsett, som kan lære nye prøvetakere om anatomien til fisk og hvordan vi tar våre prøver? Det er stor forskjell på hvordan modningsstadiene ser ut på forskjellige arter, så her er en utfordring 😊

Ny bruk av AR og VR i helsesektoren

Research group: Collaboration, Interaction and Graphics
(https://www.hvl.no/forsking/gruppe/samarbeid-interaksjon-og-grafikk/),
(https://ict.hvl.no/research/computer-graphics/)
Internal supervisors: Harald Soleim (harald.soleim@hvl.no), Atle Geitung (atle.geitung@hvl.no),
(Daniel Patel (daniel.patel@hvl.no)).
External supervisor: Håkon Garfors (hakon.garfors@helse-vest-ikt.no)
Software development tools: AR, VR, Unity, …

Bakgrunn

Dette er en liste av ulike AR og VR-prosjekt. Noen av prosjektene er ikke super-konkrete, men åpner mulighet for å komme med idéer og mer konkrete løsninger selv.

Oppgavene

Virtuell bronkoskopi

Undersøkelse av spiserør før operasjon er i dag vanskelig og medfører ofte flere feilstikk med kanyle (både ubehag og svært kostbare kanyler), da spiserøret på hver pasient ofte har store variasjoner gjør det jobben vanskelig. Her har vi i lag med flere leger på Førde Sjukehus diskutert en løsning med å bruke AR-briller for å kunne vise modell av spiserør under/rett før undersøkelse, her er også alternativ å bruke VR i forkant for å gjøre seg kjent med pasientens spiserør i forhold til resten av overkroppen. Her vil altså det å bruke 3D-modeller fra CT/MR/PET og vise disse i AR/VR være aktuelt. Se Helse Sørøsts prosjekt i forbindelse med ortopedi for inspirasjon.

AR-briller i ambulanse

For videooverføring og medisinske vitale data fra ambulanse til legevakt/akuttavdeling, her har vi flere pågående initiativ/prosjekt. Robust mobilt helsenett (nasjonalt prosjekt der vi er først ut med å teste løsninger) der vi kombinerer 4G fra Telenor, ICE og Telia og vi jobber med ulike løsninger for å understøtte en bedre kommunikasjonsmåte fra ambulansen og inn til lege, der lege kan gjøre en vurdering på pasienter med gul/oransje på video for å avklare alvorlighetsgrad på en bedre måte og få pasienten til riktig instans raskere. Vi kan også overføre prosedyrer til ambulansearbeider på direkten. Her samarbeider vi med Universitetet i Stavanger og andre helseregioner (Innlandet), og har god kontakt med ambulansemiljøene og akuttavdelinger. Her kan oppgaven for eksempel være å lage HUD i AR for å understøtte ambulansearbeider og gi info om pasienten, vitale data fra måleutstyret, medisinliste, pasienthistorie, fargekoder for risiko med mer. Her er et hav av muligheter.

Pasientkonsultasjon psykiatri

Bruk av Hololens/VR for pasient som er hjemme i dialog med terapeut på sjukehuset der vi vil ta terapeuten inn i AR som et Hologram ved å bruke Holocap (transporterer vha Kinect en live-video av en 3D-modell av en person inn i AR/VR). Virtuell terapi der man bruker en kombinasjon av VR og AR, eventuelt alternativt mobil/PC.

Psykoedukasjon

Bruk av AR-briller der samme terapeut kan snakke foran flere barn samtidig (psykoedukasjon), og der alle barna blir anonyme for hverandre.

Bruk av AR for interne pasientkonsultasjonar

Til bruk på sykehuset for å skjerme helsepersonell i å komme i kontakt med pasienter med Covid-19. Tilsvarende initiativ som Helse Sør-øst har jobbet med og vant pris sammen med Sopra Steria.

Bruk av AR for fjernstøtte medisinteknisk personell

Her har vi allerede hatt et prosjekt i Helse Førde der vi prøvde ut Hololens 1 for å gi medisinskteknisk personell fjernstøtte ved reparasjon, feilsøking og vedlikehold av medisinteknisk utstyr. Der ringte tekniker med Hololens opp til en på kontoret som satt med PC og sendte instruksjoner til brillene, og så video fra Hololens. Brukerne var veldig fornøyde med løsningen og den understøttede arbeidsflyten veldig godt, men selve Hololens 1 brillene var for tunge og klumpete å bruke. De ønsker å prøve dette med en bedre teknisk løsning, der Hololens 2 er veldig aktuell. Her kan være å sy sammen ulike komponenter for å tilby en komplett, brukervennlig løsning til teknisk personell som ønsker fjernstøtte.

Opptrening av pasienter med hjerneslag/nedsatt funksjonsevne

Fysiske øvelser med virtuelle objekter (baller, redskaper m.m.) for å trene opp bevegelse hos pasienter med redusert motoriske evner. Her er altså enkle øvelser for å trene opp kroppen og hodet igjen etter funksjonsevne har blitt svekket, det kan være balltrening, holde kniv og gaffel, helle kaffe fra kanne til kaffekopp, og ellers daglige enkle hverdagslige ting. Her samarbeider vi med fysioterapeuter og leger i både Helse Førde og Helse Bergen, der vi har god kontakt med det kliniske miljøet, og som er interesserte i å samarbeide med HVL for å få utvikla løsninger for å gjøre det enklere for pasienter å komme seg.

Eksponeringsterapi fobier/angst

Til vårt VR-rom som i dag er utstyrt med VR-briller, får vi henvisninger for ulike typer fobier og andre lidelser der vi bruker blant annet eksponeringsterapi for å behandle pasientene. Ved ytterligere bruk av gode løsninger for VR/AR kan vi utvide vårt behandlingstilbud og tilby enda flere pasientgrupper behandling. Her kan det være sosial angst, presentasjonsangst, fobi for edderkopper, frykt for mørke, trange rom, brann, flyskrekk med mer.

Bruk av AR for pasientundersøkelse sengepost Helse Stavanger

Her har vi et innovasjonsprosjekt der vi har prøvd ut visning av ultralyd i Hololens 1 i sanntid, dvs når undersøkelsen av pasient pågår med ultralyd, får lege opp ultralydbildet i sanntid i Hololens som en video over pasientområdet som blir undersøkt. Altså ultralydbilde i sanntid i AR som vises over pasienten.

Visning av CT-modell i AR for bedre planlegging av kirurgi

Her bruker vi i dag 3D-printede modeller av brudd for å få bedre forståelse av skade, for å være bedre forberedt til faktisk operasjon. Her vil Hololens kunne brukes i flere scenarier. Vi har et initiativ her for bruk av VR til akkurat dette, men AR vil i mange tilfeller være bedre, og det vi holder på å utvikle her kan også brukes på Hololens.

Project “pust”-
Development of technologies to prevent child death

Sudden Infant Death Syndrome (SIDS) and Sudden Unexpected Infant Death (SUID) are among the major reasons for infant death globally. SUID is a term used to describe the sudden and unexpected death of a baby less than 1 year old in which the cause was not obvious before investigation. These incidents often happen during sleep or in the baby’s sleep area. Sudden unexpected infant deaths include sudden infant death syndrome (SIDS), accidental suffocation in a sleeping environment, and other deaths from unknown causes. Note that accidents with kids that is more than one year old also occur when they are not under direct supervision. In recent years, SUID deaths have accounted for about 40% of sudden and unexpected infant deaths up to 4 years.

“The death mechanism pre-SIDS is yet to be known, but it is believed that a downscaling of respiration and/or heart function initiates it, which in turn leads to lack of oxygen, coma and death” - Landsforeningen uventet barnedød(LUB)

The initial ambition was to explore and substantiate opportunities for applying acoustic technologies to detect deviations in breathing patterns, and as such pre-empt and prevent fatalities due to respiratory failure of children. Throughout the exploration phase and testing it was discovered that acoustic sensors needed to be combined with other sensor technologies to meet the criteria given by the project. We want to investigate if inclusion of short distance radar and thermal imaging data could be used to improve the detection and ensure the data quality needed to provide real time warning in a non-intrusive matter.

The first goal is to build the ecosystem needed to develop, test and validate a device that will use synthetic data to warn when respiration deviates from the normal and gives a warning when respiration fails. The device should function as an advanced “baby-call”.

Findings done with acoustic sound beam testing, gave good results in certain sleeping phases, but could not give good enough data to analyse it with AI techniques when the kids were in deep sleep. Infants and small kids breathe extremely silently during deep sleep, hence other sensors need to be combined and tested in the project to meet the goal of the project, which is to ensure security. It is likely that the project would need cross-sensor/multiple sensors to accurately monitor breathing without falling out during the monitoring period. Testing done with short wave radar indicates that this technology has big limitations when it comes to distance.

We believe that it will be much easier to first develop the technologies needed for monitor healthy grownups since they breath heavier (more acoustic sound), has bigger movements in the chest (short wave radar) and gives a bigger heat signature when breathing. Evidentially the long-term ambition is to develop technologies to collect data on infant respiratory patterns, and from there apply IOT and data from respiration to pre-emp and prevent fatalities with machine learning-artificial intelligence. The overshadowing long-term goal is to collect data from infants with the vision to shed new light on SIDS.

Project “Pust” represents an idea that is relevant and innovative. The product we outline represents something completely new in the market and has the potential to change how we monitor our infants, children and grown-ups with special needs, people in prison, at healthcare institutions, the elderly etc. in a user friendly and reliable package.

As an example, a colleague from the naval officer school managed to commit suicide inside a psychiatric institution June 2021. These kinds of deaths can potentially be avoided by applying new technology that can lower the risk of human error.

The technologies are changing rapidly and gives us further motivation to explore the potential that lay within monitoring of respiratory patterns and vital signs. For example, Somnofy has started to sell their sleep monitor product, that uses a short-wave radar sensor produced by a Norwegian company, and recently Google released their google nest sleep monitor.

Project “pust” is funded by a grant from Innovation Norway and is connected to a network of relevant experts from the academic sector, healthcare sector and commercial actors.
The project aims to cooperate through open innovation to create the synergies needed to realize the product. The project represents a complex system under development and is looking for 1-2 master students that will:

- Investigate how different sensor data (thermic capacities, short distance radar, acoustics data or combination of these) could be used to monitor respiration and investigate how different AI techniques could be used to detect changes in respiration for different groups of people, e.g., children, adults, healthy and non-healthy persons

Aktuelle prosjekt sammen med CodeLab

Research group: Collaboration, Interaction and Graphics
(https://www.hvl.no/forsking/gruppe/samarbeid-interaksjon-og-grafikk/),
(https://ict.hvl.no/research/computer-graphics/)
Internal supervisors: Harald Soleim (harald.soleim@hvl.no), Atle Geitung (atle.geitung@hvl.no),
(Daniel Patel (daniel.patel@hvl.no)).
External supervisor: Ruben Patel (ruben.patel@codelab.no)

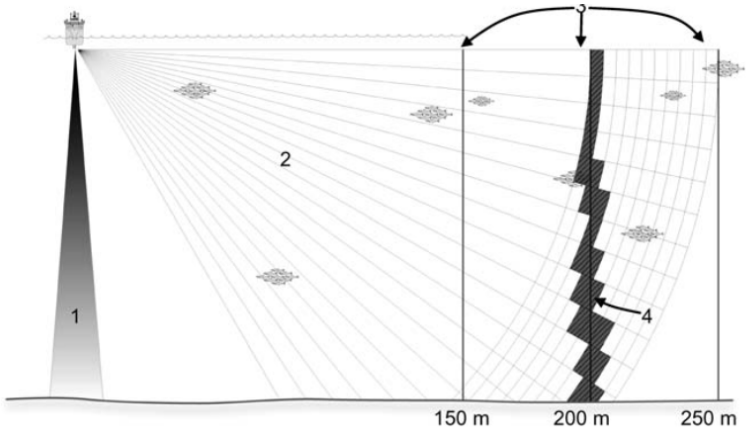
Bakgrunn

Dette er en liste av ulike prosjekt som CodeLab kan tilby.

Oppgavene

Målfølging av flere objekter basert på data samplet fra en ikke-rektangulær grid.

Målet med oppgaven er å teste ut ulike metoder for målfølging. Dataen dette skal gjøres på er fra en scannig sonar og er dermed ikke rektangulær, se Figur 1. I praksis betyr dette at posisjonen på objektet er mer usikker jo lengre vekk man kommer fra sensorene. Sonaren skanner ved å endre azimut og tilt vinkel. Det kan derfor være hensiktsmessig utføre målfølging i samme koordinat system. På denne måten har man mer kontroll over usikkerheten som ofte brukes inn i målfølgingen.

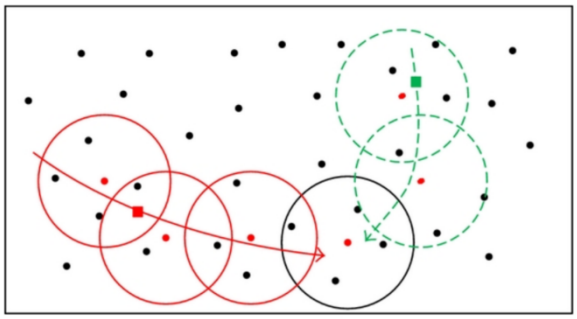


Figur 1 Sampling på et ikke rektangulært grid. 1) viser sampling volum på et ekkolodd med en stråle. 2) viser samples på en ikke liner grid. 4) Viser samples langs en vertikal strek gjennom vannkolonnen.

Typisk steg for målfølging av flere mål er:

- Mål deteksjon, der man får en posisjon og posisjons usikkerhet.
- Mål følging for enkelt mål. Kjente metoder er:
  - Ulike kalman filtere
  - Ulike partikkel filtere
- Følge flere mål samtidig. Her må man ta en avgjørelse på hvilket mål som tilhører de ulike mål stiene. I praksis betyr dette å se på ulike metoder for å løse tilordnings problemet. Typiske metoder er:
  - Munkres algoritme
  - Hungarian method
- Metode for å måle ytelse på målfølgingen.

Figur 2 viser en situasjon der man følger to mål. Den svarte sirkelen angir en deteksjon som må tilordnes en sti. Hvilken sti som målet skal allokeres til avgjøres ved å løse tilordnings problemet.



Figur 2. Viser to stier med tilhørende deteksjoner. Røde prikker viser detekterte mål. Sirklene viser usikkerheten. Grønn og rød pil indikerer stien for to ulike mål. Svart sirkel omgir et mål som ikke har bli tilegnet noe sti

Intelligent Markerings verktøy for video data

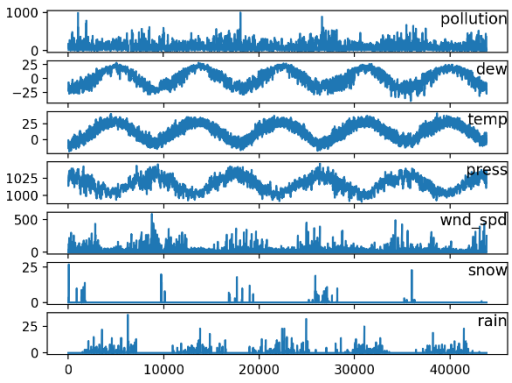
For å kunne trene opp gode algoritmer for å finne objekter i video, trenger man en fasit. Fasiten består av video bilder og tilhørende metadata som inneholder informasjon om hvor man kan finne objektene i videoen. Dette brukes til å trene opp, verifisere modell og beregne statistikk for å si noe om hvor god modellen er.

Markering av data kan ta tid. Det er derfor viktig at prosessen er rask og effektiv. Markerings verktøyet må derfor kunne foreslå markeringer selv. Dersom de er feil, blir de slettet av brukeren. Video er som oftest korrelert i tid. Det kan derfor også være gunstig å bruke målfølgings teknikk for mer presise deteksjoner.

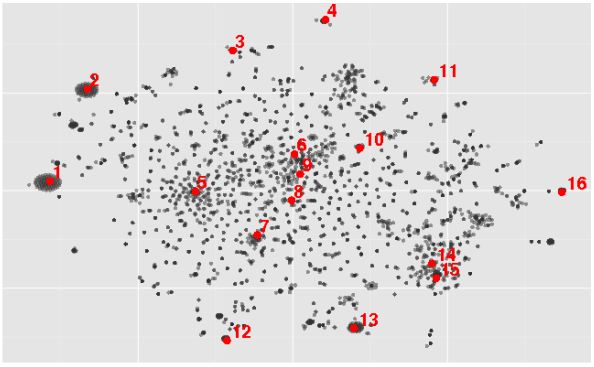
Figur 3. Deteksjon I video med målfølging. Rektangler viser detektert mål og streker viser sti til målet

Intelligent Markerings verktøy for multivariat tidsserie data.

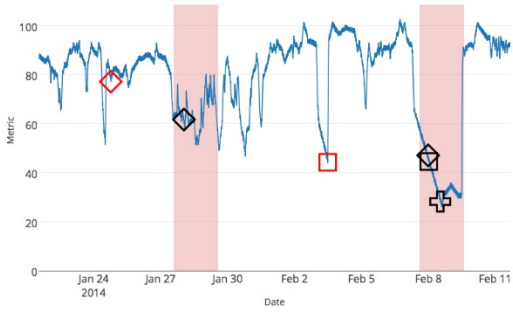
For å kunne trene opp gode algoritmer for å finne hendelser i multivariat tidsserie data trenger man en fasit. Fasiten består av multivariat data og tilhørende metadata som inneholder informasjon om hvor man kan finne hendelsen i dataen. Dette brukes til å trene opp, verifisere modell og beregne statistikk for å si noe om hvor god modellen er.
Markering av data kan ta tid. Det er derfor viktig at prosessen er rask og effektiv. Markerings verktøyet må derfor kunne foreslå markeringer selv. Dersom de er feil, blir de slettet av brukeren. Det kan også være gunstig redusere dimensjonen i dataen og plotte dette som et korrelasjons plott for å se etter klynger. Man kan da markere klyngene og på den måten markere flere hendelser samtidig.



Figur 4. Eksempel på multivariate tidsserie



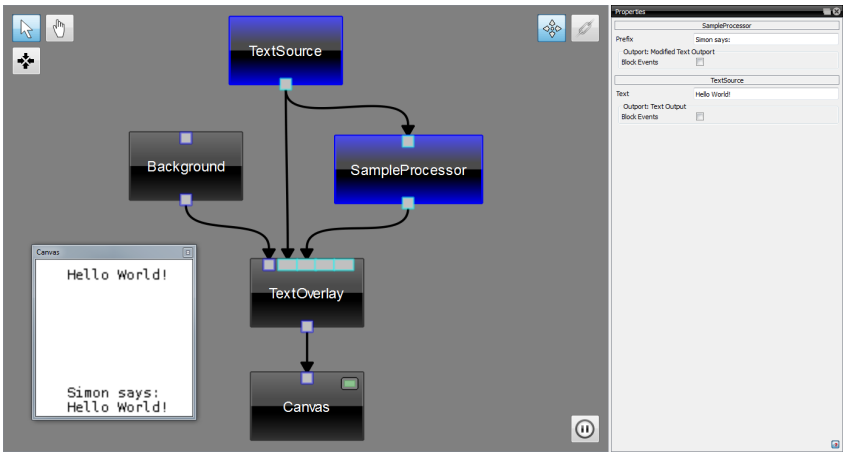
Figur 6. Dimensjons reduksjon og klustering av data



Figur 5. Markering av tidsserie data

Rammeverk for å prosessere flere datastrømmer i sanntid.

For å kunne ta gode beslutninger er det nyttig å bruke data fra flere kilder. Typisk prosesserings rekkefølge er : Lese data->Preprosessering-> koble data med annen data->Kategorisering-> Beslutning->Postprosessering.
Målet er å utvikle et modulært prosesserings verktøy der hver modul programmeres og vises i et grafisk grensesnitt der de kan kombineres.

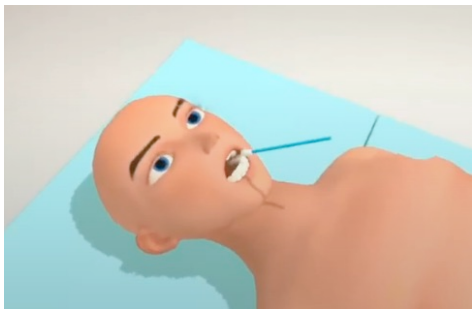


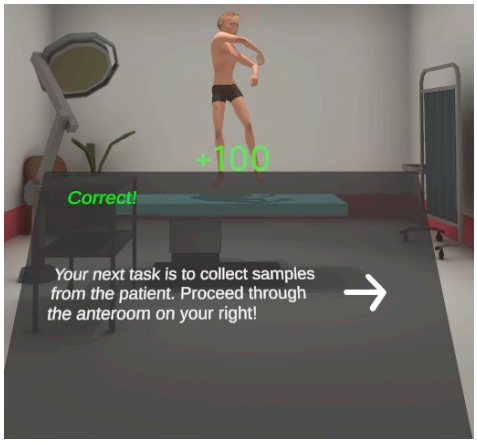
Figur 7. Eksempel på bruker grensesnitt for rammeverk for prosessering av flere datastrømmer.

Stopp MRSA 2.0

Research group: Collaboration, Interaction and Graphics
(https://www.hvl.no/forsking/gruppe/samarbeid-interaksjon-og-grafikk/),
(https://ict.hvl.no/research/computer-graphics/)
Internal supervisors: Harald Soleim (harald.soleim@hvl.no), Atle Geitung (atle.geitung@hvl.no),
(Daniel Patel (daniel.patel@hvl.no)).
External supervisor: Eva Cathrine Backer (eva.cathrine.backer@helse-vest-ikt.no)
Software development tools: VR, Unity, …

Bakgrunn





Bakterier som er motstandsdyktige mot antibiotika er vurdert av WHO til å være den største trusselen mot helsen i verden. Bare i dag dør rundt 700 000 personer hvert år av resistente bakterier. I 2020 laget studenter ved HVL et VR-spill/simulator for spesialisthelsetjenesten knyttet til vurdering og prøvetaking av en av disse fryktede bakteriene, MRSA. Det forventes oppmerksomhet rundt spillet når dette skal lanseres høsten 2020, med trolig påfølgende innspill fra helsepersonell, sykehus og kompetansesentra om videreutvikling av denne første versjonen.

Oppgave

Aktuelt å «videreutvikle» vil kunne være:

- Økt detaljering og introduksjon av flere steg knyttet til MRSA-temaet
- Nye nivå i spillet, eller et helt nytt spill knyttet til
- Andre spesifikke resistente bakterier av like stor betydning som MRSA, eksempelvis vankomycin-resistente enterokokker (VRE) og Gram-negative bakterier med utvidet resistens mot betalaktamer, cefalosporiner og/eller karbapenemer (ESBL/KPB).
- Andre infeksjonstemaer med høyt fokus i spesialisthelsetjenesten som Kirurgisk antibiotikaprofylakse,
- Opplæring av korrekt vurdering av luftveisinfeksjoner (svært viktig for å redusere bruk av antibiotika),
- Opplæring i korrekt valg av antibiotika, (her forventes flere ideer fra nasjonalt kompetansesenter på området.)

Det er også ønskelig å refaktorere selve applikasjonen (programmet) med en målsetting om å lage et generisk rammeverk for prosedyrebaserte system i helsevesenet.

Det er ønskelig med to studenter på denne oppgaven.

Masterprosjekt

TekLab (https://teklab.uib.no).

Vi planlegger et nytt MakerSpace i MCB, og studentene kan være knyttet til aktiviteter her både i 2022 og 2023. TekLab har et nært samarbeid med firmaet Spello (https://spello.no), som består av tidligere studenter på våre fag i MCB, og som spesialiserer seg på nye løsninger for VR og AR. De utvikler løsninger innenfor sektorene utdanning/museum/turisme. Spello kan også være oppdragsgiver, i samarbeid med TekLab.
Vi kan være biveiledere, teknisk support og/eller oppdragsgivere alt etter hva som passer.

1. Virtuell turisme – Togethere. Hovedprosjektet til Spello er Togethere - en applikasjon for smarttelefoner utviklet i Unity. Her arbeider de med sosial, virtuell turisme i form av høykvalitets 360-graders video. Selskapet er også interessert i å utforske en VR-versjon av applikasjonen til Oculus Quest. Her vil studentene få mulighet til å jobbe med brukergrensesnitt i VR, strømming av høykvalitets 360-graders video til VR-hodesett, arbeid med avatar-representasjon/animasjon og voice chat i VR.

2. Museumsteknologi. En eller to studenter kan samarbeide om en innovativ applikasjon for HoloLens 2. Det er interessant for TekLab/Spello at applikasjonen kan utløse hendelser i et museum ved hjelp av NFC-brikker. HoloLens 2 er et avansert AR-verktøy som har svært mange muligheter. Programmeringen bør helst skje i Unity og/eller Mozilla Hubs.

Veileder: Atle Geitung (atle.birger.geitung@hvl.no) og Harald Soleim (harald.soleim@hvl.no)

VR-konsert II

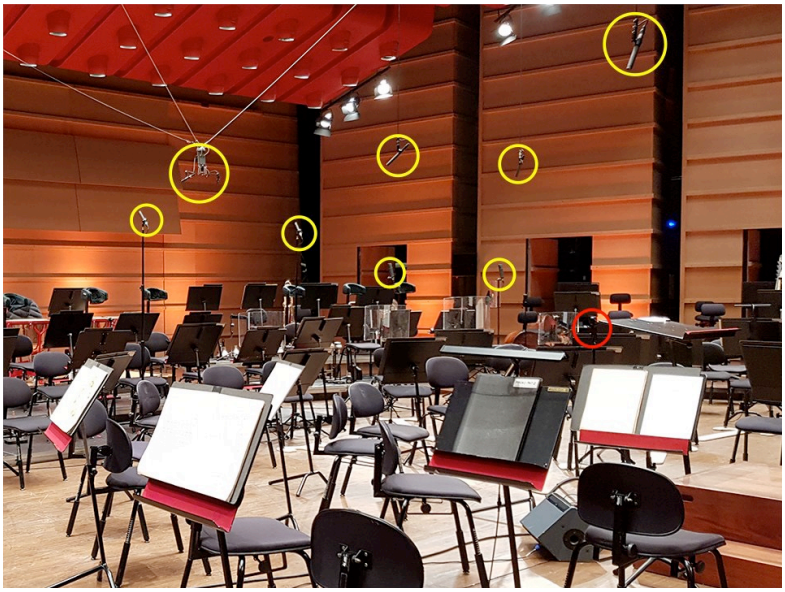
Research group: Collaboration, Interaction and Graphics
(https://www.hvl.no/forsking/gruppe/samarbeid-interaksjon-og-grafikk/),
(https://ict.hvl.no/research/computer-graphics/)
Internal supervisors: Harald Soleim (harald.soleim@hvl.no), Atle Geitung (atle.geitung@hvl.no),
(Daniel Patel (daniel.patel@hvl.no)).
External supervisor: Ingeborg Ekeland (ingeborg@harmonien.no)
Software development tools: VR, Unity, 3D video, 3D sound, …

Bakgrunn

Harmonien ønsker å kunne sende konserter direkte som VR-konserter med mulighet til å nå mange og også kunne gi brukerne mange muligheter som eller ikke er mulig. For eksempel å sette seg inn i orkesteret. Til dette trenger vi 3D-video og 3D-lyd i tillegg til 3D-modell av Grieghallen hvor Harmonien holder sine konserter. Selv om dette er spesielt for Harmonien, kan vi tenke oss en generell løsning for alle konsertsaler. Det er lagd en første versjon som et masterprosjekt og den viser at dette er mulig, men det er mye som gjenstår å forske på.

Oppgave

Vi ønsker å utvikle konseptet med realtime-sendinger av VR-konserter. Videre må nåværende løsning få et VR-brukergrensesnitt slik at det blir tilgjengelig for andre enn programmereren. Mikrofoner må kunne plasseres, lyden må kunne mikses, bilder må kunne lages ut fra en 3D-modell (i dag har vi kun 360-video fra gitte posisjoner), og mye mer. VR-lyden er ekte VR-lyd for hele salen.



Figur 1. The scene in Griegsalen before the concert. Yellow circles are some of the microphones. Red circle is the 360° camera we used for recording the video

Liker du å jobbe med musikk, lydproduksjon, VR, 3D-grafikk, 3D-lyd og programmering er dette oppgaven for deg.

Det er en fordel å være to på oppgaven.

A VR-viewer for anatomiske modeller

Research group: Collaboration, Interaction and Graphics
(https://www.hvl.no/forsking/gruppe/samarbeid-interaksjon-og-grafikk/),
(https://ict.hvl.no/research/computer-graphics/)
Internal supervisors: Harald Soleim (harald.soleim@hvl.no), Atle Geitung (atle.geitung@hvl.no),
(Daniel Patel (daniel.patel@hvl.no)).
External supervisors: Rolf Arne Haakonsen, Håkon Garfors (hakon.garfors@helse-vest-ikt.no),
Thomas Fiskeseth Larsen (thomas.fiskeseth.larsen@helse-vest-ikt.no)
Software development tools: VR, 3D printer, Unity, …

Bakgrunn

I tilfeller med store skader eller uvanlige medfødte defekter, ønsker klinikeren seg så god oversikt over pasientens anatomi som mulig. Medisinsk-teknisk avdeling sin 3D-lab har de siste årene levert en tjeneste hvor DICOM (pasientbilder) konverteres til en utskriftbar fil som gjør det mulig å levere fysiske utgaver av beinbrudd, nyresvulster eller annen anatomi til de som skal behandle pasienten.

3D-utskrift eller VR

Noen ganger er det derimot ikke nødvendig med en fysisk modell, eller for knapp tid til å vente på produksjonen. I disse tilfellene ønsker Haukeland universitetssykehus å finne gode og stabile VR-løsninger for å demonstrere pasientmodellene til klinikerne.

Den virtuelle viewer

Løsningen på dette ligger i å utvikle en virtuell viewer hvor pasientmodellen kan håndteres av medisinsk personell i et VR-miljø som er tilpasset deres behov. Eksisterende løsninger på markedet er for komplekse eller oppfyller på andre måter ikke de behovene som vi anser som kritisk for demonstrasjon.

INNOVASJON I HELSE VEST

Verktøy for visualisering av sammenstilte romlige marine data

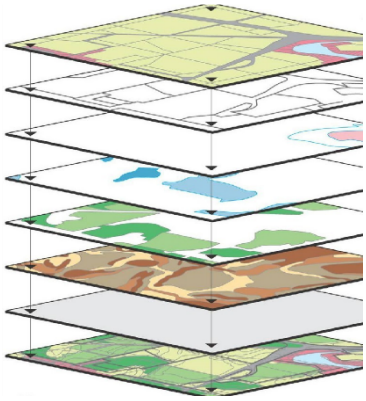
Research group: Collaboration, Interaction and Graphics
(https://www.hvl.no/forsking/gruppe/samarbeid-interaksjon-og-grafikk/),
(https://ict.hvl.no/research/computer-graphics/)
Internal supervisors: Harald Soleim (harald.soleim@hvl.no), Atle Geitung (atle.geitung@hvl.no),
(Daniel Patel (daniel.patel@hvl.no)).
External supervisor: Sam Subbey (samuels@hi.no)

Mål

Hovedmål: Lage et verktøy for visualisering og sammenstilling av romlige data fra ulike kilder.

Delmål: Undersøke metoder for romlige datainterpolering av data, når et eller flere datasett som skal sammenstilles mangler informasjon i overlappende områder.

Bakgrunn



Overvåking og datainnsamling er helt nødvendig for en helhetlig forvaltning av fiskeresusser i fjordene og havområder. Havforskningsinstituttet (HI) har derfor, fra år til år, drevet med overvåkingsaktiviteter i disse områdene. Ved å koble f.eks., data fra de oseanografiske og biologiske undersøkelsene som gjennomføres på de samme toktene, kan vi skaffe oss unike tverrfaglige kunnskap om det marine miljøet. Sammenstilling av data over tid gir informasjon om f.eks., faretruende endringer i havet. Det er en utfordring når data som skal sammenstilles er samlet inn fra ulike plattform (kilder) der kildene har forskjellige (rom/tid) oppløsninger.

Oppgavebeskrivelse

I denne oppgaven ønsker vi å lage et verktøy som gjør det mulig å sammenstille romlig data fra forskjellige kilder. Verktøyet må kunne lage flere overlappende lag med romlige data (se figur), og håndterer både dynamiske og statiske data. Det skal være mulig å bruke rom/tid avgrensning av visualiseringen. Videre, må det være mulig å fryse et eller flere data-lag i tid. Verktøyet skal brukes til å besvare en del økologiske spørsmål, som for eksempel, om det finnes kobling mellom romlige endringer i temperatur og mønstre av fiskeutbredelser. En prototype av verktøyet skal bruke data tilknyttet loddebestanden i Barentshavet.

TILLEGGSINFORMASJON

- Oppgaven passer bra for to (2) studenter som ønsker å jobbe i lag
- Studentene får kontorplass ved HI (Nordnes) i forskningsgruppen «Fiskeridynamikk»
- Samarbeid med forskere (oseanografer, biologer, økologer og dataingeniører) blir sentral

Høgskulen
på Vestlandet

03.11.2020

Spillutvikling – Resuscitering av nyfødte (Master i jordmorfag, HVL)

Bakgrunn for prosjektet

Resuscitering av nyfødte er en situasjon som studentene sjeldent eller aldri får erfare i klinisk praksis. Til tross for dette er det forventet at en nyutdannet jordmor har både kompetanse og ferdigheter knyttet til resuscitering av nyfødte barn. En slik kritisk situasjon kan oppstå uventet og det er derfor nødvendig at jordmødre og annet helsepersonell er godt forberedt og har kompetanse i bruk av de nødvendige prosedyrer som kreves i en slik situasjon.

Gjennom SIM-Arena og de ressursene vi har der kan studentene simulere på denne situasjonen, og gjennom simulering trene på den aktuelle algoritmen for gjenoppliving av nyfødte barn. Utfordringen knyttet til simuleringstreningen er at studenten sjelden utfordres på å ta en beslutning i tillegg til å øve på de tekniske ferdighetene.

Vi planlegger derfor å lage et VR-spill basert på algoritmen fra Norsk Resusciteringsråd, med et variert antall av pasientscenarier. Når stress og tidspress er en faktor er det viktig å ha tilstrekkelig trening i prosedyrer og fremgangsmåter, slik at man tar den rette beslutningen knyttet til relevant tiltak - et slikt spill vil kunne bidra i å sikre studentenes kompetanse og trygghet, samt muligheten til å trene uavhengig av lærer, tid og sted.

En gruppe på 3 studenter hadde dette som Bachelorprosjekt i 2020 og utviklet en prototype, som er en veldig god basis for videre utvikling.

Vårt forslag til masterprosjekt 2022 er å videreutvikle prototypen der hensikten med prosjektet er å utvikle et VR-basert simuleringsverktøy for resuscitering av nyfødte.

Vi ønsker mer autentisk miljø og øke spillbarheten

Mulige fokusområder for bacheloroppgave:

- Virtuell guiding/veiledning av brukeren
- grafisk forbedring, mer realisme
- stimulering av baby
- forbedre interaksjon
- scenariobygger og registrering
- utvide muligheten til å dekke andre aldersgrupper

Arbeidsoppgaver

Utvikle beskrevet læringsspill i unity. Primært for VR (oculus quest 2, men muligheter for andre platformer bør tas hensyn til.

Spilleren får presentert en nyfødt som i en eller annen grad har behov for livreddende førstehjelp. Informasjonen er begrenset til respirasjon, hjertefrekvens, tonus, refleks og hudfarge (apgar score).

Spilleren ser babyen liggende foran seg på skjermen og hun/han må ved hjelp av audiovisuell input tolke behov for livreddende tiltak, og ut fra den informasjonen vurdere hvilke tiltak som skal iverksettes. Studenten kan velge mellom tiltak som stimulering, frie luftveier, sug, innblåsing/ventilering, hjertekompresjoner, tilførsel av iv væske, blod osv. Studenten må utføre hjerte lungeredning der han/hun blant annet skal sørge for frie luftveier, sikre hodeleie og iverksette innblåsinger eller kompresjoner i riktig takt og med korrekt antall repetisjoner.

Tilstanden til pasienten påvirkes av spillerens valg og målet er å redde pasienten. Om studenten skulle gjøre valg som vil dramatisk forverre situasjonen vil spillet ende i at en virtuell kollega/lege gripe inn og redde situasjonen.

Alle valg vil bli fortløpende registrert og i debrifing etter endt øvelse vil disse bli vurdert opp mot en fasit. Studenten kan også bli bedt om å vurdere egen innsats i en refleksjonsnotat på slutten av spillet.

Eksempel på ønsket funksjonalitet: Hjertekompresjoner gjøres f.eks ved å trykke på riktig plass på brystkassen, i korrekt tempo og riktige antall kompresjoner. Tilsvarende teknikk kan også anvendes for innblåsing.

Vi har også tanker om hvordan dette kan utvides og tilpasses pasienter i alle aldre og tenker at dette fint også kan utvides til et masterprosjekt.

Kontaktpersoner

Liv Irene Ruud - Faglig koordinator SimArena – fakultet for helse og sosialvitskap. Underviser i Simulering HLR/AHLR - nyfødt/barn/voksne.

Katrine Aasekjær – førstelektor ved institutt for helse og omsorgsvitskap – Master i jordmorfag. Underviser i grunnleggende jordmorfag, med fokus på studentaktive læringsformer og bruk av digitale ressurser i undervisningen. Har ansvar for simuleringstrening ved utdanningen, og er opptatt av at studentene i tillegg til å lære seg kliniske ferdigheter også utvikler evnen til å ta en beslutning.

Kan kontaktes på kaaa@hvl.no

Ivar Rosenberg - prosjektleder e-læring, Fakultet for helse og sosialvitskap siden 2015. Er medlem i VR-teamet på FHS. Har 10 års erfaring med e-læring og utvikling og bruk av interaktiv 3d I oljebransjen.

Kan kontaktes på ivar.rosenberg@hvl.no Mobil: 93617784

Veiledere : Atle Geitung, atle.birger.geitung@hvl.no Harald Soleim , harald.soleim@hvl.no

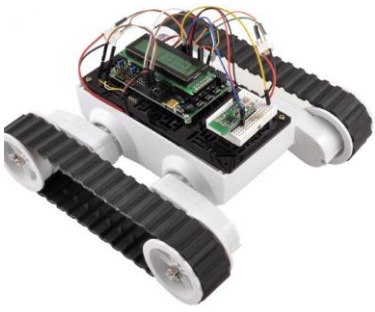
Robot modeling and programming

Simulations based on models have proven successful in many areas such as automotive and aerospace industry, where the final goal is to create physical systems with the same behaviour as the models. However, as those systems get more sophisticated, the need for better modelling languages and simulation tools, as well as automatic transformation from the models into the target technologies, has become paramount. The goal of this Master Thesis is to build better tools and abstractions for modelling of scenarios involving autonomous, heterogeneous robots with collaborative behaviour and distributed communication, including automatic code generation into different target platforms, like Ardupilot, ROS, etc. The idea is to define a language for definition of workflows where actions are specified graphically. The ICT Engineering group also owns a set of Arduino robots, CrazieFlie drones, an ErleRobotics drone, Rovers, etc. See also previous master theses at https://ict.hvl.no/wirom/

In this Master thesis, a prospective student should improve the modelling environment by performing the following tasks. Introduce additional useful abstractions for robot behavior on a platform-independent level. Allow for the customization of the behavior and code, based on the target platforms and the available hardware of the robots (sensors, motors, and actuators). Additionally, students may be interested in distributed cooperative systems of robots, or formal verification of the models according to correctness, energy consumption, or time constraints.

See also https://github.com/FabianSchuessler/DroneProject and http://ict.hvl.no/master-thesis-robot-programming-and-modelling/

Contact person: Adrian Rutle (aru@hvl.no)



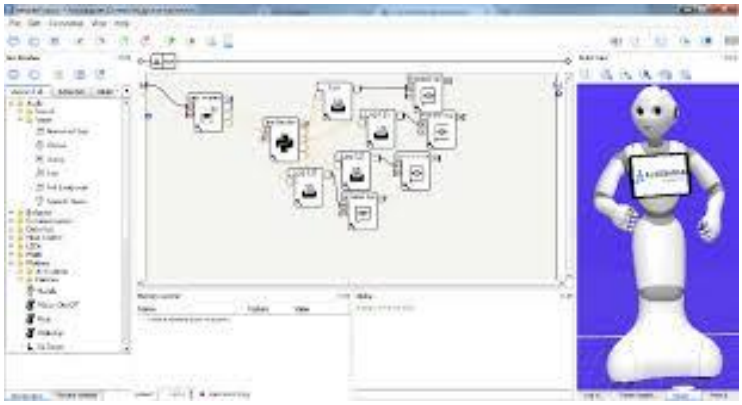
Project Title: **Robot based interaction between remote caretaker and patient**

Adviser: Marcus Landschulze, marcus.landschulze@hvl.no, E403

Co-Adviser: Knut Øvsthus, Knut.Ovsthus@hvl.no and someone from Haukeland Hospital/Alrek

HVL Research Group: Automation & Robots, Software engineering, Center for Care Research, West

Objective: For many years are robots around hospitals and give surgeons steadier hand for delicate medical procedures or help nurses in their daily work. Today are robots finding their way into healthcare-technology and will interact with patients in new or different ways. Robots act as an around-the-clock sitter, assist frail and elderly patients out of bed or chair or provide entertainment.
In this master project you will investigate the feasibility whether it is possible to connect a distant caretaker or doctor via the robot to a patient or someone with special needs. The focus is to build an interface where the caretaker verbally interact with a patient via the robot and simultaneously controls emotional movements (body language) of the robot with a web-interface.
The outcome of this project will be used to write a research application for the next level, the autonomous interaction. If the project gets funding from the Norwegian Research Council / EU we will enroll a PhD position possibly for you.



Research Questions: In this thesis you will develop a software interface/program to provide verbal communication from the caretaker to the patient via the robot. In the second step you will program a Pepper robot via Choregraphe which allows you to control the robot in a virtual environment. The final step will be to build a web-interface where a caretaker can control the robot movements of Pepper by pressing e.g. emoticons and test it under “real” conditions possibly at Haukeland hospital/Alrek.

Further information:

Getting started with virtual Pepper robot & Choregraphe:

https://www.youtube.com/watch?v=ubMuqIF9yRY

or in more detail:

https://www.youtube.com/watch?v=wSoGO1iL_v4

Documentation:

http://doc.aldebaran.com/2-4/software/choregraphe/index.html