THORVALD
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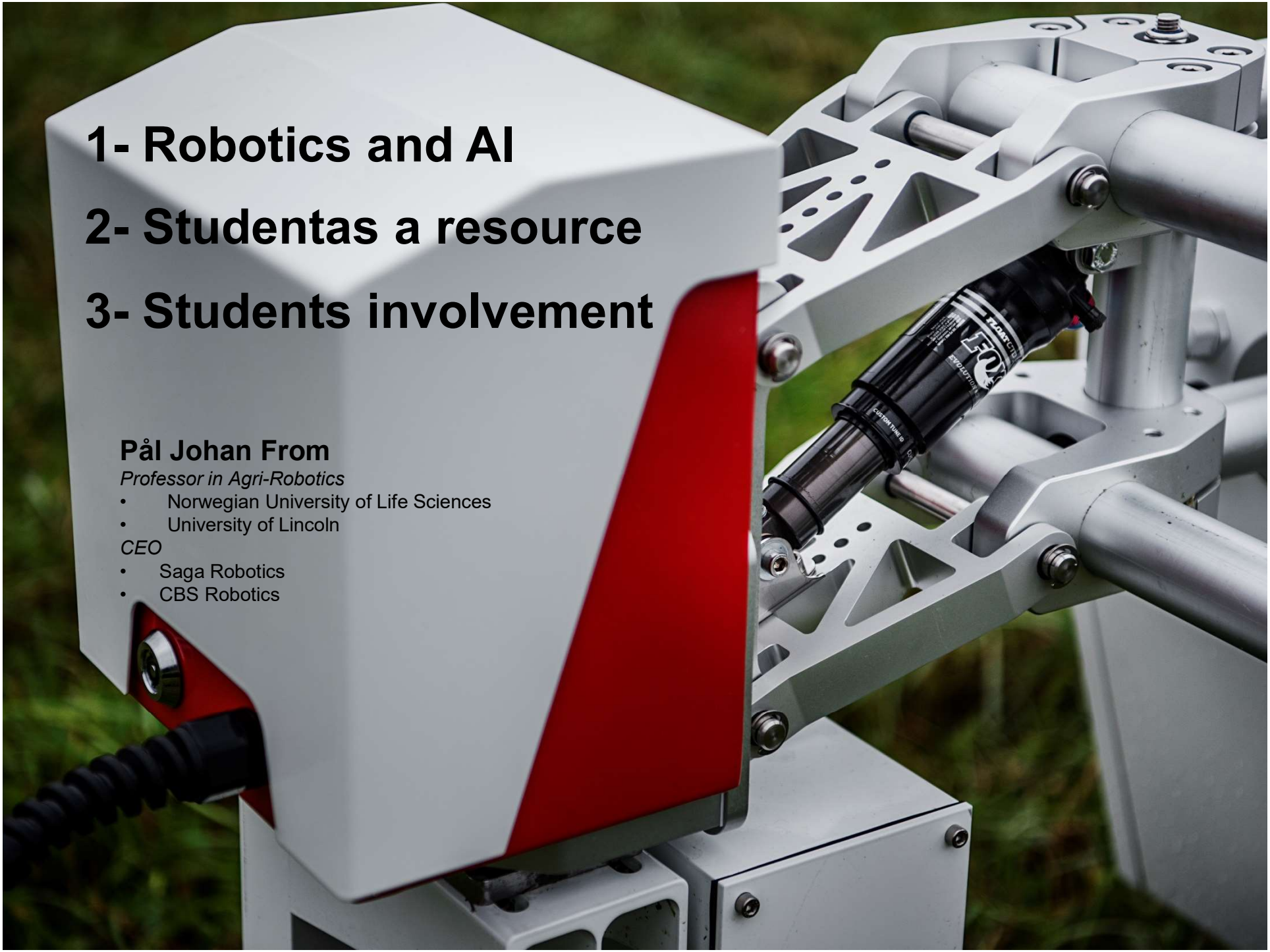
Student involvement in research

$$
\begin{aligned}
\mathrm{d}q_+^i - \mathrm{d}q^i &= \frac{\partial^2(\mathcal{H}h_+)}{\partial p_i^+ \partial t}\,\mathrm{d}t + \frac{\partial^2(\mathcal{H}h_+)}{\partial p_i^+ \partial t_+}\,\mathrm{d}t_+ + \frac{\partial^2(\mathcal{H}h_+)}{\partial p_i^+ \partial q^j}\,\mathrm{d}q^j + \frac{\partial^2(\mathcal{H}h_+)}{\partial p_i^+ \partial p_j^+}\,\mathrm{d}p_j^+, \qquad i = 1, .\\
\mathrm{d}p_i^+ - \mathrm{d}p_i &= -\frac{\partial^2(\mathcal{H}h_+)}{\partial q^i \partial t}\,\mathrm{d}t - \frac{\partial^2(\mathcal{H}h_+)}{\partial q^i \partial t_+}\,\mathrm{d}t_+ - \frac{\partial^2(\mathcal{H}h_+)}{\partial q^i \partial q^j}\,\mathrm{d}q^j - \frac{\partial^2(\mathcal{H}h_+)}{\partial q^i \partial p_j^+}\,\mathrm{d}p_j^+, \quad i = 1, .\\
&\frac{\partial^2(\mathcal{H}h_+)}{\partial t^2}\,\mathrm{d}t + \frac{\partial^2(\mathcal{H}h_+)}{\partial t \partial t_+}\,\mathrm{d}t_+ + \frac{\partial^2(\mathcal{H}h_+)}{\partial t \partial q^j}\,\mathrm{d}q^j + \frac{\partial^2(\mathcal{H}h_+)}{\partial t \partial p_j^+}\,\mathrm{d}p_j^+\\
&\quad + \frac{\partial^2(\mathcal{H}^- h_-)}{\partial t \partial t_-}\,\mathrm{d}t_- + \frac{\partial^2(\mathcal{H}^- h_-)}{\partial t^2}\,\mathrm{d}t + \frac{\partial^2(\mathcal{H}^- h_-)}{\partial t \partial q_-^j}\,\mathrm{d}q_-^j + \frac{\partial^2(\mathcal{H}^- h_-)}{\partial t \partial p_j}\,\mathrm{d}p_j =
\end{aligned}
$$



1- Robotics and AI

2- Studentas a resource

3- Students involvement

Pål Johan From

Professor in Agri-Robotics

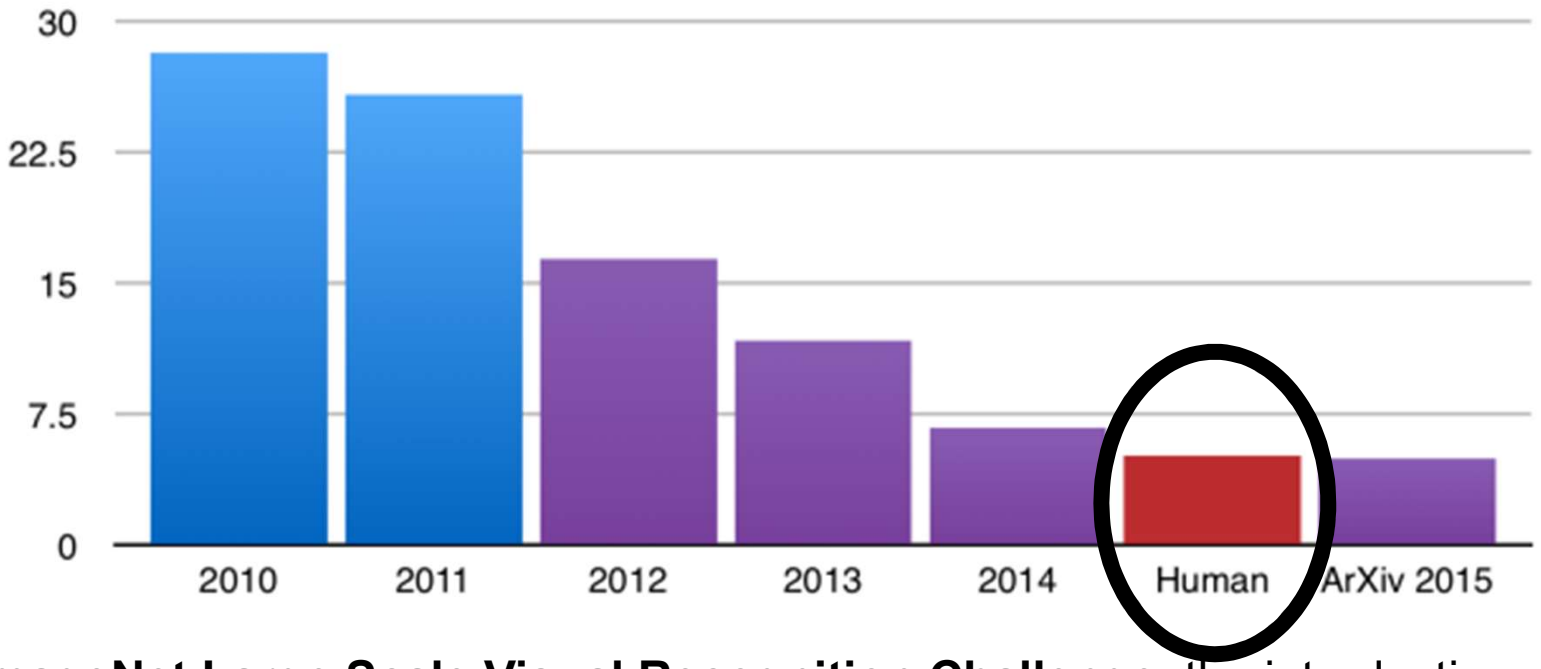
- Norwegian University of Life Sciences
- University of Lincoln

CEO

- Saga Robotics
- CBS Robotics

Machine Vision & Deep Learning

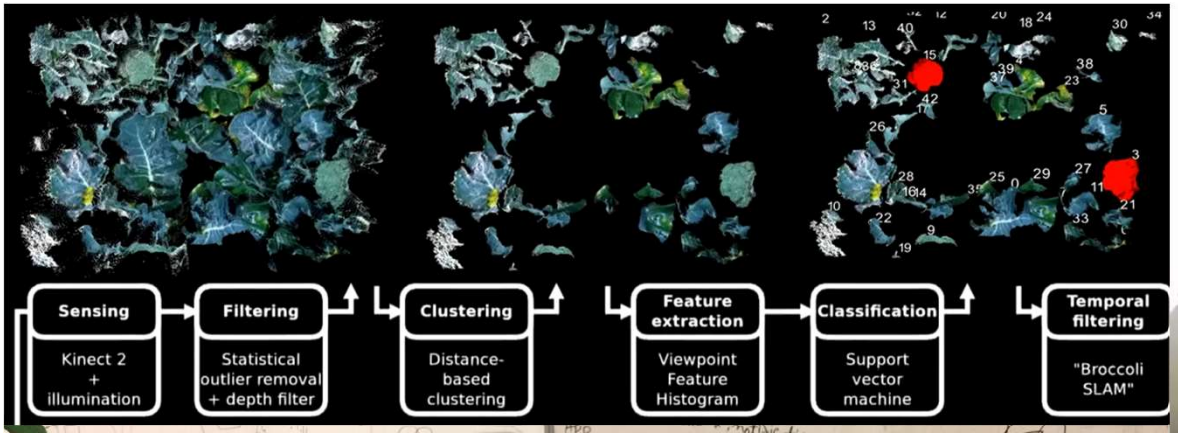
…revolution…



ImageNet Large Scale Visual Recognition Challenge: the introduction of deep learning algorithms into the challenge reduced the top-5 error by 10% in 2012. Every year since then, deep learning models have dominated the challenges. In 2015, researchers trained very deep networks that **surpass human performance**.

Machine Vision & Deep Learning

Machine Vision & Deep Learning



Students as a resource

2015 – 3 people/1 robot

2016 – 2 people/2 robots

2017 – 11 people/13 robots

2018 – 36 people/ 23 robots

UNIVERSITY OF LINCOLN

Students as a resource

Faculty

- Pål Johan From Professor (Robotics)

Researchers

- Grzegorz Cielniak Adjunct professor (20 %) iProcess (RCN project)
- Olga Korostynska Adjunct professor (20 %)
- Alexander Mason Adjunct professor (20 %) MeaTable (RCN project)
- Adjunct professor (20 %) Future Farm (RCN project)
- Postdoc Autonomous Navigation
- Postdoc Future Farm (RCN project)

PhD students

- Lars Grimstad
- Tuan Dung Le
- Ya Xiong
- Vignesh Raja Ponnambalam
- Abhishesh Pal
- Marianne Bakken
- Aleksander Eilertsen
- Marco F. dos Santos Xaud
- Yuanyue Ge
- Ivar Oveland (Geomatics)
- PhD Candidate, RCN project
- PhD Candidate, RCN project

Staff

- Project coordinator
- Robotics Engineer (75 %) (RCN project)
- Robotics Engineer (10 %)
- Robotics Engineer (10 %)
- Engineer, project work (temporary staff)
- Engineer, project work (temporary staff)
- Engineer (Technician)

Master students

- Master student
- Master student
- Master student
- Master student
- Master student
- Master student
- Master student
- Master student

Student project 1
Thorvald
20-30 master students

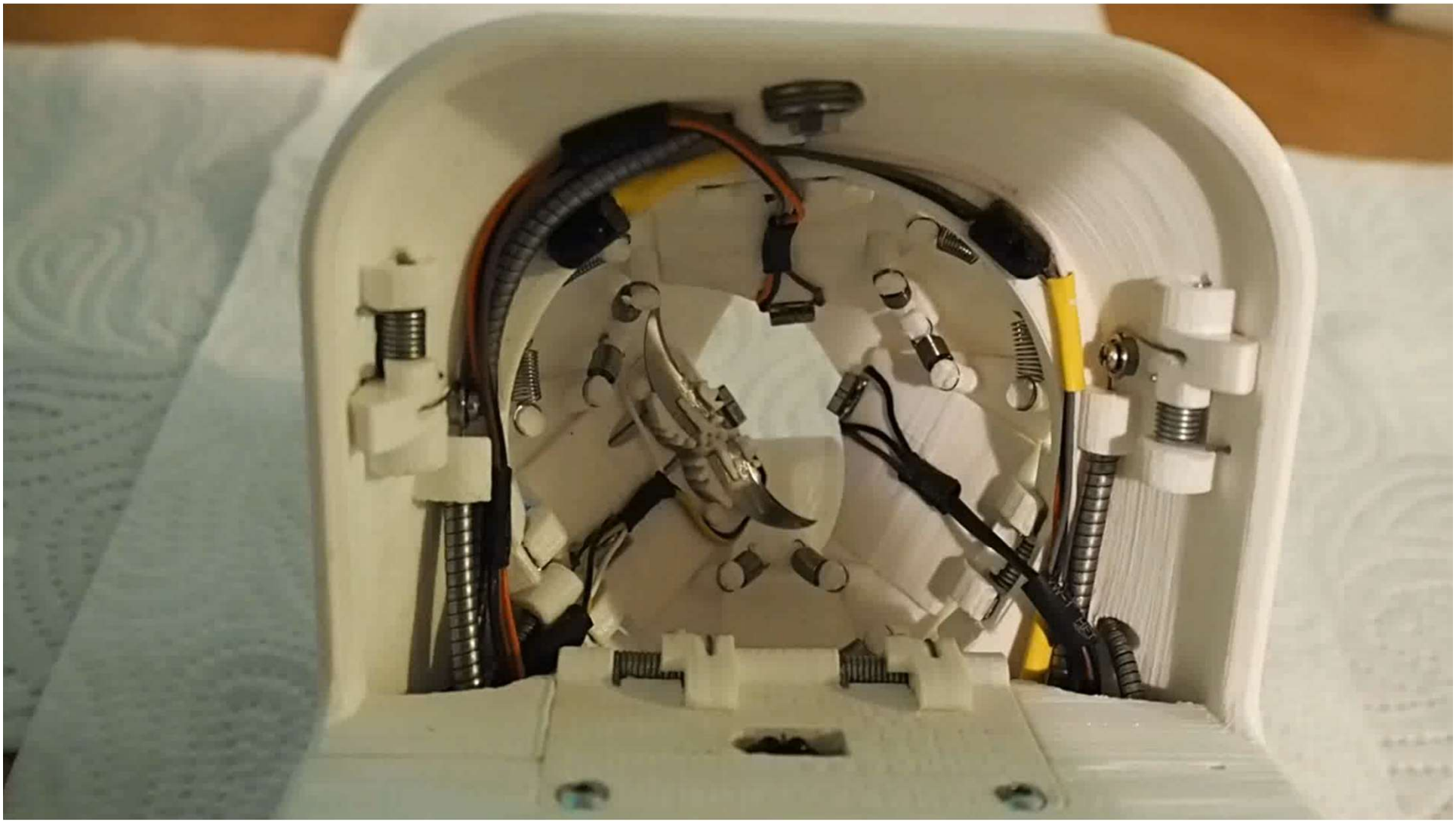
A: Battery enclosure
B: Drive module
C: Steering module
D: Suspension module

Thorvald

Thorvald

Student project 2 - **Manipulator**

Student project 3 - **Harvester**



Student project 3 - **Harvester**

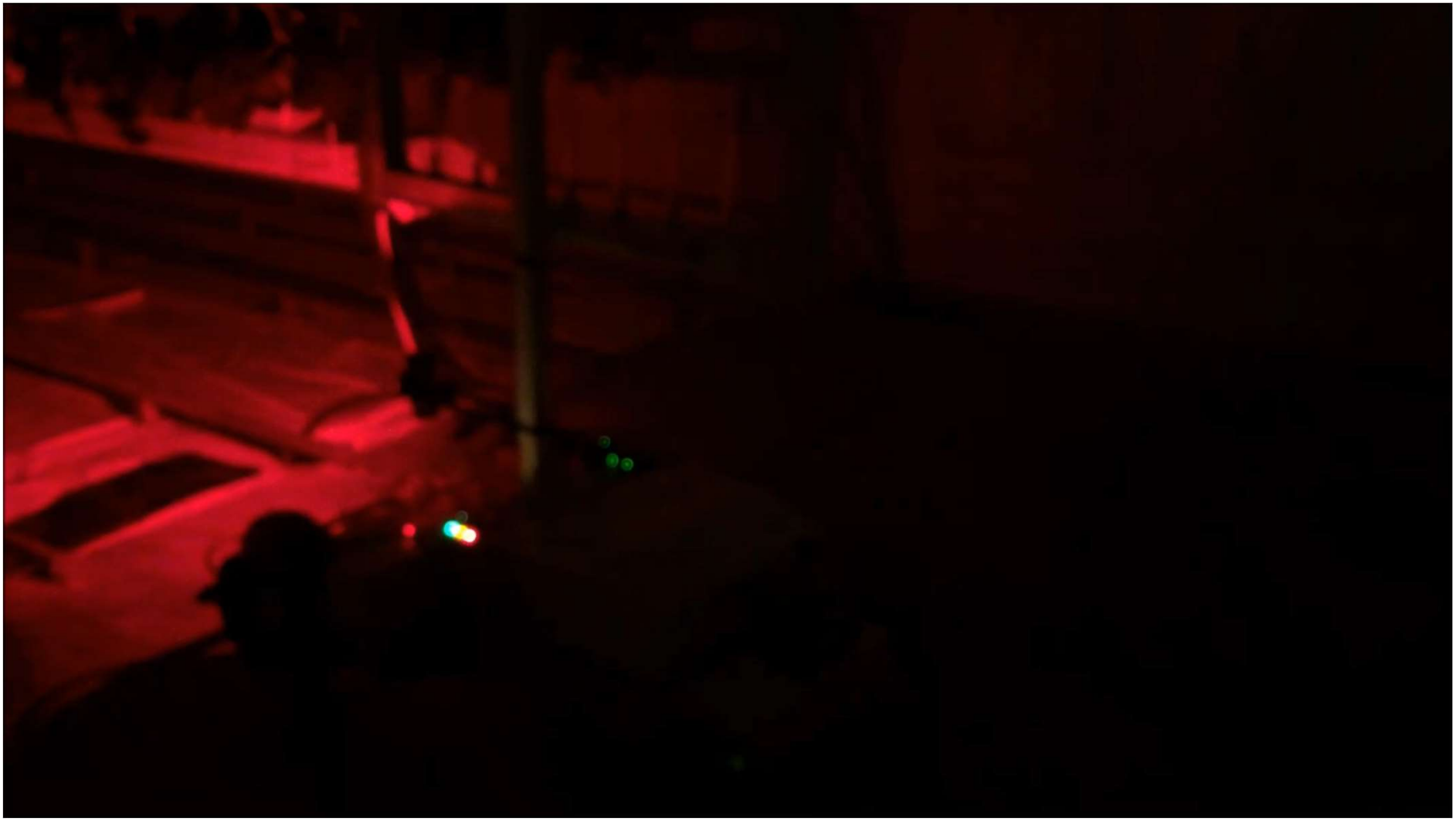
Obstacles and picking path planning

Based on 3D point-cloud, detect obstacles
and select the best path

Failure Cases

Student project 4 - **Greenhouse**

Student project 4 - **Greenhouse**



SAGA ROBOTICS

Student project 5 - **UMOE**

UTFORSK – 4 år, 2 MNOK

- Årlige workshop'er i Norge og Brasil
- La studentene delta forskning
- Industridrevet

Autonomous Monitoring Robot

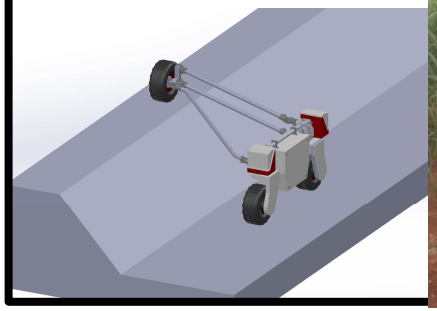
Operates between cane rows

Advanced sensors for monitoring weed and disease outbreak

- Camera
- Laser
- IR camera
- Geotagging

Maintain field ridges free of weeds

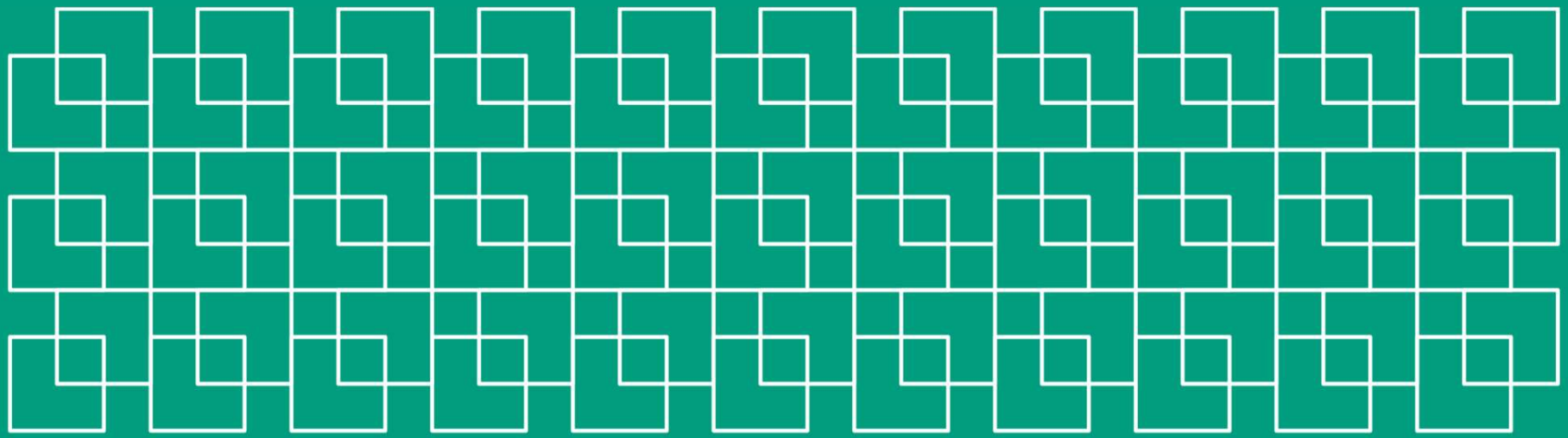
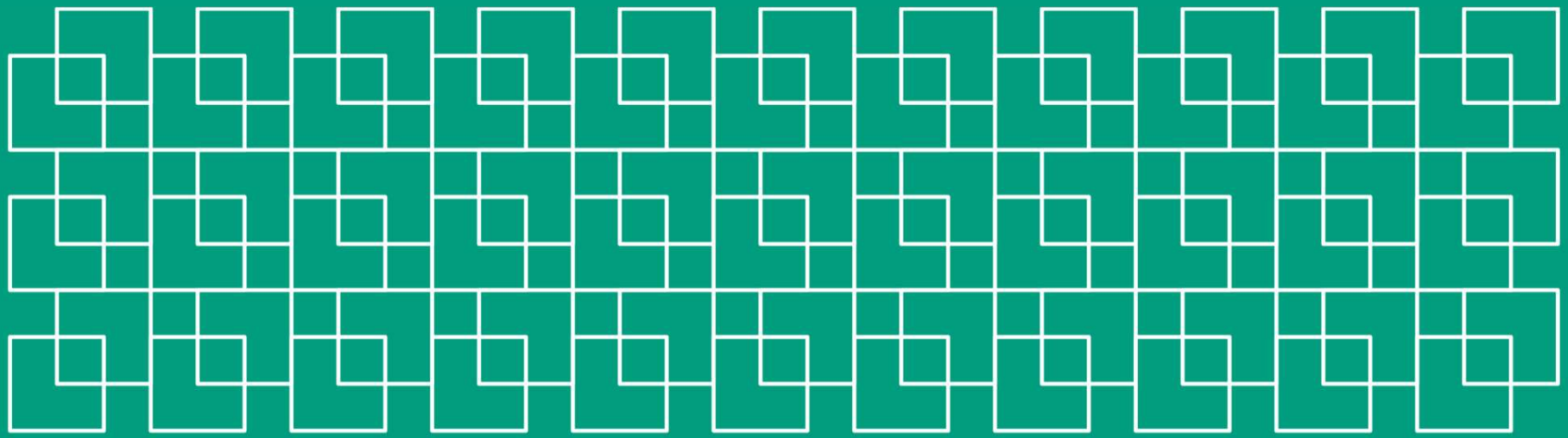
- Precision herbicides
- Greatly reduced field weed intrusion



Student project 6 - **Gras**

Conclusions:

Use technology to get students involved
Let them work in teams
Pysically located in the lab
Tightly integrated with the group



Thanks