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How to Attract new Generations to Science, Technology, Engineering and Mathematics (STEM) by using IoT, Robotics and Drones?

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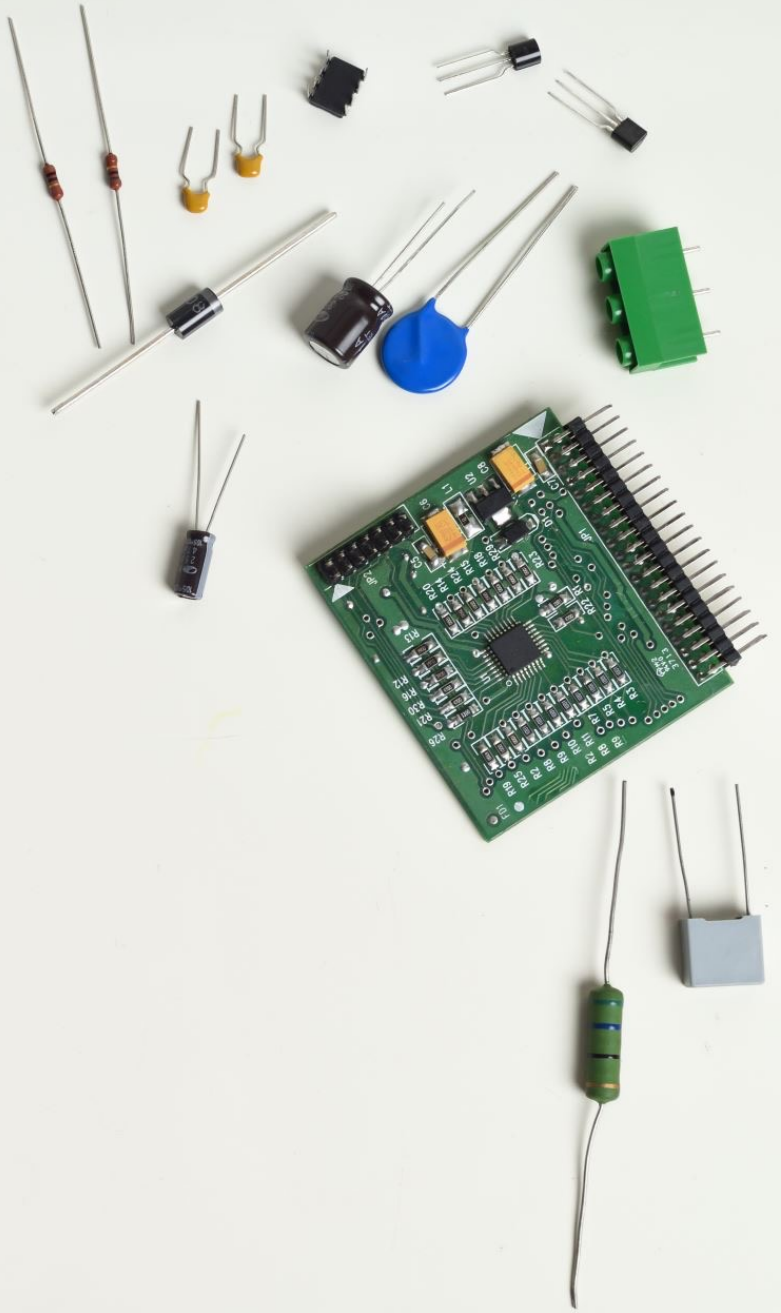
About me

- Professor of Information Systems at the University of South-Eastern Norway
- Research on smart cities and intelligent systems
- Teach Internet of Things (IoT) and Data Science
- Passionate about STEM education (worked with schools)
- I love to build cyber-physical systems and play with robots and drones
- Co-organizer of a summer school on IoT in agriculture



The need for STEM education

- In Norway, we need more scientists and engineers
  - Moving away from oil and gas, we need scientists and engineers to fill new jobs in renewable energy, biotechnology, and other technology fields
  - Scientists and engineers are essential for green transformation
- However, the number of students studying science and engineering is too low
  - Mathematics is seen as hard
- The government is not helping
  - Incentives to take advanced mathematics (extra points in the university admission process) will be removed

“The role of the teacher is to create the conditions for invention rather than provide ready-made knowledge”

Seymour Papert

Internet of Things

- The Internet of Things (IoT) consists of “things” connected through the Internet
- Modules are inexpensive, available, and easy to connect
- Students at all levels can create exciting solutions using off-the-shelf components, including microcontrollers, communication devices, sensors, and actuators.
- IoT is a perfect tool to spark interest in STEM

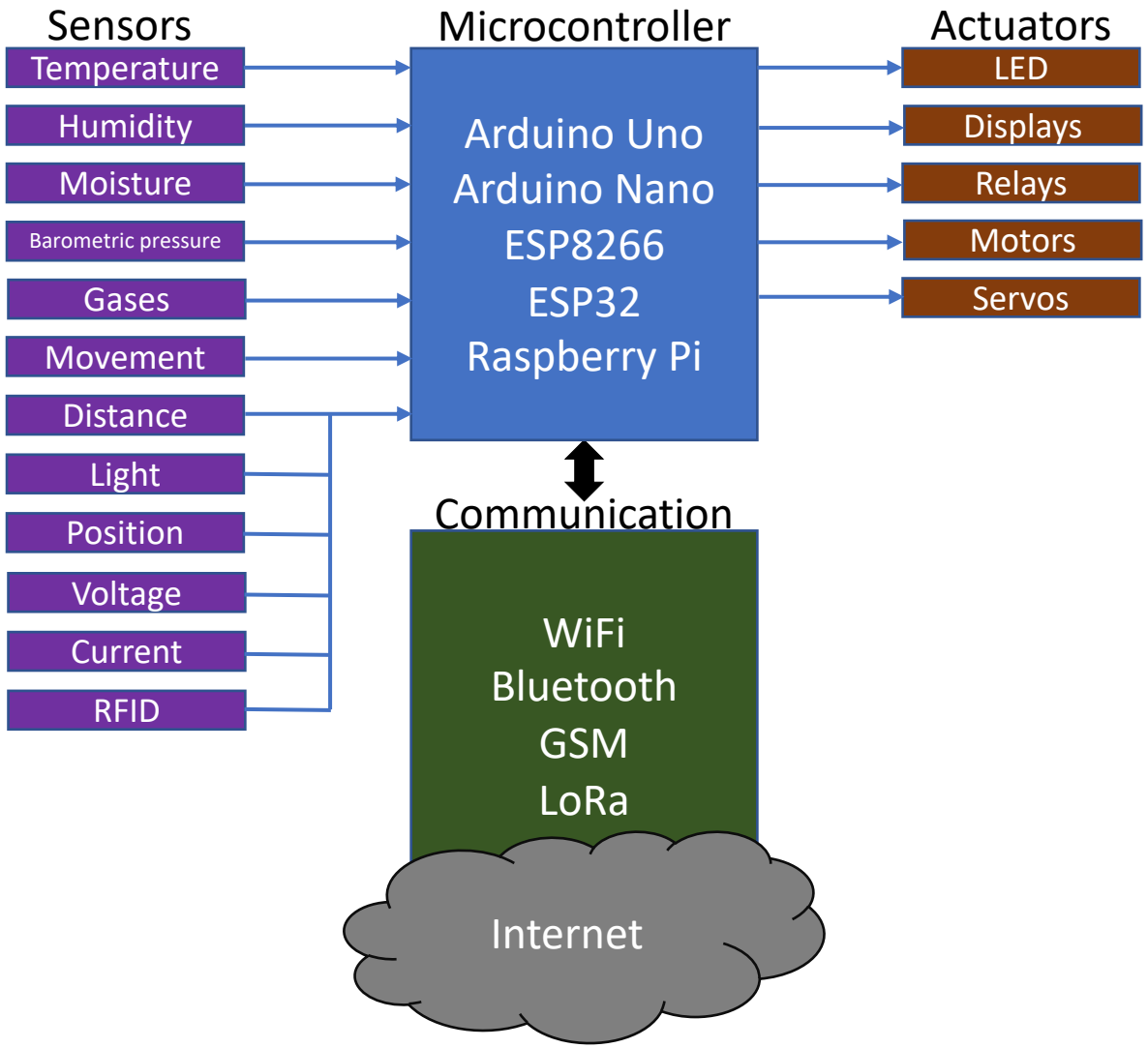
Internet-of-Things - Overview

Microcontrollers
Processes input to make output (*Computational capacity*)

Sensors
Collect input data

Actuators
Makes things happen

Communication
Communicates with the outside world through Internet



IoT can be used on all levels

- From kindergarten to the university
- IoT can be used to engage students in STEM
- Explore
- Learn
- Make

Kindergarten

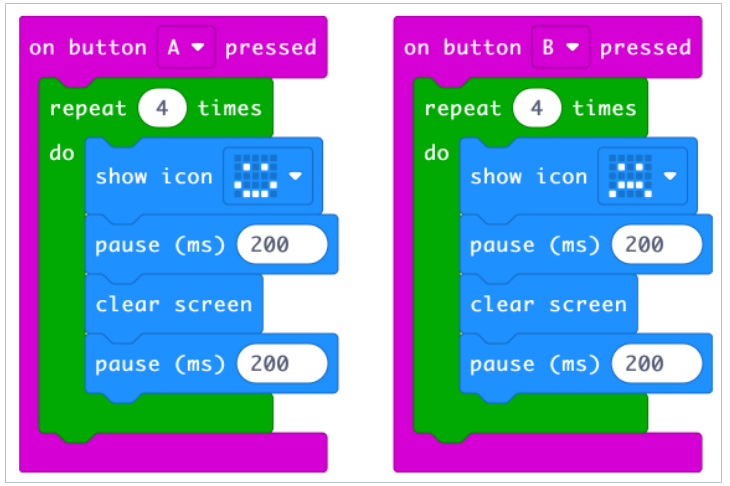
- Interconnected blocks
  - Photosensor / light
  - Distance sensor / motor
  - LEGO and similar building blocks
- Robots

In primary school

BBC micro:bit

- Processor
- LED matrix
- Buttons
- Accelerometer
- Temperature sensor
- Light sensor
- Compass
- Speaker
- Microphone
- Many experiments to choose from (e.g., create a beating heart)

Use this link to see the video:
https://youtu.be/wSXwc3rlJ7s



“The greatest sign of success for a teacher is to be able to say, ‘The children are now working as if I did not exist”

Maria Montessori

Secondary school

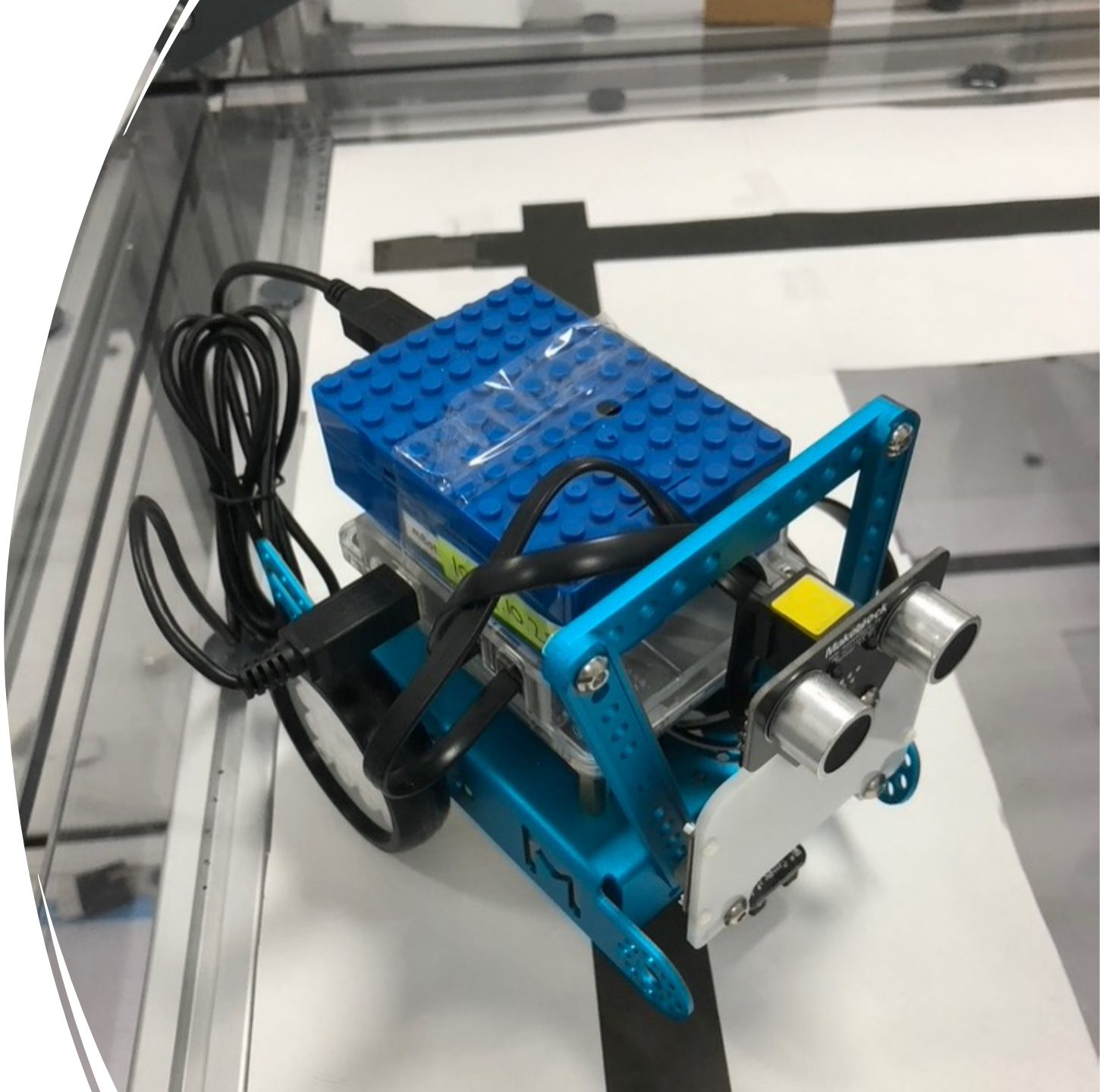
- Playing with more advanced technology
  - Microcontrollers
  - Robots
  - Drones
  - 3D-printing
- Integrated with STEM topics (e.g., why does a drone fly?)

Horten High School (Norway)

- Research program in science (Environment and Technology)
- Collaboration with USN
- For students with special interests in science and technology

University

- Using more advanced controllers, sensors, and actuators
- Solving real problems
- Bachelor theses
- I will show three examples at the end of my presentation



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Laboratory assignments

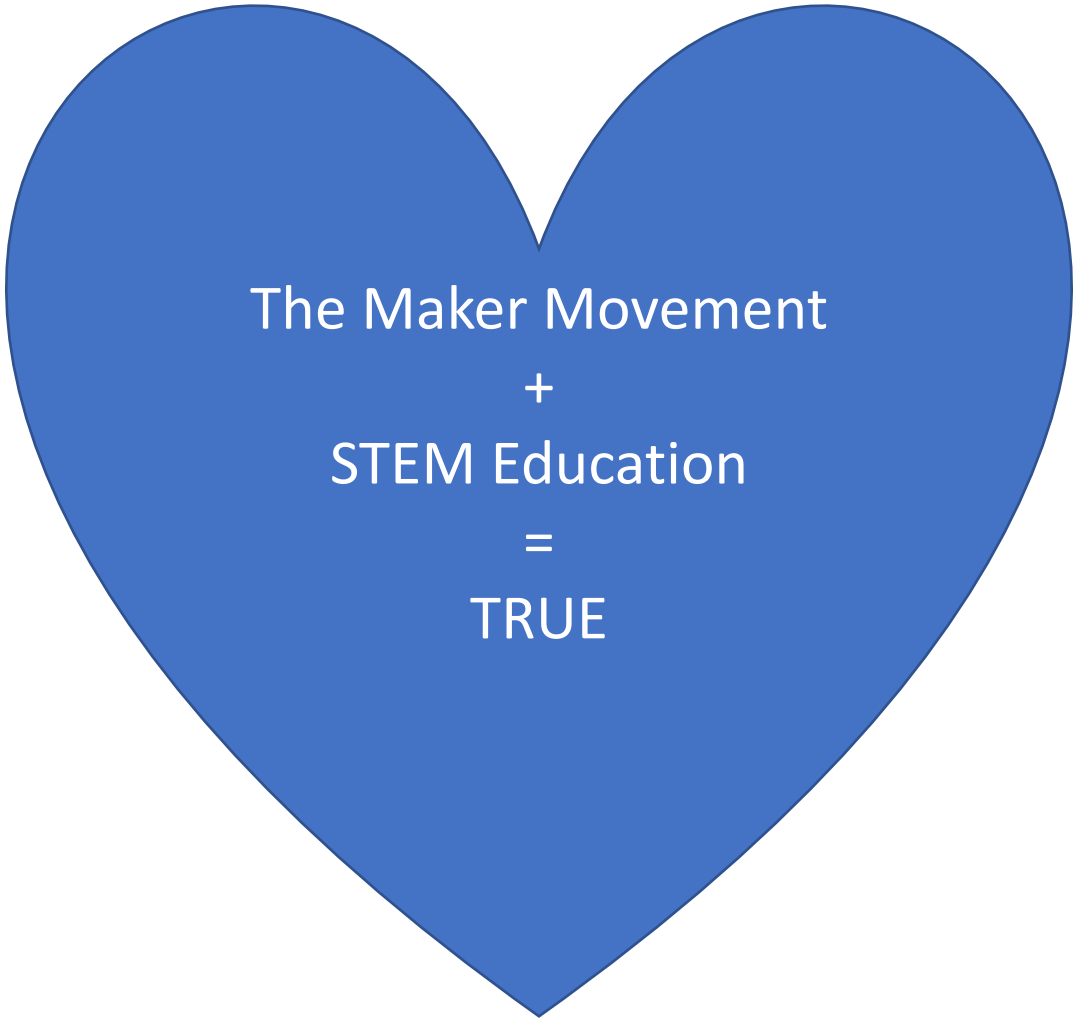
(IoT course)

- Measure temperature, humidity, distance
- Detect movement
- Store data on SD-card
- Use real-time clock
- Detect smoke
- Output data through displays (LED/LCD/OLED)
- Control the outside world through relays, motors and servo
- Read and write RFID tags
- Capture data from infrared remote controls, play back data on infrared transmitter
- Transfer wireless data through radio, WiFi and Bluetooth
- Connecting to a cloud service with dashboard

Observation

- You do not need to be a car mechanic to drive a car
- Choose the right level of exposure

Innovation



Tell me and I forget,
teach me and I remember,
involve me and I learn

Benjamin Franklin

Other initiatives for IoT in STEM

- Kidsakoder (the kids are coding)
  - Voluntary organization
- Science museum, knowledge centers, Newton room
  - Space to design, create, and play (also with IoT)
- Hackatons and competitions
  - Innovation days

Summer School on IoT in Agriculture

Vestfold, Norway, July 2022

Contributions of IoT to STEM education

From abstract concepts to real-world applications	Meaningful and engaging learning, practical skills and hands-on experience
Interdisciplinary learning	Computer science, engineering, data analysis, cross-diciplinary thinking
Data-driven decision making	Apply mathematical and statistical concepts to real-world sitations (e.g., weather station)
Collaboration and communication	Teamwork
Future readiness	Prepared for future careers

Three examples of Bachelor theses (USN)

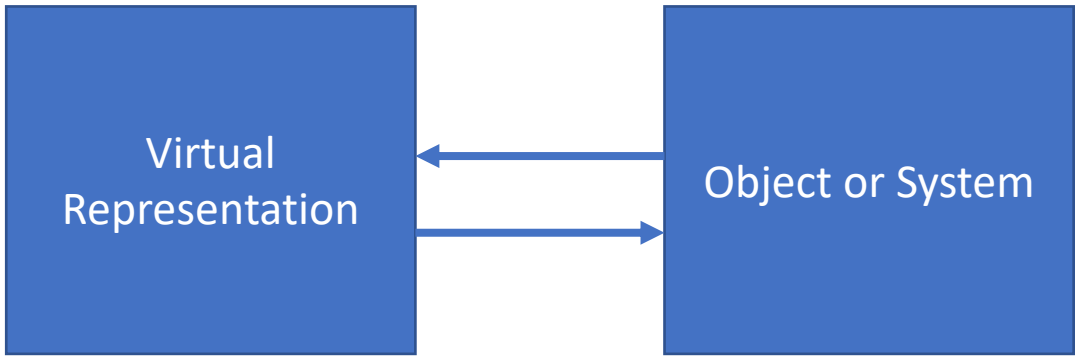
- Truck theft device for Circle-K
- Digital Twin for the Telemark Canal
- Detection of gas/smoke in a ventilation system

Truck theft device for Circle-K

Anti-theft device, different operation modes. Sending messages about irregularities to operation centre.

Digital Twin

“A digital twin is a virtual representation of an object or system that spans its lifecycle, is updated from real-time data, and uses simulation, machine learning and reasoning to help decision-making.”



https://www.ibm.com/blogs/internet-of-things/iot-cheat-sheet-digital-twin/

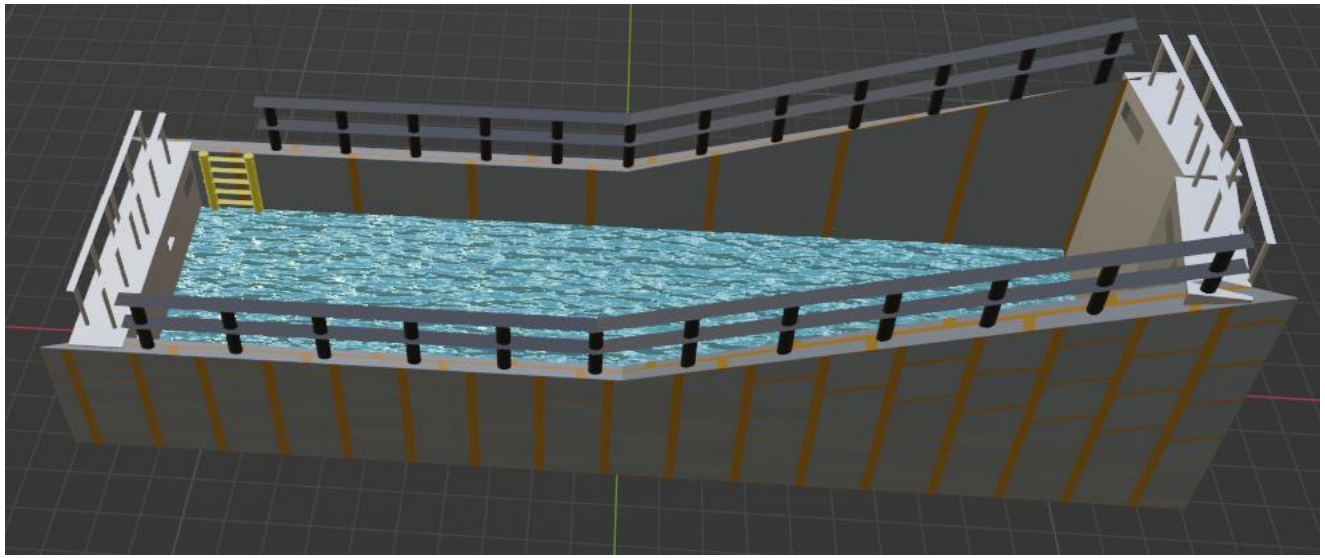
Digital Twin Project: Telemark Canal

- The Telemark Canal was completed in 1898
- 500 men / 5 years
- Length: 105 km.
- 18 lock chambers
- Height difference: 72 meters
- Aim: Deploy sensor platforms in all lock chambers
- Demonstration case for digital twin / Internet of Things

Digital Twin: Telemark Canal

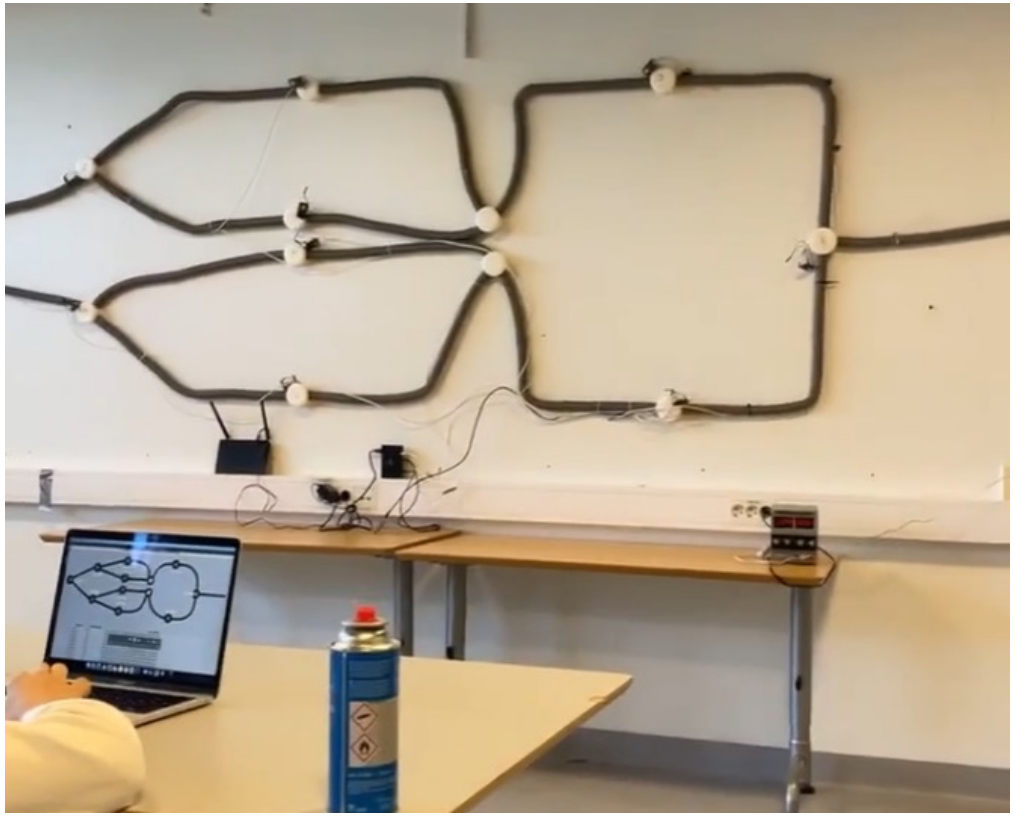
- Focus on one lock chamber
- **Proof of concept**
- Rough physical environment
- Sensors needed protection

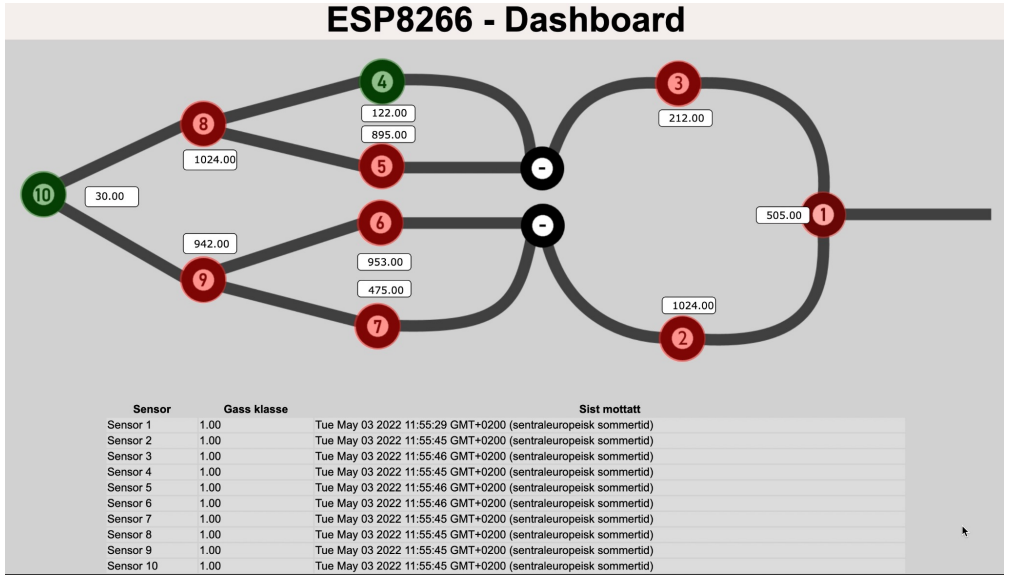
Digital Twin – Lock chambers -Telemark canal



Using sensors to measure the filling and position of the gates

Detection of gas/smoke in ventilation system





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Also a digital twin. Sensors detect changes in air quality and data is used to find root cause of warning.

Two examples of projects

- Environmental monitoring (water)
- Parking spot detection

Environmental Monitoring with Buoy

- Lidia-Ana-Maria (RO)
- Developed an Android App to visualize data from a buoy sensor platform
- Worked with a team of engineering students (other faculty)
- Used as input to a research project application

Free Parking Spots Counter

- Ionut-Alexandru Enache (RO)
- Using an overhead camera to detect available parking spots.
- **IoT** as technology
- Tensorflow and openCV

Thank you for listening

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