

An overview of research

Robotics and Intelligent Systems group



Robotics and Intelligent Systems (ROBIN)



Jim Tørresen
Professor, Group leader



Mats Høvin
Assoc. Prof.



Kyrre Glette
Assoc. Prof.



Kai Olav Ellefsen
Assoc. Prof.



Yngve Hafting
Ass. Prof.



Vegard D Søyseth
Principal Engineer

Postdocs:
Frank Veenstra (IFI)



Michael Joseph
Krzyzaniak (RITMO)



Ulysse Côté-Allard
(INTROMAT)



Hoang Minh Pham
(INTROMAT)



Diana Saplacan
(VIROS)



Adjunct positions (20%):

Alexander Wold (assoc.prof.)

Charles Martin (assoc.prof.)

Ole Jakob Elle (Prof.)

Roar Skogstrøm (lecturer)

Ståle Skogstad (assoc.prof.)

Tønnes Nygaard (lecturer)

PhD students

(ROBIN main superv.):

Adel Baselizadeh

Benedikte Wallace (RITMO)

Bjørn Ivar Teigen (DOMOS)

Eivind Samuelsen

Emma H Stensby

Farzan M. Noori

Julian Fuhrer (RITMO)

Katrine Nergård

Marieke van Otterdijk

Mojtaba Karbasi (RITMO)

Tom Frode Hansen (NGI)

Students: Bachelor ~200; Master: ~58
Robotics and Intelligent Systems program

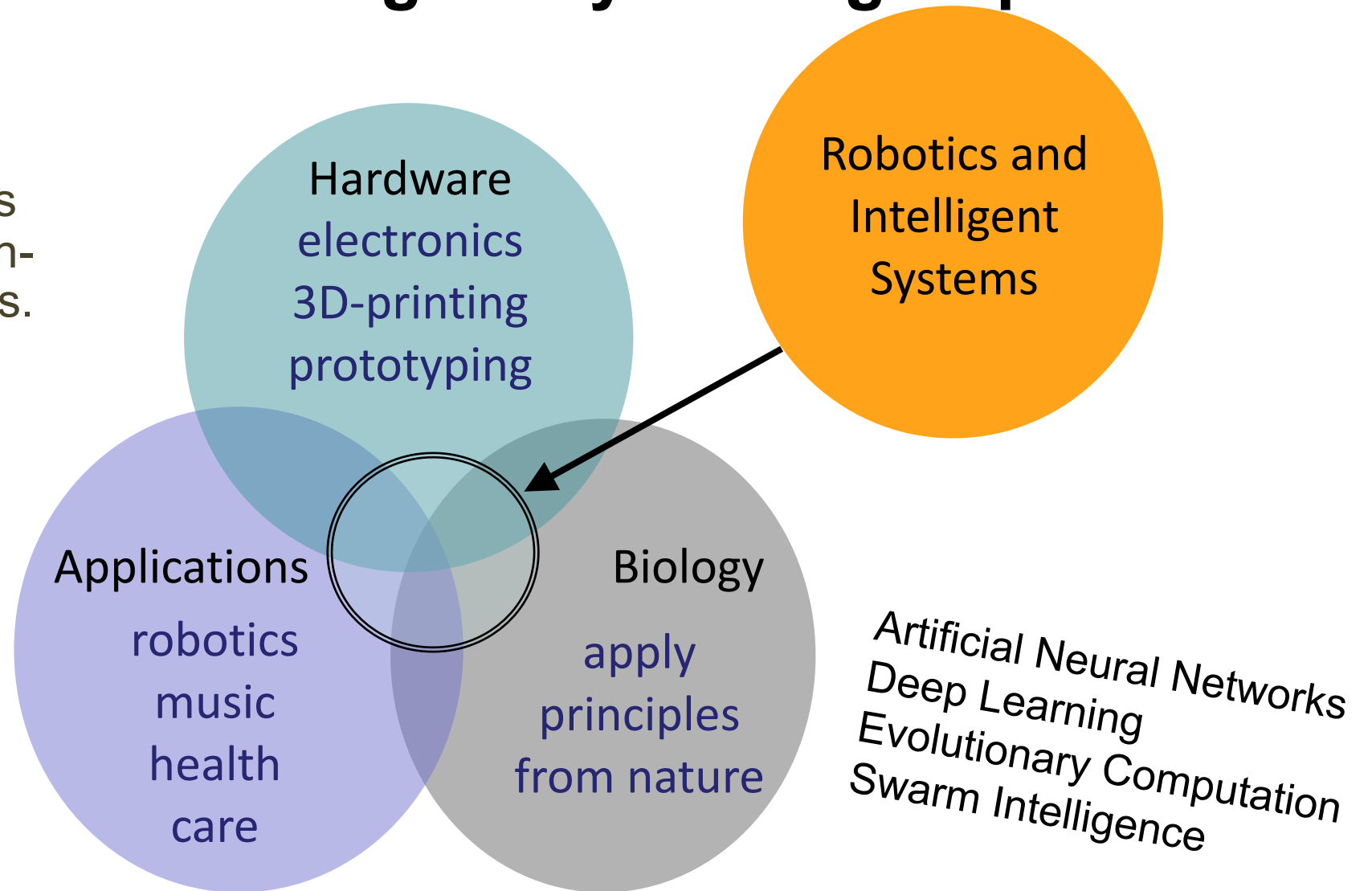
Students hired on hourly basis:
Magnus E. Seierstad

Visiting researchers

Robotics and Intelligent Systems group

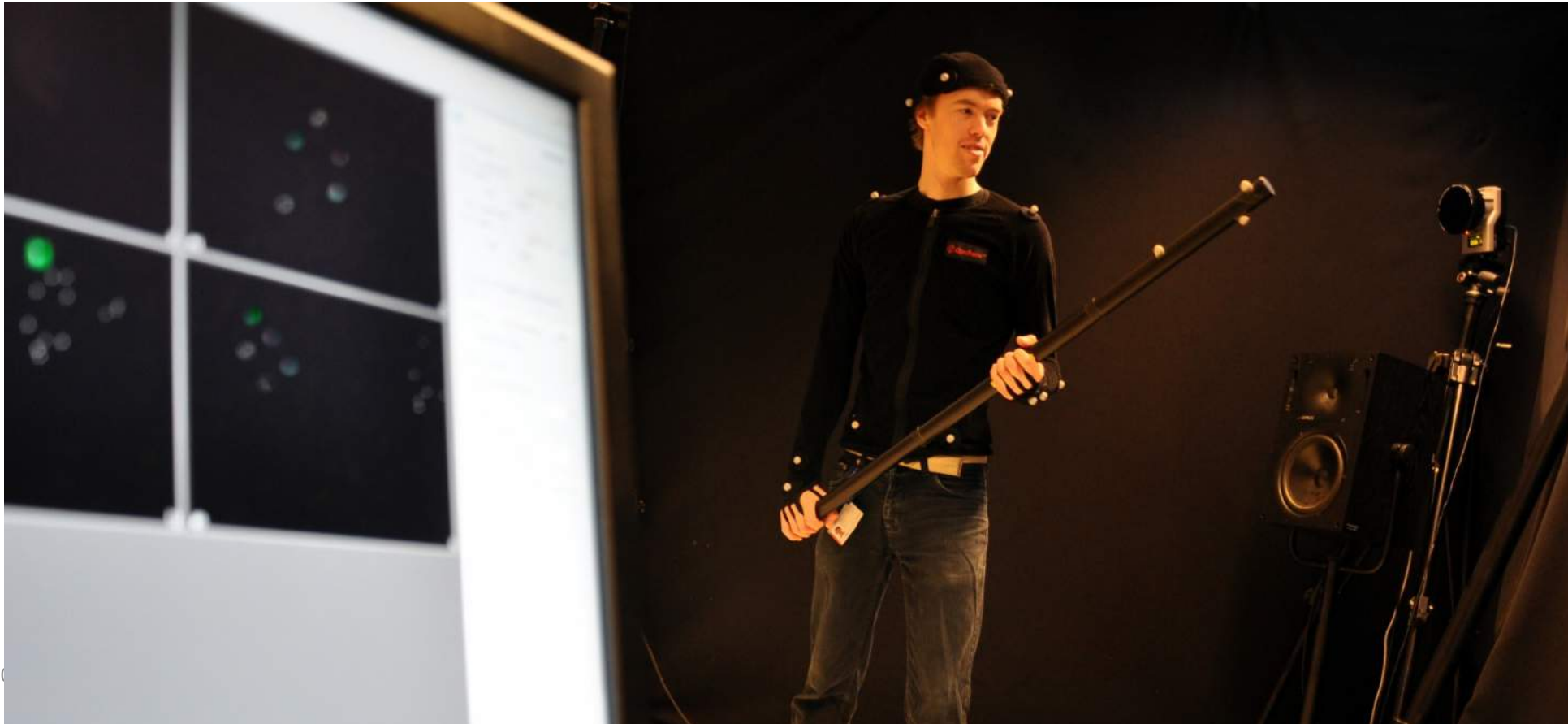
ROBIN

Creating systems
for demanding run-
time environments.



Motion Capture Facilities (ROBIN)

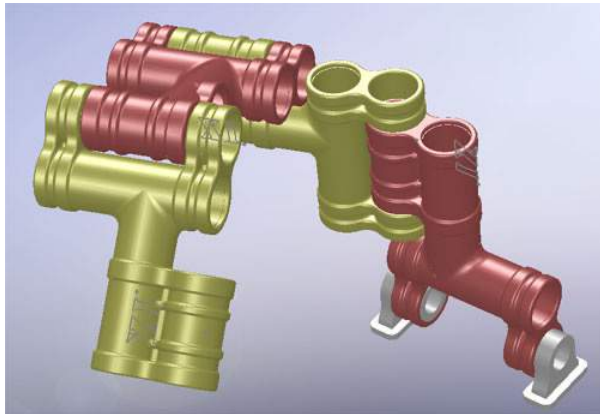
- Allows precise tracking of human and robot motion
- Camera-based and on-body motion capture



Rapid Prototyping Facilities (ROBIN)



- 3D printers and milling machines
- Large potential for developing innovative robot systems.



Rapid Prototyping Facilities

3D-printers (ROBIN)



HP Jet Fusion 540

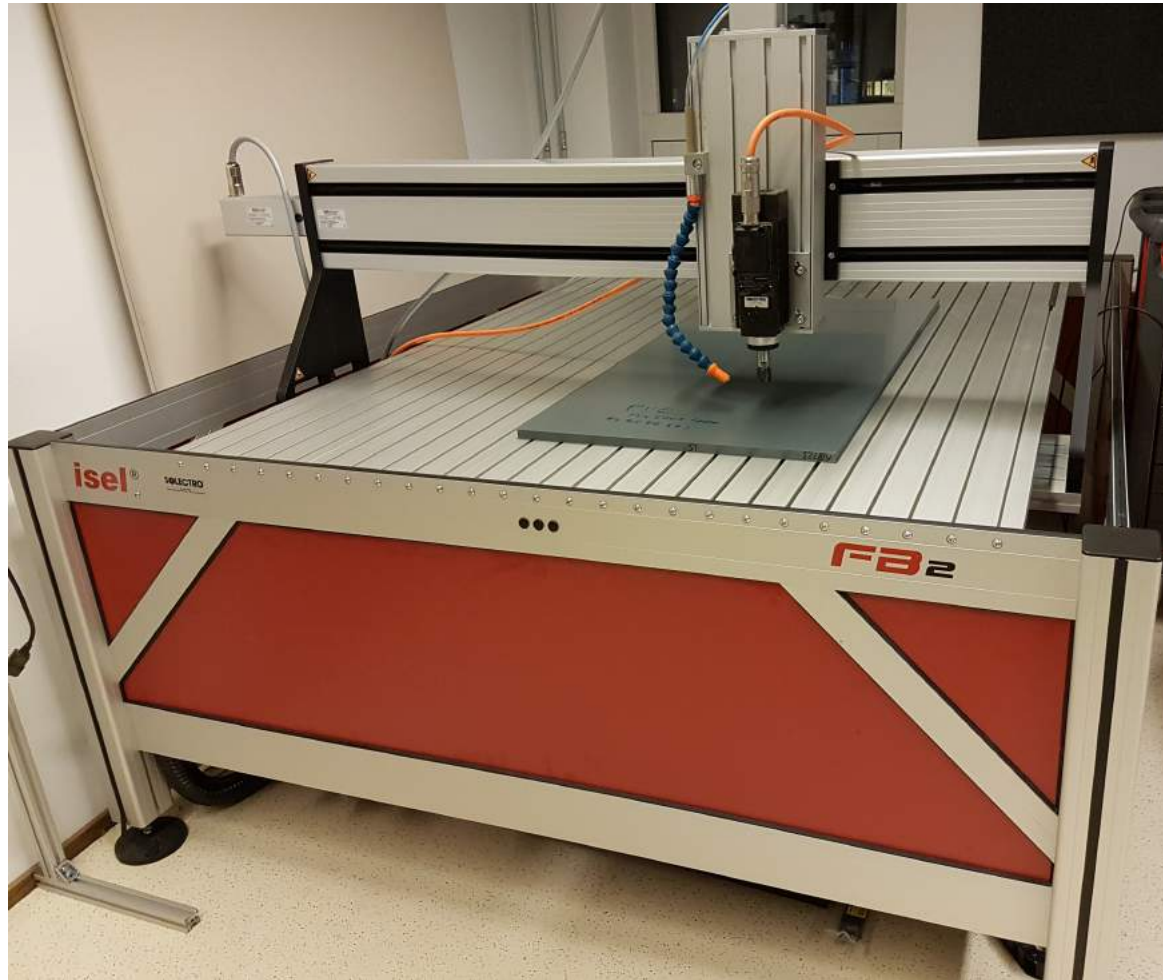


Markforged Mark X
(carbon fiber 3D printer)



Rapid Prototyping Facilities

Milling Machines (ROBIN)



Robotics and Intelligent Systems (ROBIN) research group

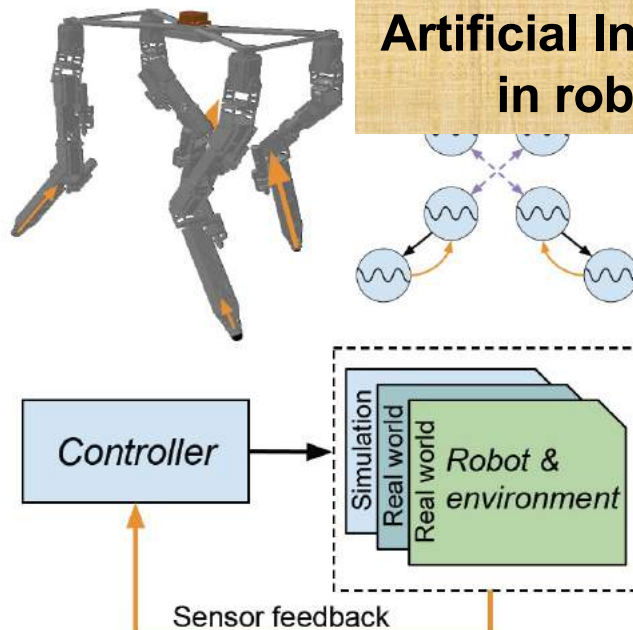
Artificial Intelligence
in smartphones

Interactive music

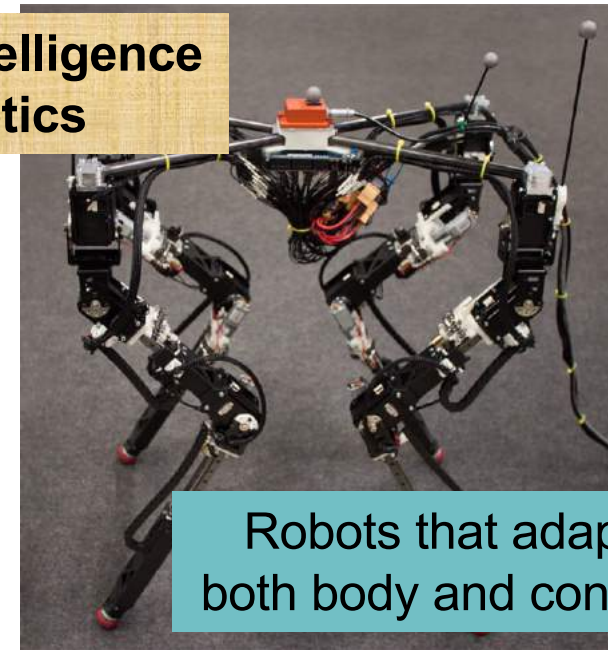
Adaptive and autonomous
mental health treatment



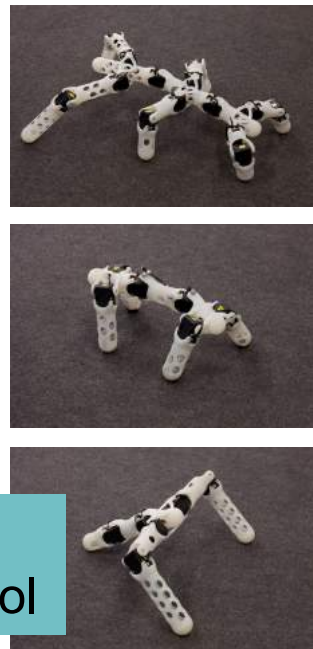
Robots that look after older
single people living at home



Artificial Intelligence
in robotics



Robots that adapt
both body and control



ROBIN group: AI and Machine Learning Techniques

- Feature Extraction (PCA variants, OpenPose, ++)
- Deep learning
 - Classification: CNN
 - Forecasting: RNN
- Deep reinforcement learning (robot control)
- Evolutionary computation (robot design and control, neuroevolution)
- Neuro-fuzzy systems (robot control)
- Transfer learning/user adaptive models
- Training with sparse data (oversampling)

ROBIN Research Projects and Centre Funded by the Research Council of Norway

- Prediction and Coordination for Robots and Interactive Music (EPEC, 2015-2019, FRIPRO)
- Multi-sensor Elderly Care Systems/Robots (MECS, 2015–2020, IKTPLUS)
- INtroducing personalized TReatment Of Mental health problems using Adaptive Technology (INTROMAT, 2016-2021, LightHouse project)
- **Vulnerability in the Robot Society** (VIROS, 2019-2023, IKTPLUS)
- **Predictive and Intuitive Robot Companion** (PIRC, 2020-2025, IKTPLUS)
- **Centre of Excellence for Interdisciplinary Studies in Rhythm, Time and Motion** (RITMO, 2017-2027, CoE)



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RITMO Centre of Excellence for Interdisciplinary Studies in Rhythm, Time and Motion grant 262762 (2017-2027)

- The center will study the **perceptual, cognitive** and **acting mechanisms** underlying our ability to experience rhythm and act rhythmically.
- Interdisciplinary **collaboration** between **musicology, psychology, computer science** and **robotics**.
- Machine learning and robotics to be applied

<https://www.uio.no/ritmo/english>



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TIME



MOTION



RHYTHM





Four RITMO Clusters

- **Interaction and pleasure**

- Understand why rhythms make us move, and how rhythm facilitates entrainment and interaction.

- **Structure and time**

- What are the basic features of musical rhythm and how do rhythm influence our experience of musical time

- **Structure and cognition**

- How are rhythm and our sense of time constructed in the human mind?

- **Interaction and robotics**

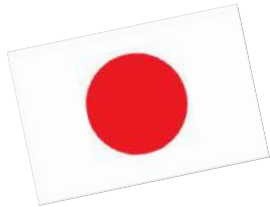
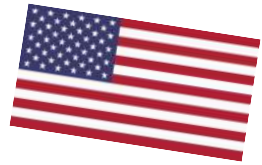
- Investigate aspects of rhythm and motion through robotics and technology



Collaboration on Intelligent Machines

Norway ↔ US, Brazil and Japan

Project manager: Jim Torresen



- Short term mobility stay for meetings
- Sharing and development of curriculum and teaching material for courses
- Long term mobility stay (students)
- Intensive course/student workshop
- Workshop/conference org. activities
- New collaborations/guest lectures (can be in Canada, China, ++)

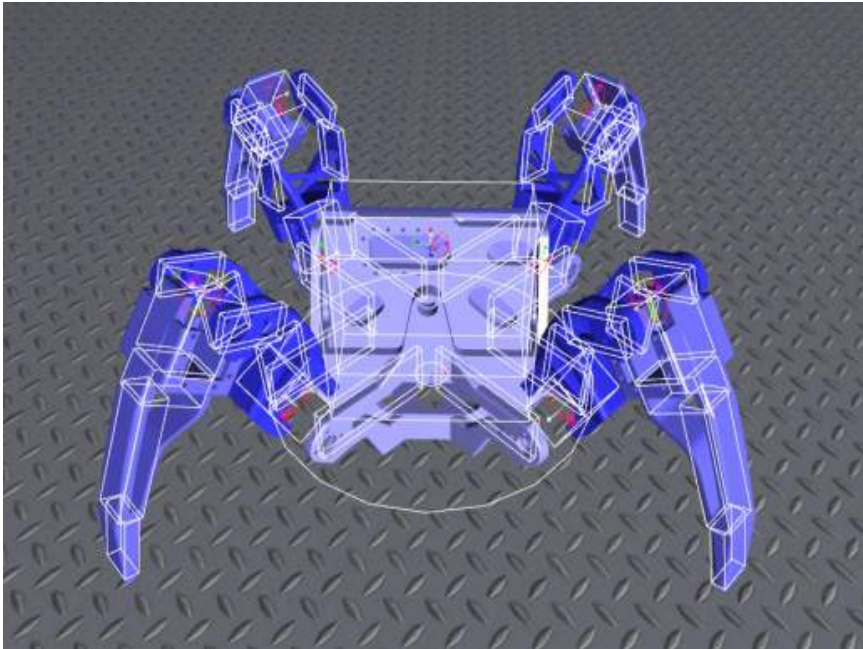


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Funding: INTPART 2017-2024



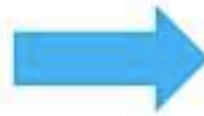
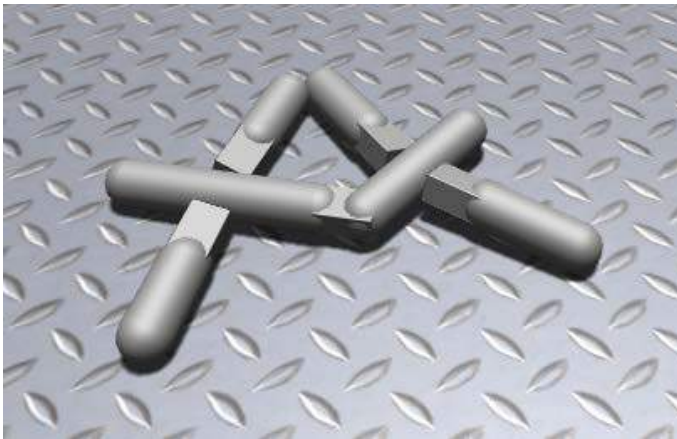
Robot Design, Simulation, Assembly and Evaluation



- Work with real robots and simulations.
- Reduce gap between simulation and reality.
- Create novel methods for design (e.g., evolution) and dynamic body shapes (morphology).

Evolved Robot Design

- Robot bodies could be difficult to design by hand.
- We use evolutionary algorithm to evolve both body and control system simultaneously.



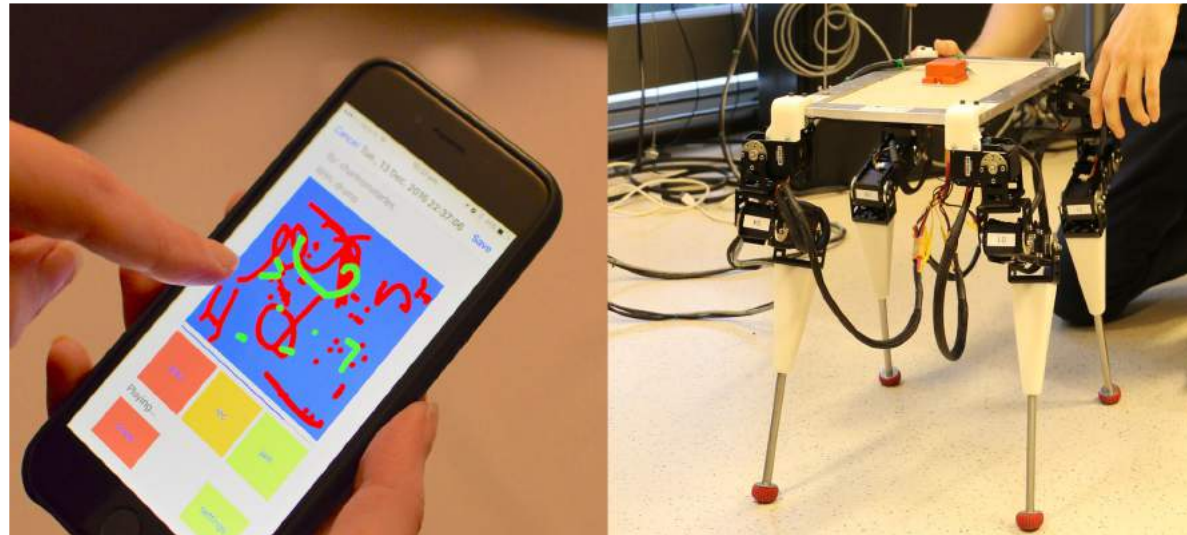


<http://uk.reuters.com/video/2015/06/15/3d-printed-robots-adapt-themselves-to-th?videoid=364592612>



EPEC: Prediction and Coordination for Robots and Interactive Music

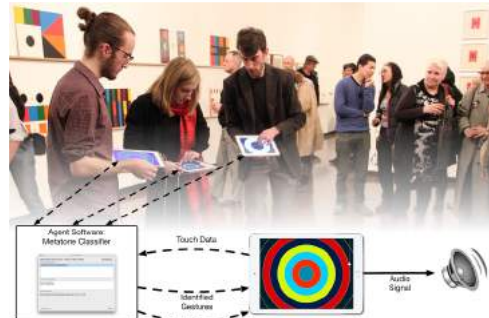
Research Council of Norway grant 240862.



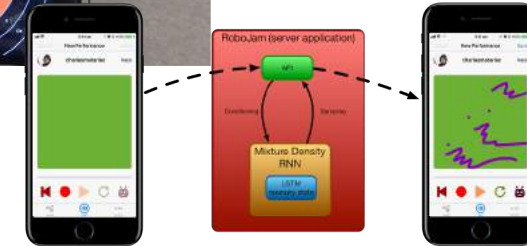
<https://www.hf.uio.no/ritmo/english/projects/all/epec/>

Goal: *Design, implement and evaluate **multi-sensor systems** that are able to **sense, learn and predict** future actions and events.*

Predictive Musical Interaction



- How can **musical instruments** be more “**intelligent**”?
- What would that mean for **musicians, music making, and music**? *microjam.info*



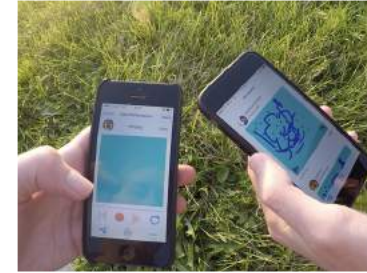
Music and Research

We make new musical instruments, measure musical experiences, find new ways to express ourselves with technology.

Why?

- Expression and creativity is important.
- Music is everywhere; people care about it.
- Music is hard; realtime, high standards.

You don't have to be a professional musician to do a great musical project!



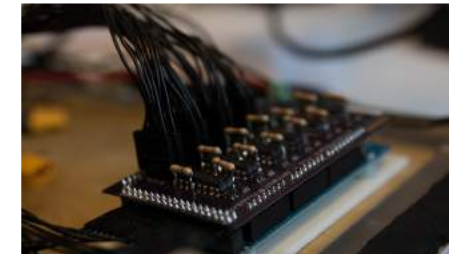
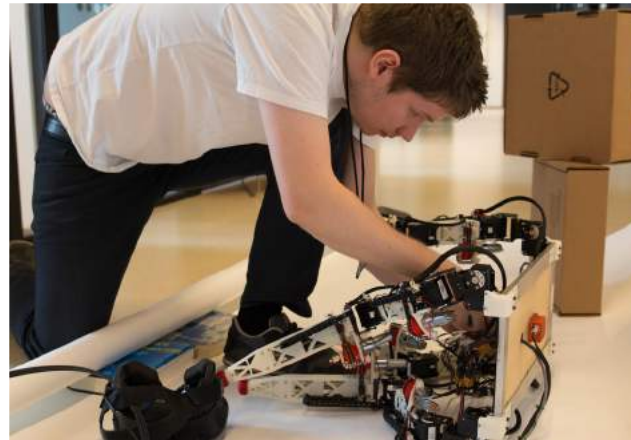
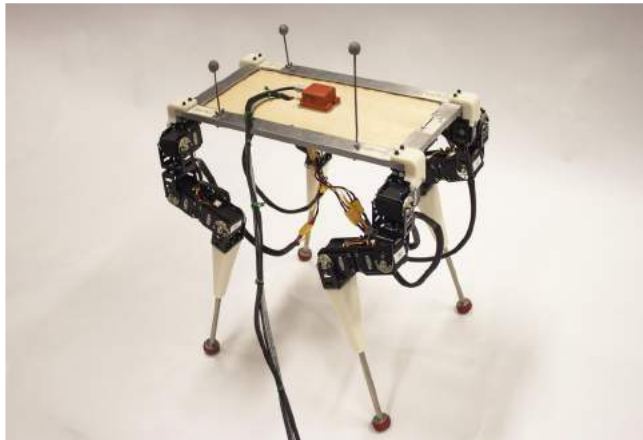
Dyret: A low-cost self-modifying quadruped

<https://www.youtube.com/watch?v=fit4c3dMqQk>

- Our most advanced legged robot to date
- Used for evolutionary experiments and research in self modelling and control

Evolutionary multi-objective
optimization in hardware for
stable and fast quadruped
robotic locomotion

Results from
evolutionary experiments



An experiment from the paper "Real-World Evolution Adapts Robot Morphology and Control to Hardware Limitations"



For more information,
please see robotikk.net

<https://www.youtube.com/watch?v=HoHPIWjTcBU>



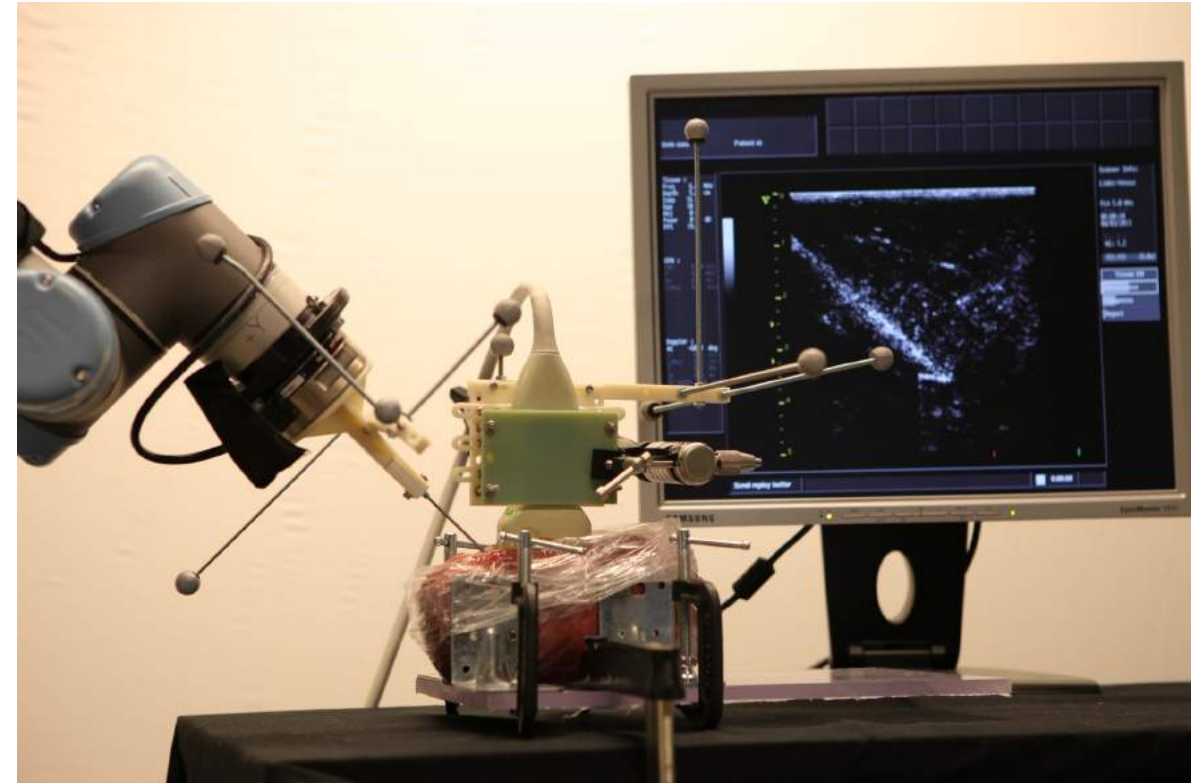
<https://www.youtube.com/watch?v=DLVc0JOWaUM>

Robot Surgery (National University Hospital)

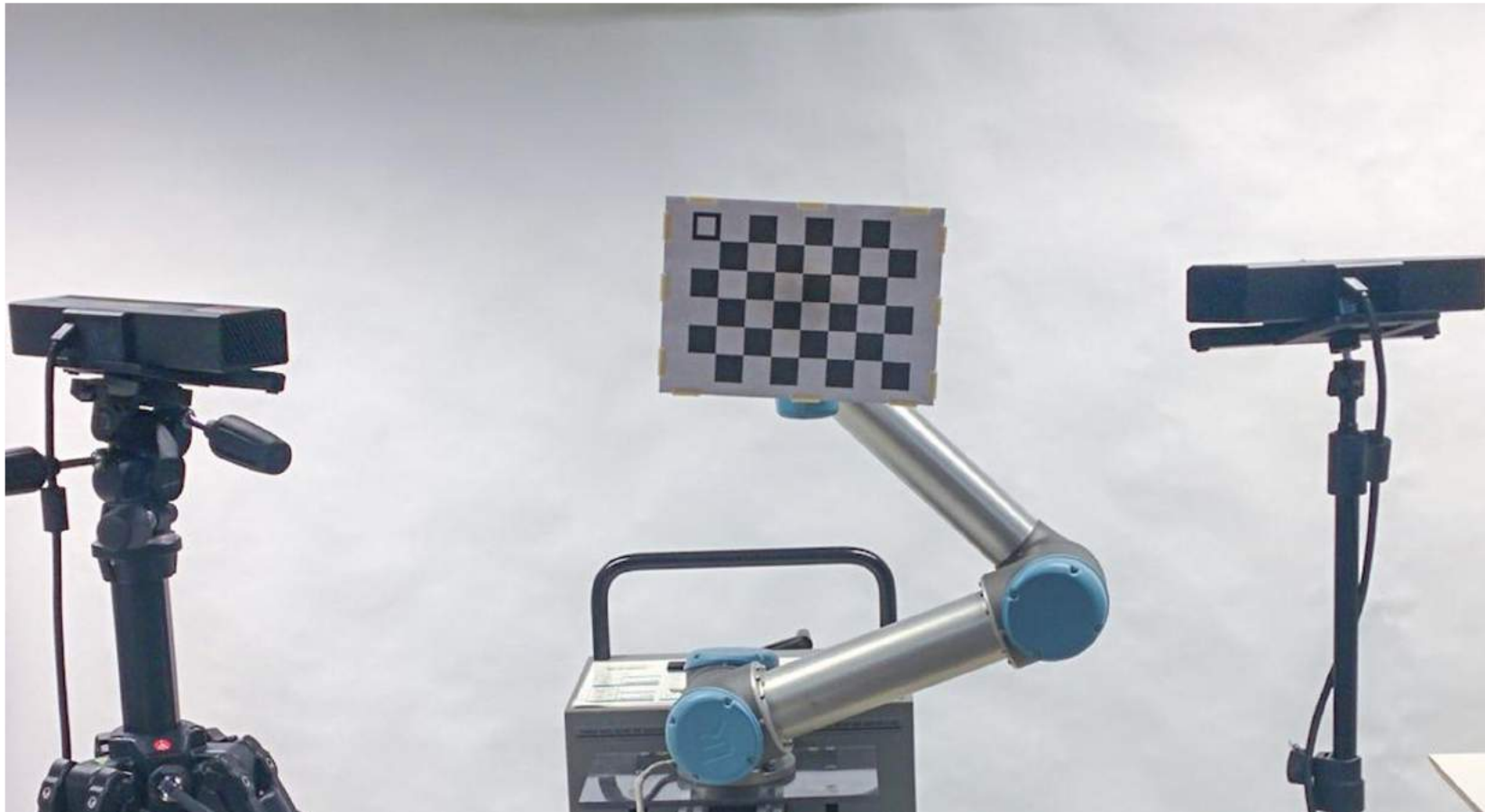
Ole Jakob Elle (ROBIN)

Interaction:

- Robot-Robot
- Human-Robot



Environment Aware Robotics System by PhD student Justas Miseikis (ROBIN, 2019)



INTROMAT: INtroducing personalized TReatment Of Mental health problems using Adaptive Technology (2016-2021)

Research Council of Norway grant 259293



Goal: Increase access to **mental health** services for common mental health problems by developing **smartphone technology** which can **guide patients**.

<http://intromat.no>

Project Manager:

Haukeland Univ. Hospital, Bergen

Funding: *IKTPLUSS Lighthouse,
Research Council of Norway*



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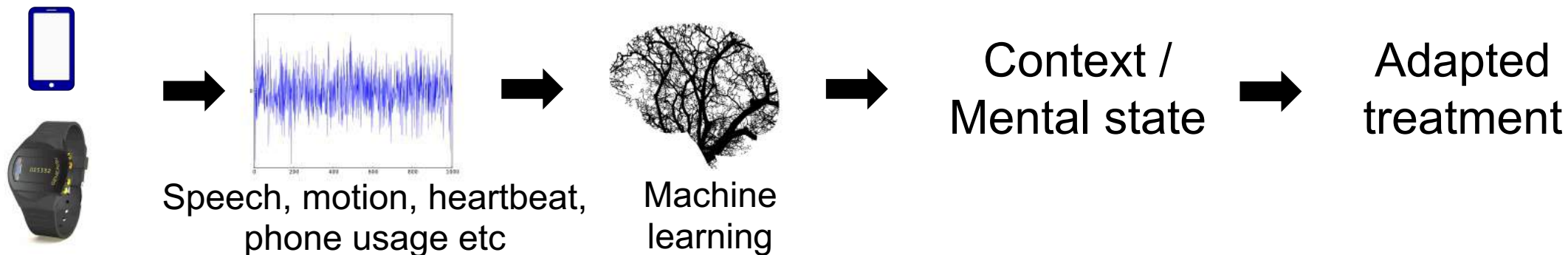
5 cases/disorders

- Relapse prevention for **bipolar disorder**
- Cognitive training in Attention Deficit Hyperactivity Disorder (**ADHD**)
- Job-focused treatment for **depression** in adults
- Early intervention and treatment for **social anxiety** disorder in adolescents
- **Psycho-social support** for women recovering from gynecological **cancer**.



Mental health monitoring and treatment (INTROMAT)

- Use of smartphones, wristwatches and virtual reality devices to monitor users' behavior.
- Analysis of sensor and behavioral data with machine learning.
- Context and mental states prediction for bipolar, anxiety and attention-deficit/hyperactivity disorders.
- Adapt clinical follow up and activate automatic treatments/training modules.





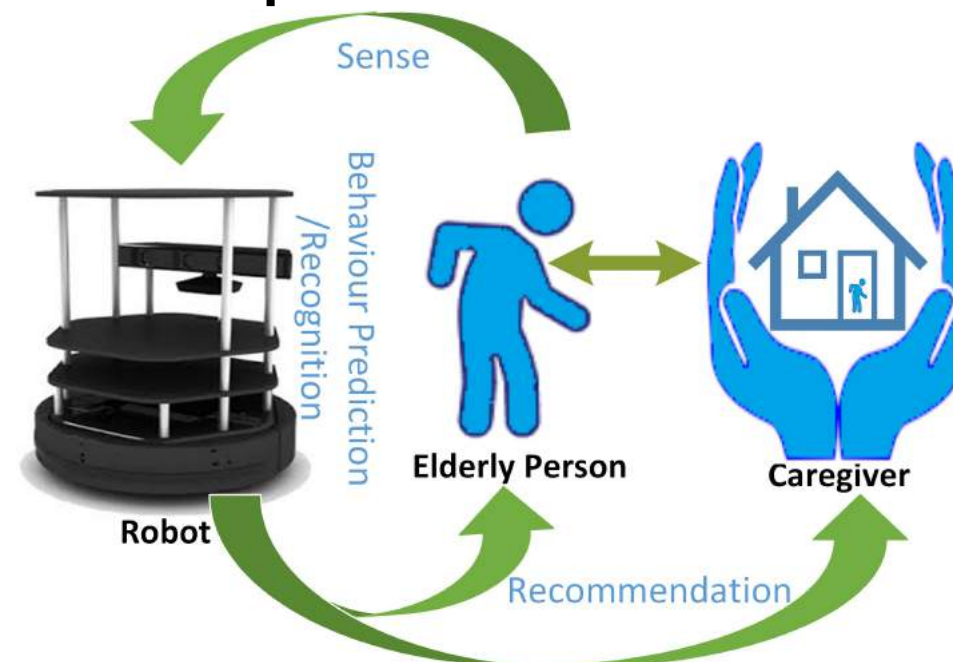
MECS: Multi-sensor Elderly Care Systems

Research Council of Norway grant 247697

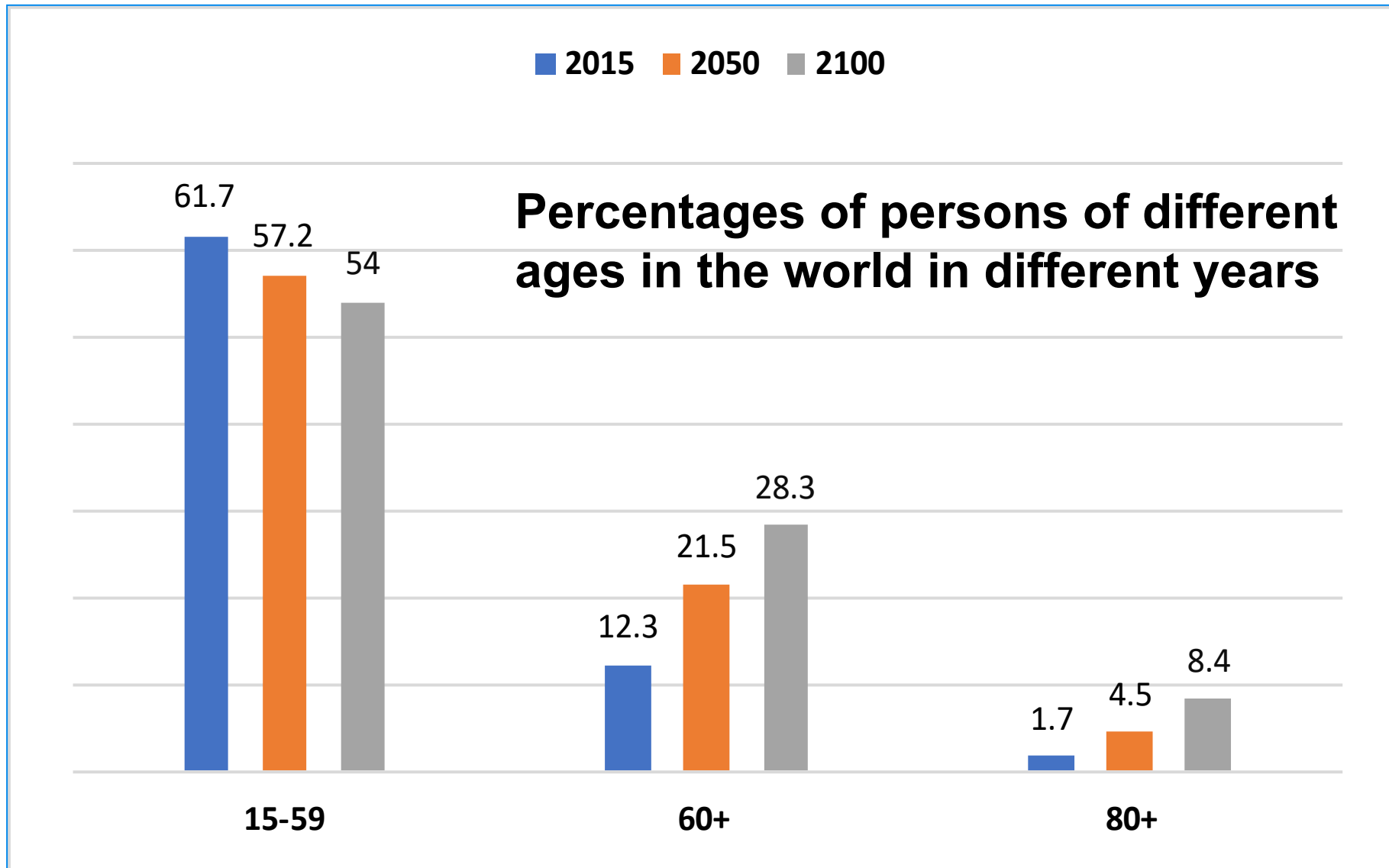
Goal: Create and evaluate multimodal mobile human supportive systems that are able to **sense, learn and predict** future events.



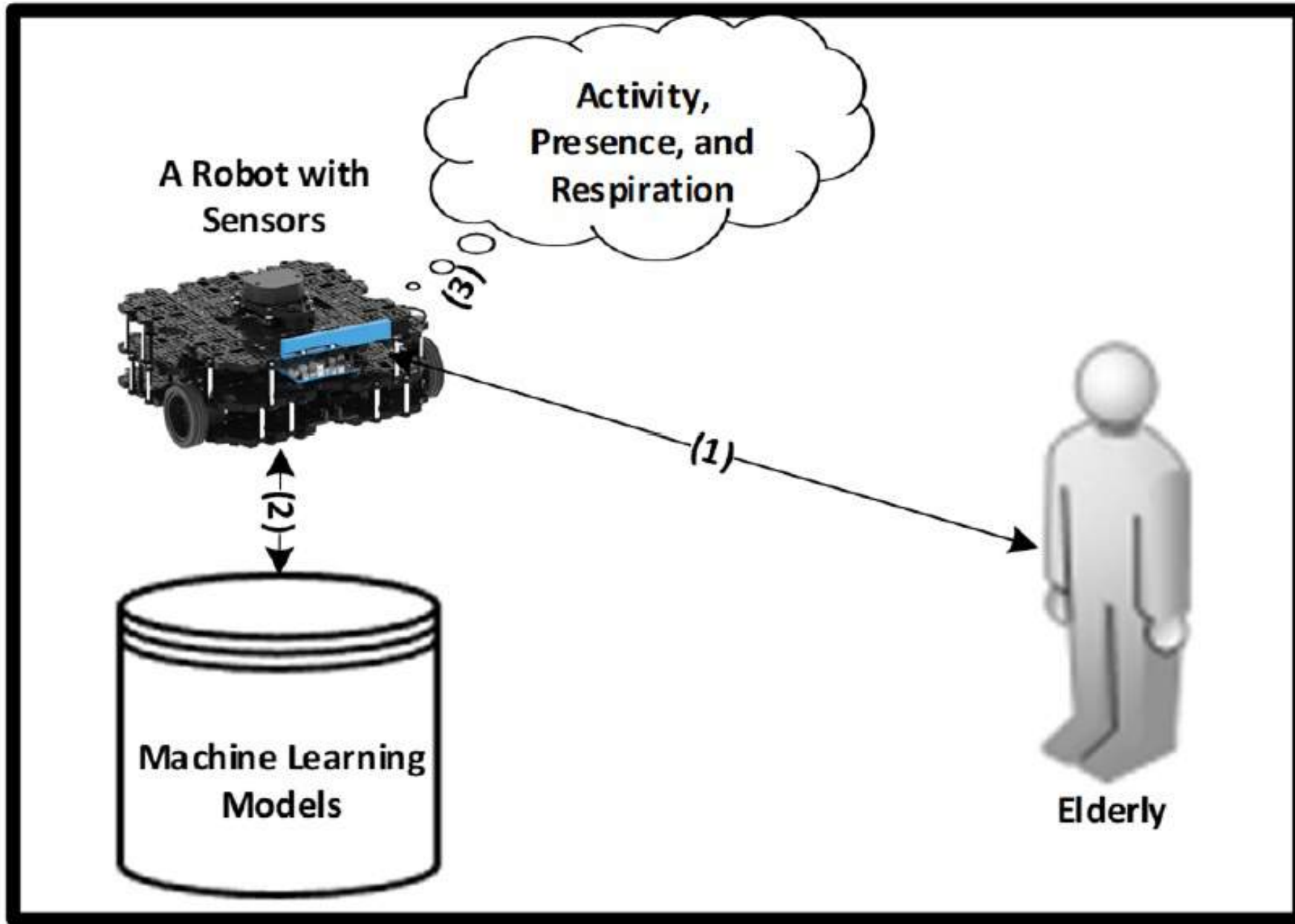
Funding: FRINATEK
Research Council of Norway



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United Nations (2015) World population ageing. United Nations, New York.





Elderly Care with Robot Companion

- Move from permanent and fixed room surveillance to **flexible and adaptive**
 - Increased privacy
 - Increased accuracy
- Active testing involving **real environments**
- **Detect and predict** falls and other non-normal situations to **notify caregiver**.
 - In emergency situations, the **robot** – rather than the elderly – **activates the safety alarm**.



User Centered Design – Participatory Design

- involve real users in **actual use contexts** (home of elderly)
- focus on behavior and **satisfying the needs** and desires of the users
- achieve improvements through **iterative testing and improvement**
- Oslo Municipality care facility: **Kampen Omsorg +**

MECS Researchers DESIGN + ROBIN group

Diana Saplacan
Rebekka Soma
Trenton Schulz



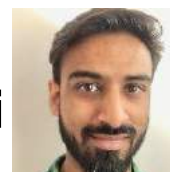
Jo Herstad
(DESIGN superv.)



Apply sensors that
provides non/less-
intrusive sensing



Farzan M. Noori
Md. Zia Uddin



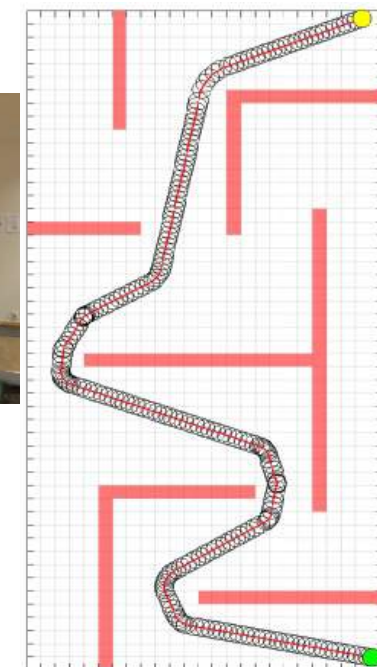
User needs and
preferences

+ Master students

Robot sensing

Robot control

Weria Khaksar



Navigation
without a
map



We are working with Kampen Omsorg+ to figure out what the robot should do and the general design of the robot

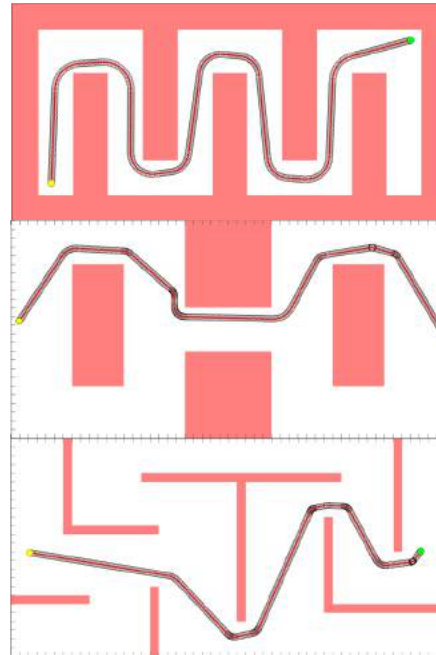


Navigation without a Map

- Having a mobile robot with 3D camera and/or Lidar.
- Moving in a completely unknown environment.
- Using the sensory information to build the path and navigate.
- Employing several AI tools including Fuzzy Logic and Genetic Algorithm

Challenge:

- Finding computationally cheap solutions with high quality.



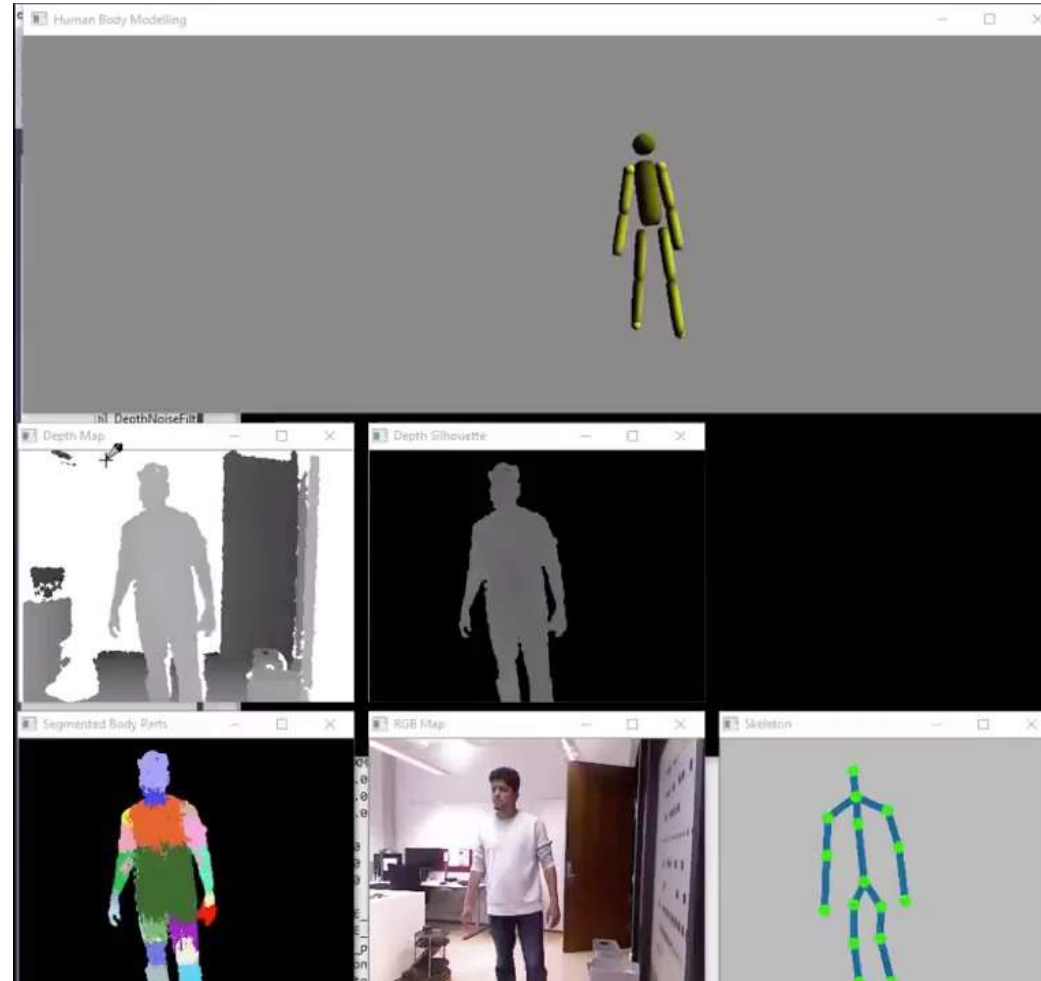


Real-time Tracking, Segmentation, and Modelling

- Deep Learning for body skeleton tracking in real-time.
- 3-d body modeling in real-time.



Depth Camera

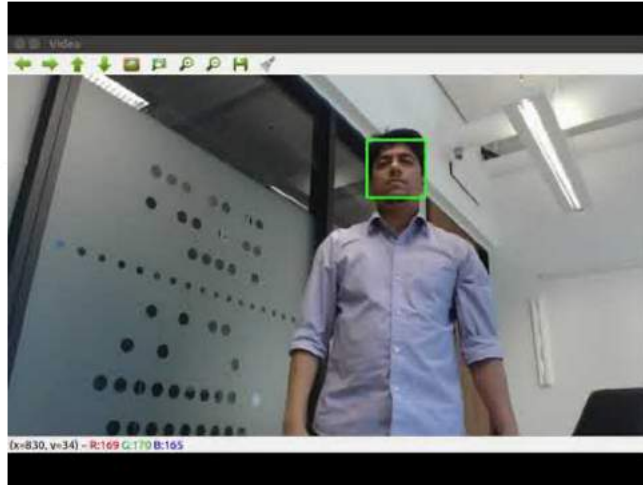




Real-time Face Tracking



RGB Camera



- Face tracking in real-time using RGB camera on a robot.
- Works well when there is enough light.

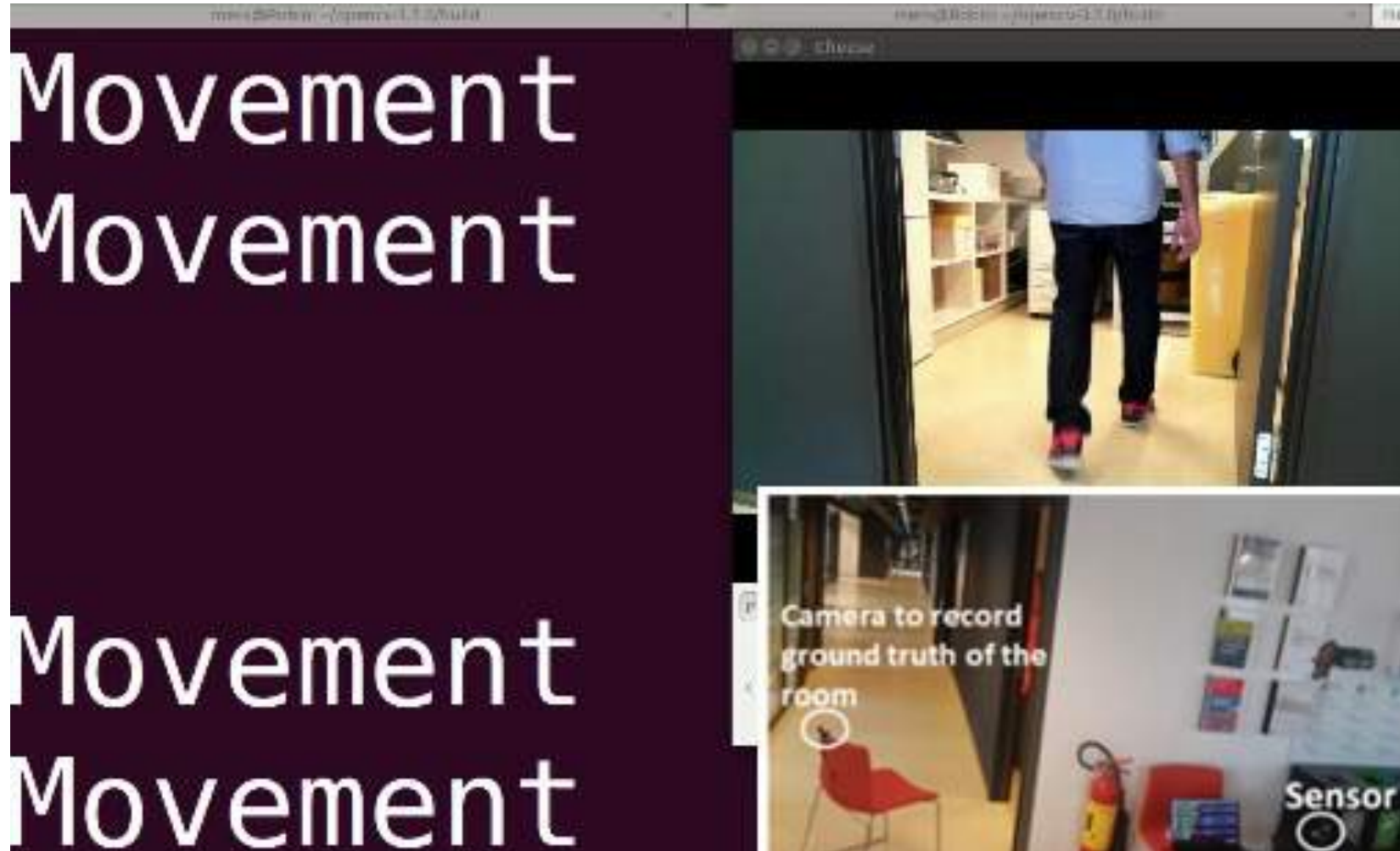


Thermal Camera



- Face tracking in real-time using thermal camera on a robot.
- Works well even in the dark.

Ultra-Wide Band (UWB) radar sensor see through walls





Ethical Concerns

1. privacy
2. security
3. safety
4. potential lack of contact with other humans

Ethical Countermeasures

- **Designers need to be aware of possible ethical challenges that should be considered**
 - e.g. select sensors protecting privacy and make the robot navigate in a safe way.
- The **systems themselves** be able to **do ethical decision making** to reduce the risk of unwanted behavior
 - train the robot to decide when to contact care giver and allow for more in-depth sensing from a home.





Ethical Concerns: Privacy

- Challenge 1: Balance the **privacy of the elderly** against the **needs for data** collection for having an efficiently functioning elderly care systems.
- Challenge 2: Protection of sensitive data to **avoid unwanted distribution and misuse** of such data.
- Mitigation:
 - **Sensor type:** Use sensors collecting less privacy related information
 - **Sensor data processing:** Process data locally rather than sending sensor data over Internet

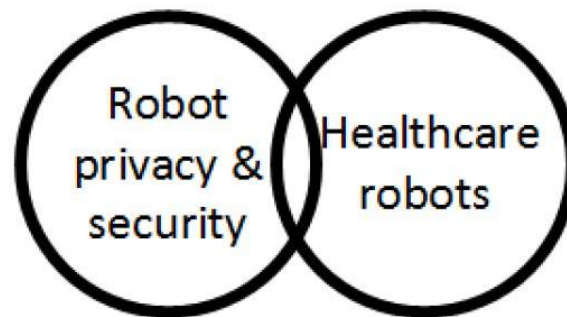
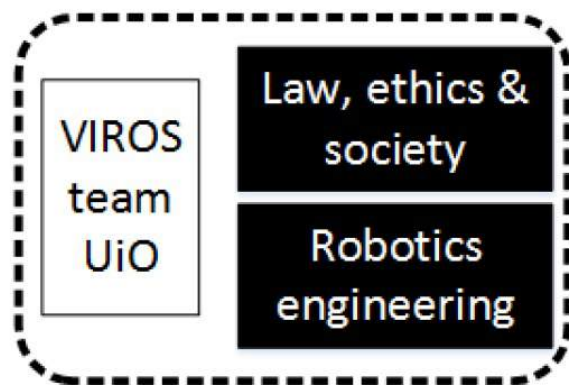


Ethical Concerns: Safety

- Challenge: Robots getting **physically much closer to humans** than what we are used to.
=> Can hit us unintentionally or hurt us through un-authorized access
- Trade-off between robot size, performance and safety
- Mitigation:
 - Equip robots with **soft material**
 - Provide a self-aware adaptable system that can **learn about the user's daily activities** and preferences

VIROS: Vulnerability in the Robot Society (2019-2023)

Research Council of Norway grant 288285



Dep. of Private Law +
Dep. of Informatics
and other
depts/partners

Goal:

1. **Develop knowledge about robot design and regulation**, to reduce digital vulnerabilities related to the increasing use of robots in our society. **Focus on privacy, security and safety**, particularly in healthcare contexts.
2. **Develop technology and proposals for regulatory measures** to reduce vulnerabilities regarding robotics.

Funding: IKTPLUSS, Research Council of Norway



**The Research Council
of Norway**

Predictive and Intuitive Robot Companion (PIRC) (2020-2025)

Research Council of Norway grant 312333

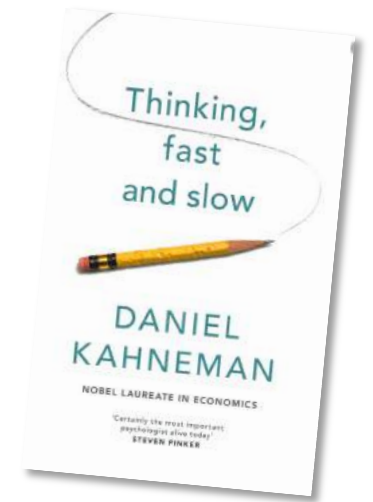


TIAGo
mobile robot
assistant



Goal: Build **models** that **forecast** future events and **respond dynamically by psychology-inspired computing:**

- Apply recent models of **human prediction** to perception-action loops of future intelligent robot companions.
- Include mechanisms for **adaptive response time** from quick and intuitive to slower and well-reasoned
- **Applications:** Physical rehabilitation and home care robot support for older people.



Funding: IKTPLUSS, Research
Council of Norway



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Report – AI Research Ethics Considerations

Released 11 November 2019. First translation
published in October 2020

- **NENT** – The National Committee for Research Ethics in Science and Technology (**Norway**)
 - Jim Tørresen member 2018–2025
- **An interdisciplinary AI working group has prepared a report:**
 - Identify and describe the **most pressing research ethics considerations** that arise with artificial intelligence research today.
 - Contribute to **increased awareness, guidance, and discussion** of these issues.

Method – NENT AI report

- **Input** from relevant Norwegian **academic/research institutions** involved in artificial intelligence research
- Review of **international and national reports** and guidelines
- Address ethics related to:
 - Replacing and extending human intelligent decision-making and actions
 - Numerous applications
 - Use and generation of big data



Look at the report? Google for "statements AI NENT"



Questions?

Make contact: jimtoer@ifi.uio.no