



SENSING FOR SCIENCE

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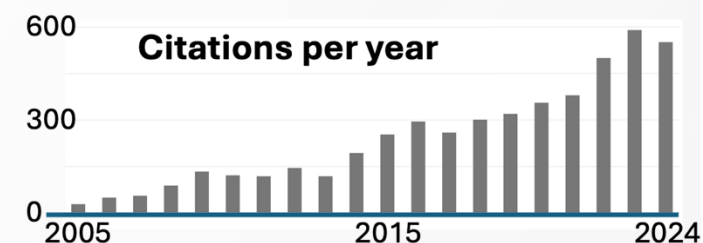
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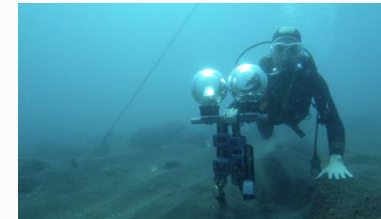
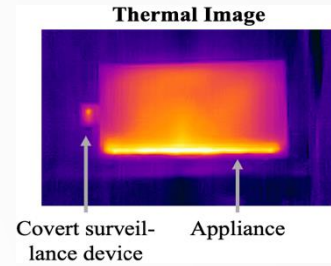
THE ROAD THUS FAR

- **Born** in Hyvinkää, Finland
- **Working** in research since 2004
- **MSc** in 2006 (UH)
 - Theoretic Modelling of Routing in Selfish Ad Hoc Networks
- **PhD** in 2009 (UH)
 - Identifying meaningful places
- **Lecturer** at Lancaster University, UK (1.2018 – 1.2019)
- **Associate Professor** at UH from 9.2018 (first part time) until 8.2023
- **Full Professor** since 9.2023
- **Member** of Helsinki Institute for Sustainability Science (HELSUS)





WHAT IS SENSING?



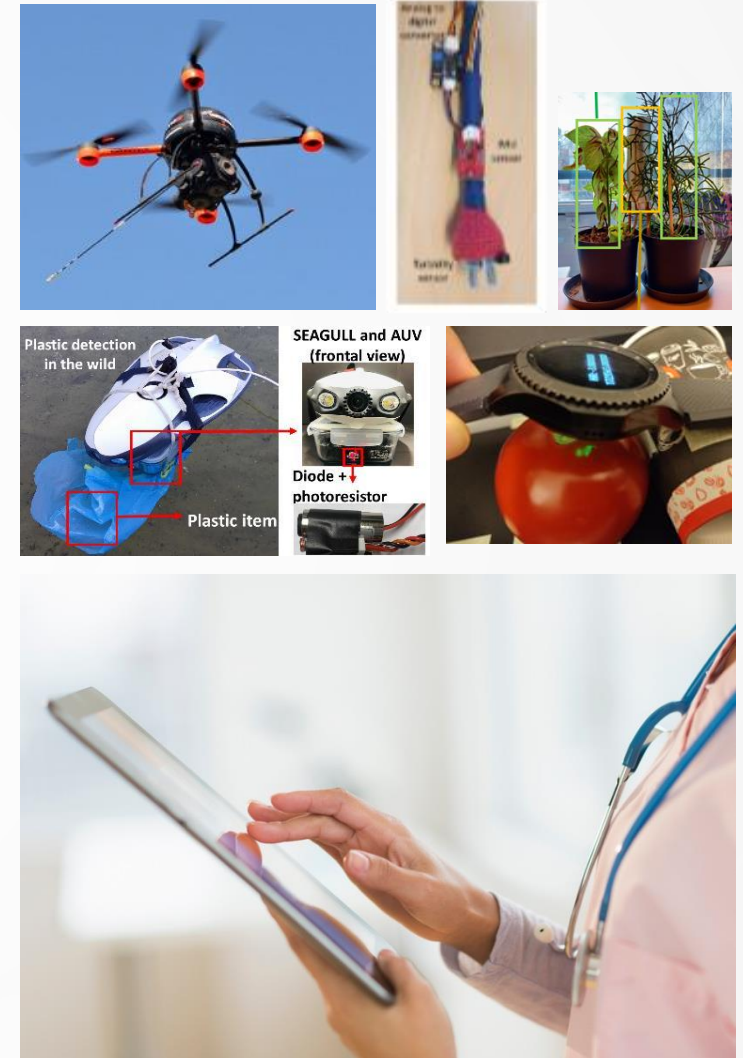
Sensing refers to the process of **detecting** and **responding** to **stimuli from the environment**. It involves the use of **sensors**, whether they are biological (like human senses) or artificial (like electronic sensors), to **gather information**. This information is then **interpreted by a system**, be it a human brain or a computer, **to make decisions or take actions**.

(Source: Microsoft COPILOT AI)



SENSORS

- Computing devices rely on (electronic) **sensors** for sensing
 - Hardware sensors: components integrated into computing devices
 - Software sensors: pieces of software that collect information
- Sensors are **measurement devices** which means they should be
 1. Sensitive to the property they are measuring
 2. Insensitive to other properties encountered in their application domain
 3. Have no influence on the property they are measuring
- Practically **anything** collecting information can be a sensor
 - Touchscreens, mobile app usage, reed switches, WiFi interfaces are examples of techniques that were not originally designed as sensors but can be used to collect information





SENSING & SCIENCE

- Sensing has a natural role in science since the inception of science
 - Fundamental role in collecting empirical data
 - Monitor and observe phenomena, provide feedback, identify changes
 - Critical for testing hypotheses
- Traditionally using **high precision measurement instruments**
 - Typically expensive, require expertise to use, and have limited context in which they can be used
- Modern devices integrate sensors and can thus be used for collecting empirical data
 - Already heavily used in several fields
 - However, not designed as scientific instruments → no rigorous process that ensure the quality of the measurements is satisfactory
 - **How can we bridge this gap?**





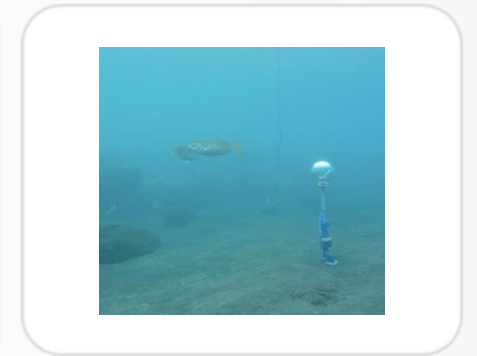
PERVASIVE DATA SCIENCE @UH: MORE AND BETTER DATA

Systems and methods that help to collect **more** and **better** data (quantity of quality data)



**Innovative
data collection**

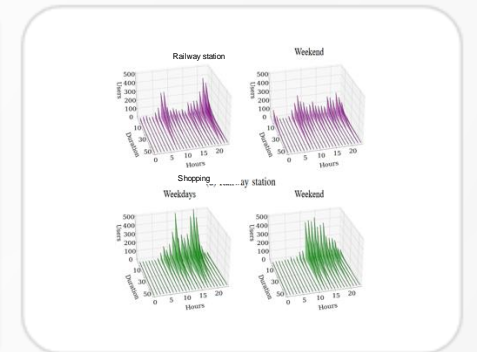
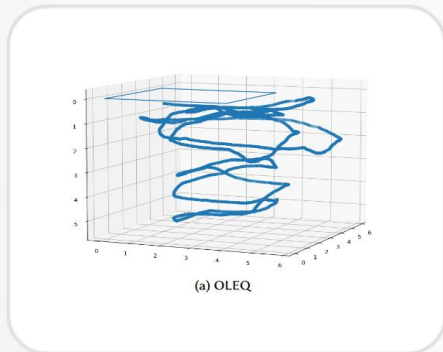
**Upscale
data collection**



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**Ensure
measurement
quality**

**Improved data
collection
systems**





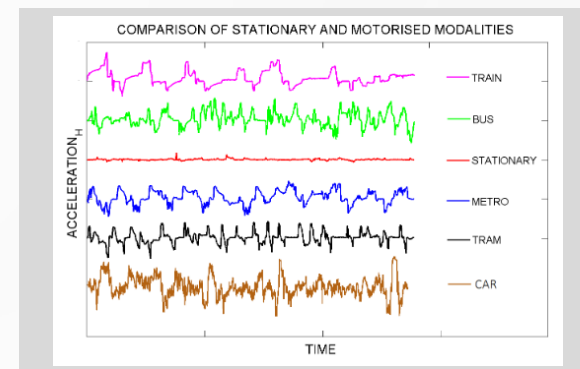
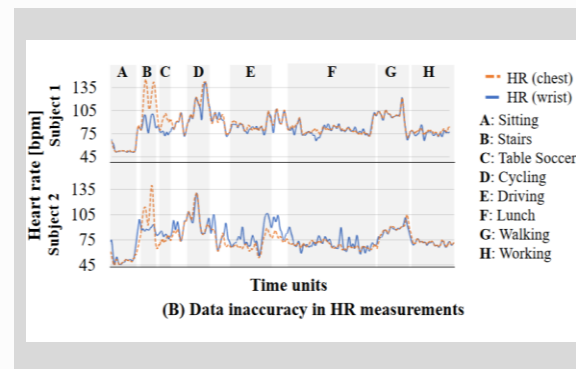
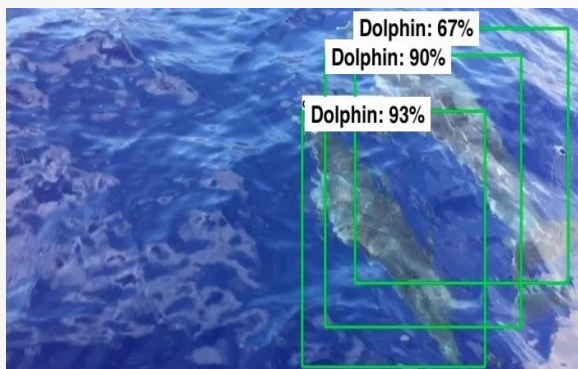
SENSING AND SUSTAINABILITY

- **Urban air pollution** an example of a domain where the need for alternative sensing solutions necessary
- Studies (e.g., Apte et al. 2017) show that urban pollution can have drastic differences within a 30-meter distance
 - Require 1000 sensors / square mile
- **Combination of low-cost sensors, high precision instruments, and AI** can help to reach this resolution
- However,
 - Need to ensure accuracy and consistency
 - Need to have good designs for sensors
 - Need to manage and maintain deployments
 - Etc.





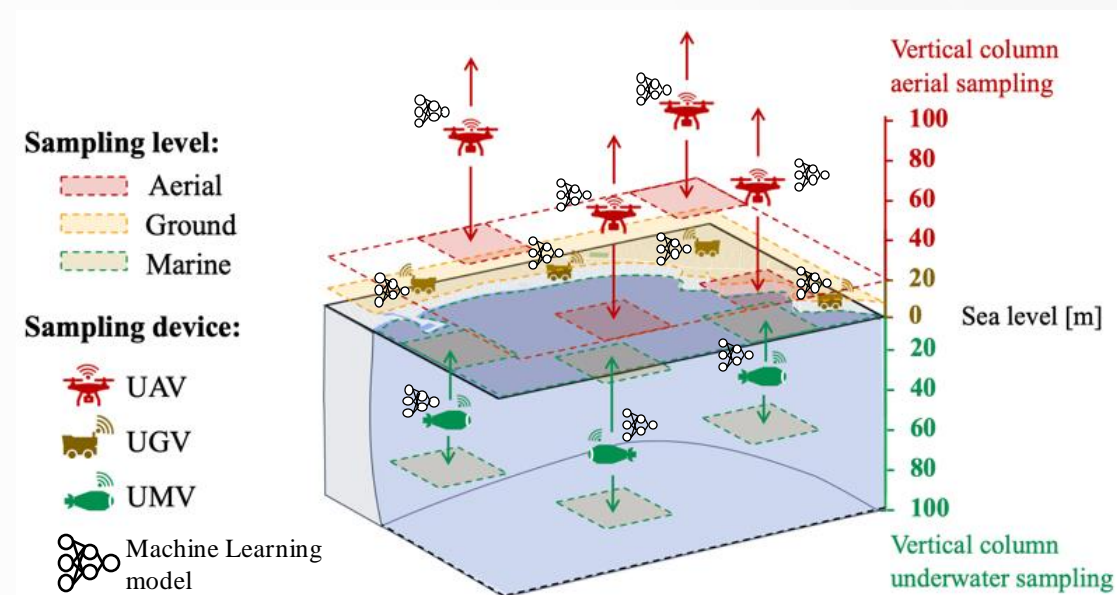
SENSING AND SUSTAINABILITY





SENSING AND ENVIRONMENTAL SUSTAINABILITY

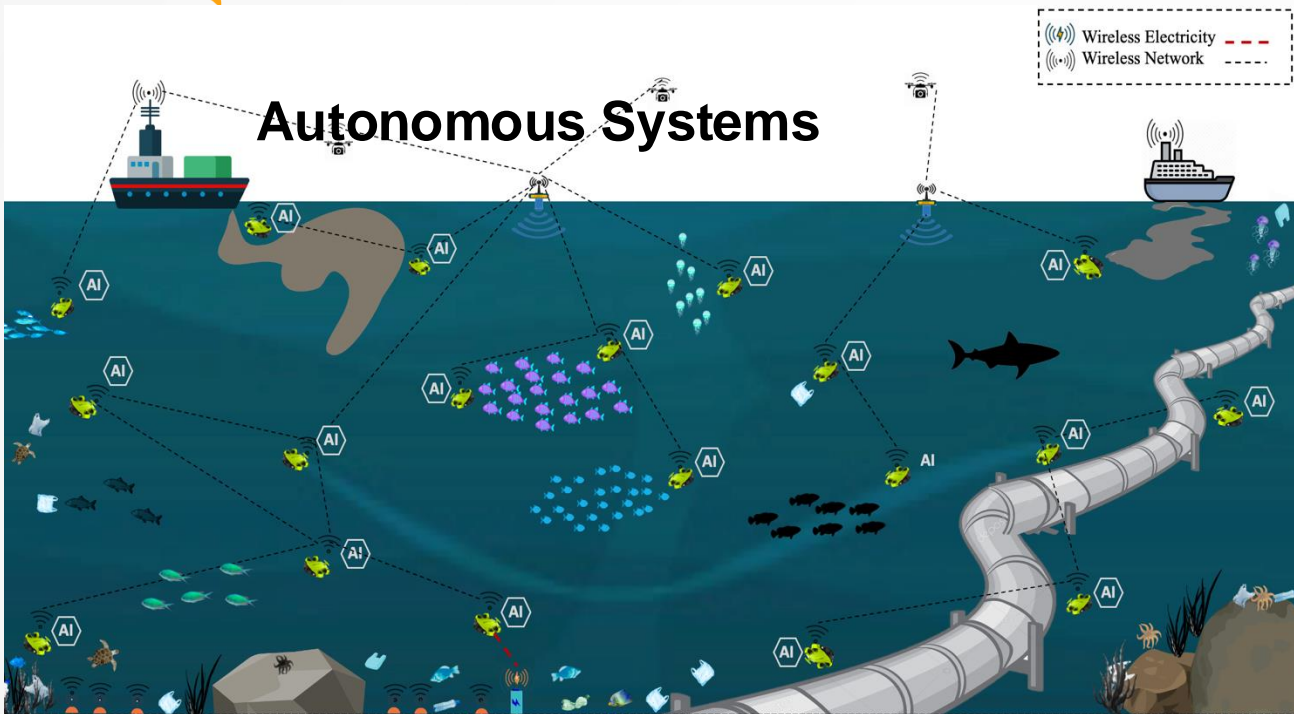
- Long-term vision to support **cross-ecosystem** environmental sustainability monitoring
 - Pollution to interlinked across ecosystems → need to monitor across all ecosystems
- Our research has addressed **land, air, water, and end-user** point-of-views for pollutants
 - Solutions for consumers to monitoring plastic, food waste etc.
 - Air quality monitoring using wearable sensors, aerial drones, and other means
 - Delivery robots and other ground vehicles for monitoring littering



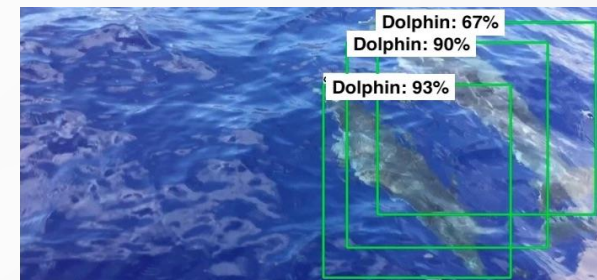
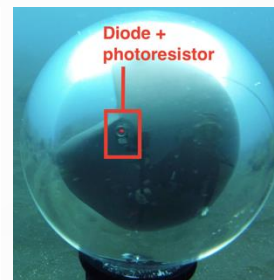
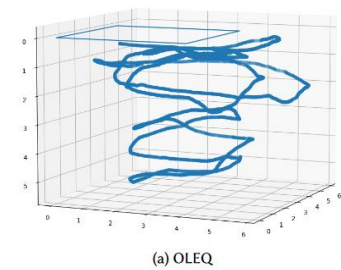
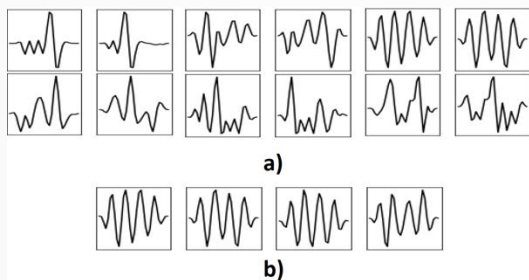
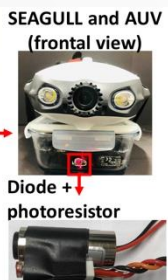
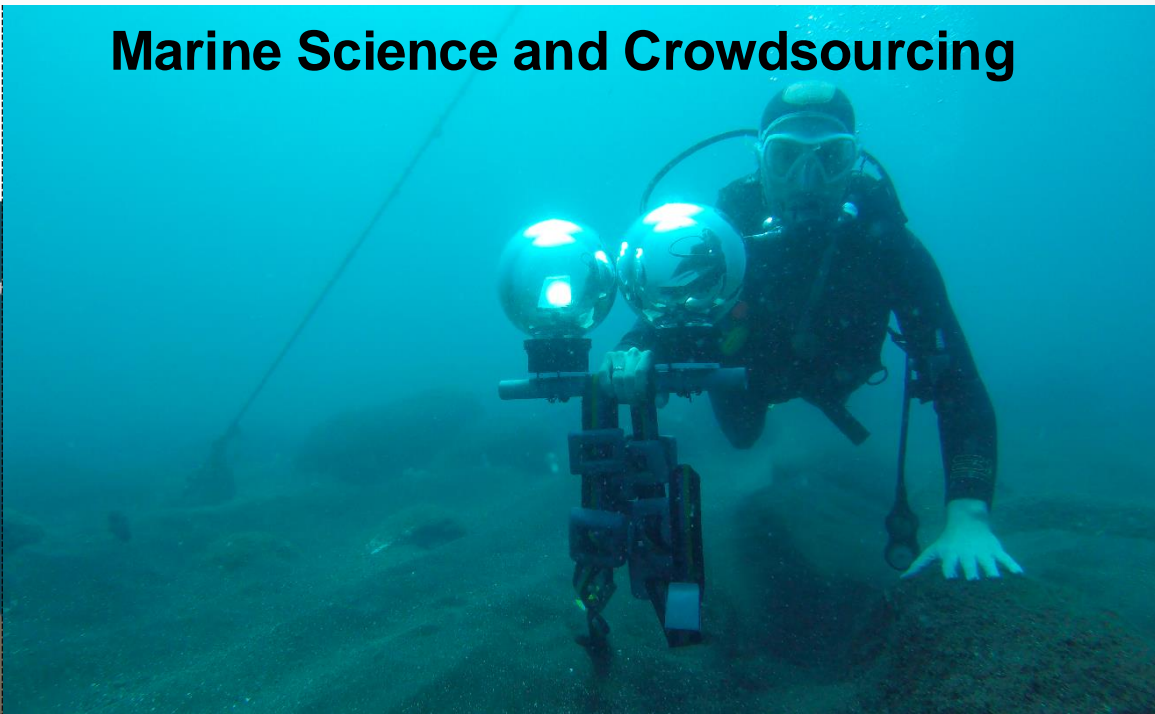


AQUATIC MONITORING

Autonomous Systems



Marine Science and Crowdsourcing





SUMMARY

- **Sensing to support science**
 - **Better data** → better understanding, better insights, and higher value
 - **Harness** everyday devices
- **Research focusing on four key challenges**
 - **New ways** to collect information and ways to collect new information
 - **Validating and improving** quality of sensor data
 - **Scaling up** data collection and analysis processes
 - **Building** better systems for collecting data
- **Other challenges**
 - Privacy, dual use potential, long term maintainability of sensor systems etc.





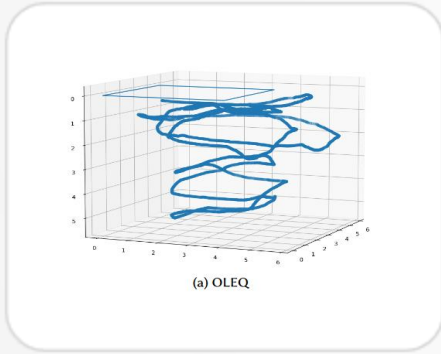
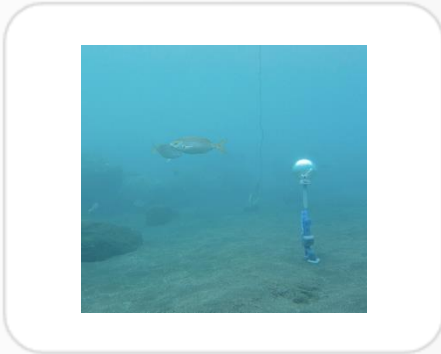
THANK YOU

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Innovative data collection

Upscale data collection



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Ensure measurement quality

Improved data collection systems

