Open Research Day

9 April 2025

09:15-09:55

Parallel Sessions- *lightning talks followed by breakout session*

A108: Robots and People

Chair: Associate Professor Jana Tumova, KTH

A123: Smart Mobility

Chair: Professor Jonas Mårtensson, KTH

A108: Robots and People

- Lightning talk: Session chair: Associate Professor Jana Tumova, KTH

1. Advancing real-time exoskeleton control for human-in-the-loop optimization (Demo)
2. Synergistic Human-Robot Collaboration in Extreme Environments: From Simulation to Experimental Validation – SHARCEX (II)
3. The Neuroscience of Engagement: A Multimodal AI Approach to Understanding and Enhancing Human-Robot Interaction (RP)
4. AUV Data Processing, Communication and Swarm Optimization in Contested and Denied Undersea Environments- ADAPCOS (II)
5. Airborne Launch and Recovery Systems – ALARS (II)
6. Digital Futures Drone Arena Gymnasium

Advancing real-time exoskeleton control for human-in-the-loop optimization (Demo)

Name
Title, Affiliation

Advancing real-time exoskeleton control for human-in-the-loop optimization

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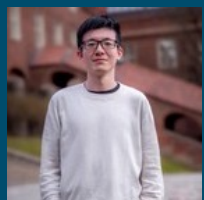

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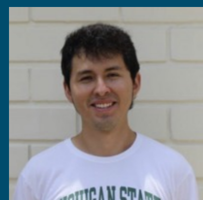

Israel Luis Peña

Post-Doctoral Researcher,
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Background and Motivation

- ~15% of world population (~1 billion people) live with a disabling condition
  - The proportion of elderly is growing
- Wearable robotic assistive exoskeletons have undergone rapid developments in the past decades, yet only a handful of products are used regularly
- In rehabilitation, motor (re)learning / neuroplasticity required learning-by-doing; the user's *active participation is crucial*
- "Optimal" exoskeleton control depends on individual, patient population & goal

Project Goals

- Testbed for human-in-the-loop optimization of exoskeleton systems
  - Modular lower-limb exoskeleton prototypes with a control architecture that can be adjusted in real-time
  - Based on bio-feedback from the users that relates to their individualized goals

Project Goals

- Tackling two specific cases

Case 1: Tethered Multi-Joint Exoskeleton System via Actuation Modules

Case 2: Quasi-Passive Ankle Exoskeleton

For more information, contact:

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Thank you

SHARCEX: Synergistic Human-Robot Collaboration in Extreme Environments - From Simulation to Experimental Validation

Ignacio Torroba
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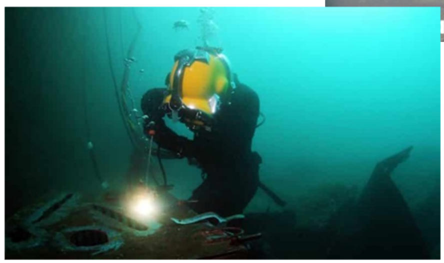
Objective

Side-by-side collaboration of divers and underwater robots in high-risk environments to reduce human exposure

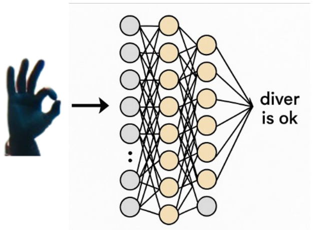


Methodology

2. Implicit and Explicit HRI
in

Human-In-the-Loop (HIL)	Implicit	Explicit
Low-level	Robot predicts the motion of the human and adapts to it	Human directly controls the robot
High-level	Robot predicts what task the human is doing and adapts to it $\phi_{human} \leftarrow prediction$ $\phi_{new} \leftarrow \phi_{old} \wedge \phi_{human}$ Re-plan	Human sends new tasks in real-time to the robot $\phi_{new} \leftarrow \phi_{old} \wedge \phi_{human}$ Re-plan

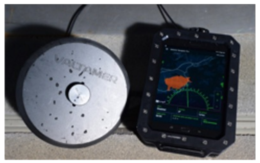
1. AUV prediction of divers intentions



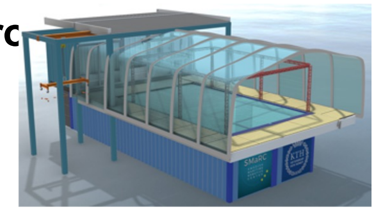
Low level task execution

High level reasoning

3. Sensing and actuation
for AUV-diver interaction



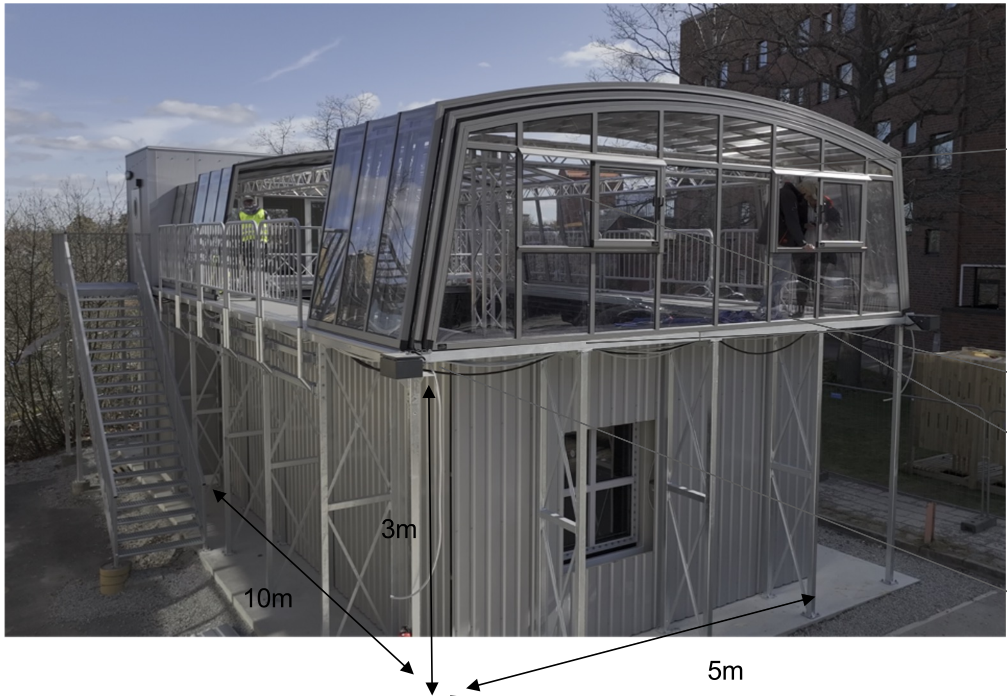
4. Data collection and
contro

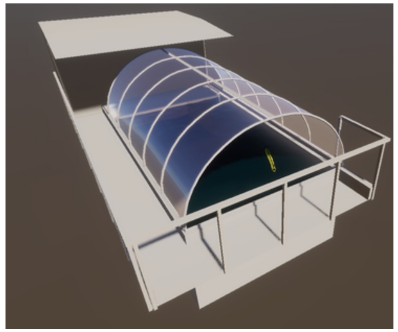


KTH water tank

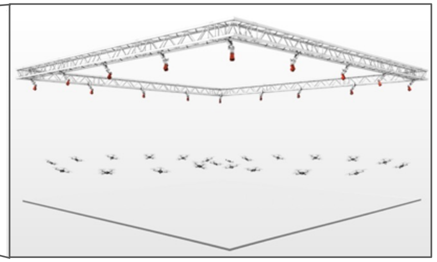
real2sim

sim2real





Surface and **underwater** mocap



- Operational 24/7 all year around.

- Controlled environment: temperature, water turbidity, lighting,currents


Thank you

The Neuroscience of Engagement: A Multimodal AI Approach to Understanding and Enhancing Human-Robot Interaction

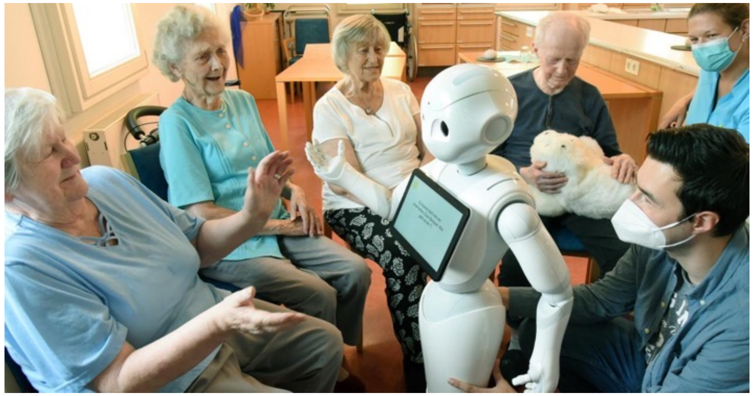
PI: André Pereira, Researcher, Docent (KTH)

Co-PI: Julia Uddén, Associate Professor, Docent (SU)

Motivation

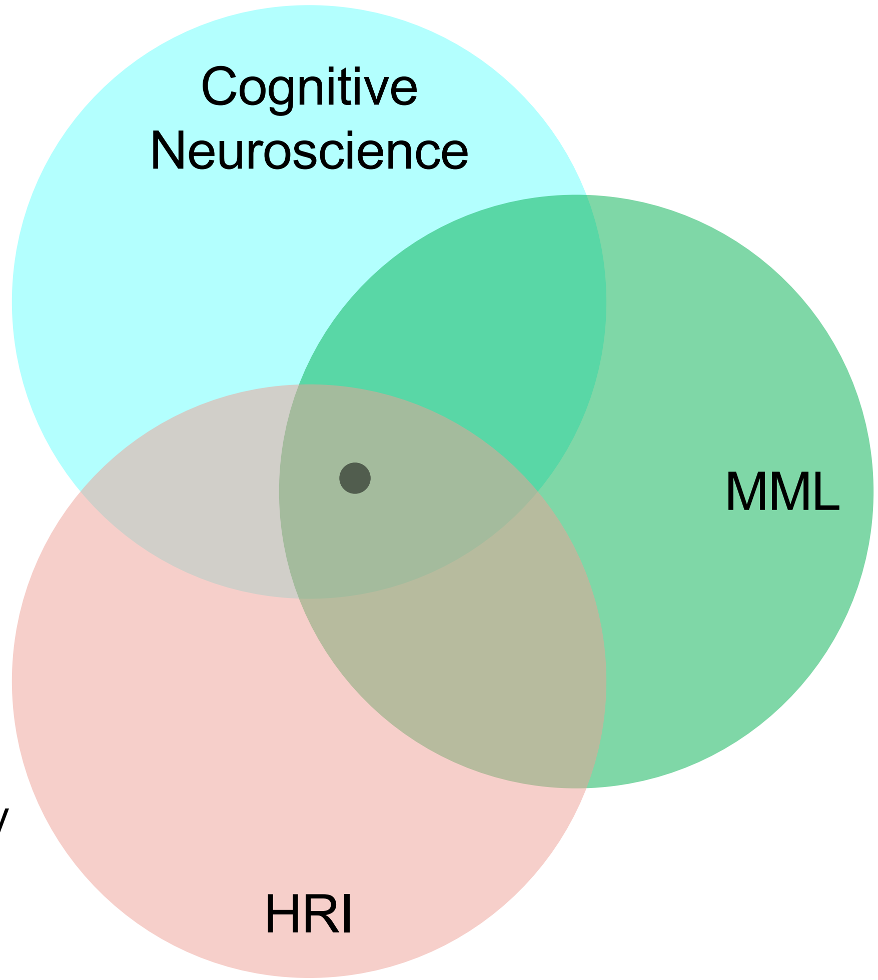
- The Importance of Engagement detection in Conversations
- The Importance of User Engagement detection in HRI
- Challenges & Limitations in Automatic Engagement Detection





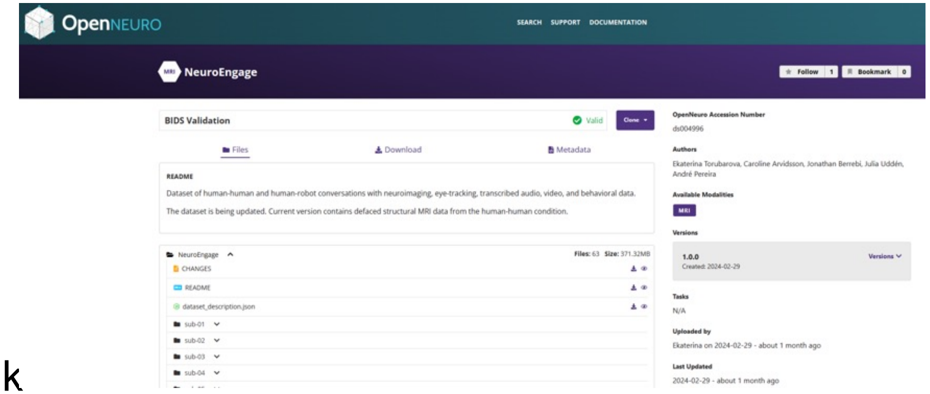
Research Gap

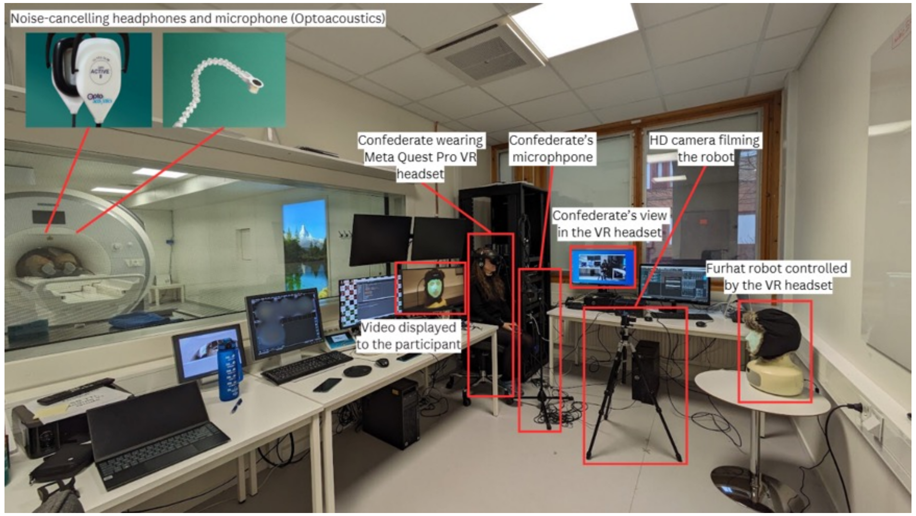
- Limited understanding of the brain in conversations
  - Understanding conversational engagement
- Understanding conversational engagement in Human-Robot Interaction (HRI)
  - Use Multimodal Machine Learning (MML) for engagement prediction and real-time adaptivity
- To maximize engagement is a trending objective in conversational systems both in research and industry



Progress

- NeuroEngage dataset, telepresence interface presented @ HRI 2025 with major release last week
- Currently
  - Enhancing the NeuroEngage with multimodal features
  - Training ML algorithms to **detect** and possibly respond to engagement levels in real time.
  - Continue investigating how certain brain areas respond to conversational engagement cues.
- Enable the creation of more engaging and effective social robots






Thank you

ADAPCOS

AUV Data Processing, Communication, and Swarm Optimization in Contested and Denied Undersea Environments

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Collaboration between Purdue, SAAB, and KTH

Axel Kärrholm
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Starting May 5th

Jan Kronqvist
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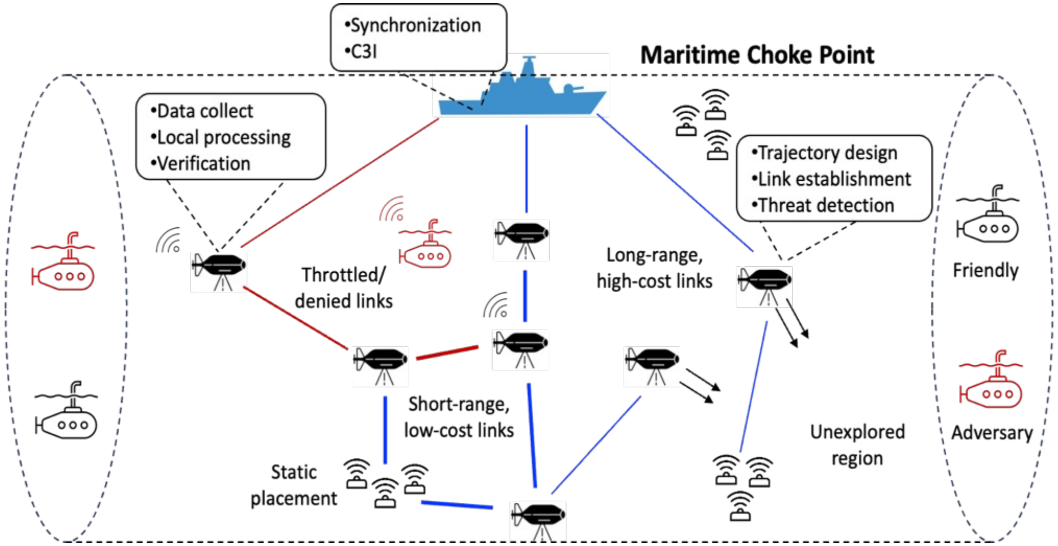
Roger Berg
Adjunct Professor
Saab and KTH

Christopher G. Brinton
Associate Professor
Purdue University

Shreyas Sundaram
Professor
Purdue University

Overview



Tasks of AUVs

- Detect the presence and movement of adversary vessels (ships, submarines, AUVs).
- Guard an area of interest and move around to maximize the coverage.
- Be as stealthy as possible.
  - As little communication as possible with the other vessels.
  - Smart movements and control of sensors.

Main AUV limitations (from our perspective)

- Limited onboard computational power.
- Limited communications and battery power.
- Environmental challenges.

Project objectives (KTH and Purdue teams)

1. ***AUV placement and trajectory design***:
   - Optimal placement of static assets (e.g., sensors)
   - Optimal combinations of sensors
   - Efficient trajectories for AUVs to follow across this region.
   - Algorithms to maximize coverage while limiting communication and consider the unique challenges of changing underwater conditions.

2. ***Local AUV data processing and computations***:
   - Computationally efficient methods for onboard AUV data processing
     - Analyze data to determine the presence of adversarial threats.
     - Compress and distribute data (as little data as possible) through the established AUV network.
   - Speed/computational complexity vs quality.
   - Traditional methods vs ML/AI based methods.

Challenges in the project

- Understanding the unique characteristics of underwater environments in terms of surveillance, data processing, and communications.
- Mathematical challenges: modelling and solving the resulting optimization problems


Thank you

Airborne Launch and Recovery Systems – ALARS (II)

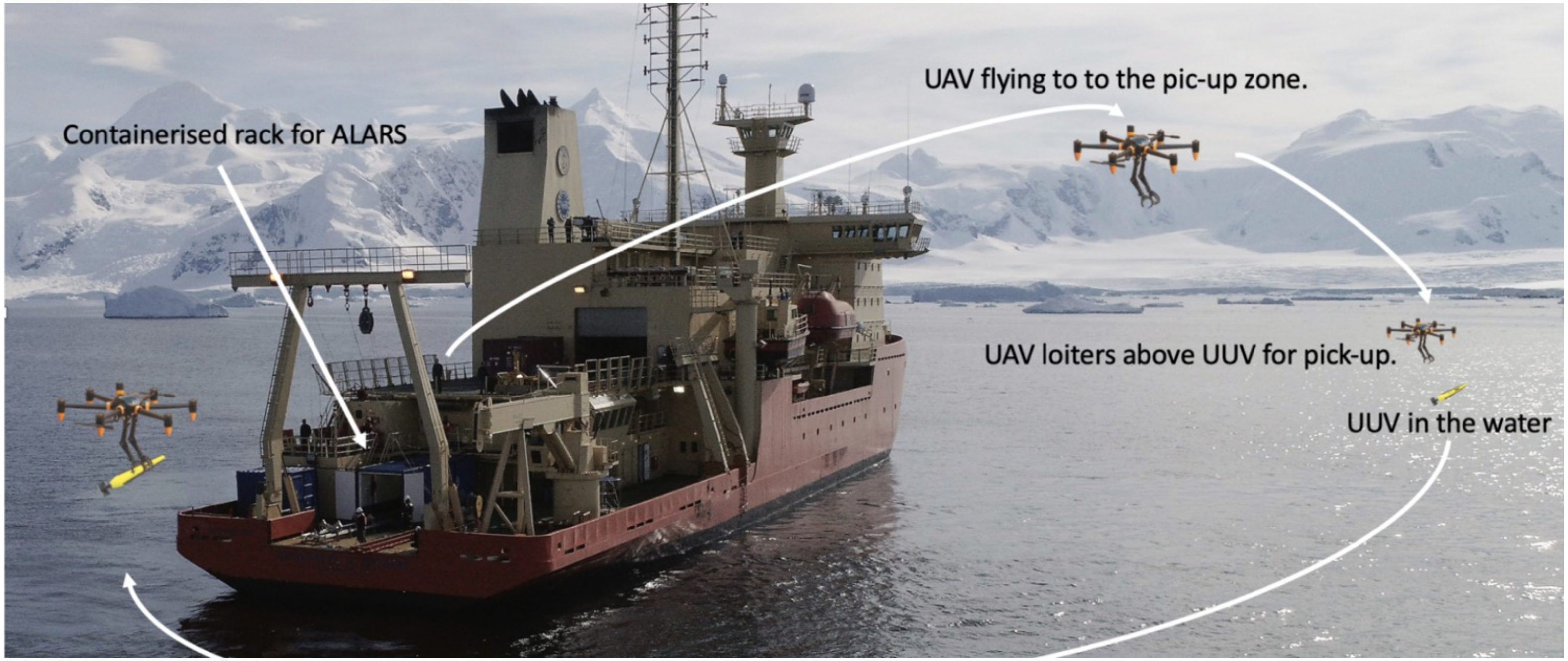
Özer Özkahraman
KTH / RPL

Aerial Launch and Recovery

- Launch and recovery of UUVs is "hard".
  - Slow down of manned vessel
  - Manned vessel detours
  - People put in risk with small boats
  - Expensive
  - Might be impossible

- We aim to launch and recover the AUV with a drone.

The Vision


UAV flying to to the pic-up zone.
Containerised rack for ALARS
UAV loiters above UUV for pick-up.
UUV in the water

In Action

Thank you

Digital Futures Drone Gymnasium

Joseph La Delfa
KTH and Bitcraze

with Rachael Garrett (KTH), Kristina Höök(KTH), and Luca Mottola (RI.SE)

The **Digital Futures Drone Gymnasium** explores the potential of physical and embodied training accessories to support drone programming and their interactions with humans.

In a Nutshell

1. Training accessories
2. Workshops
3. Pop-up exhibitions
4. Empirical studies


Thank you

digital futures

PARTNERS

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