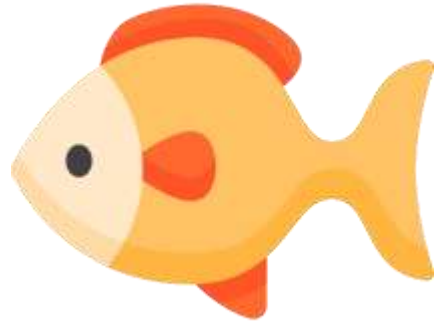


Innovatie– Marine Sensing & Robotics

Erik.Pekkeriet@wur.nl



Wat gaan we doen







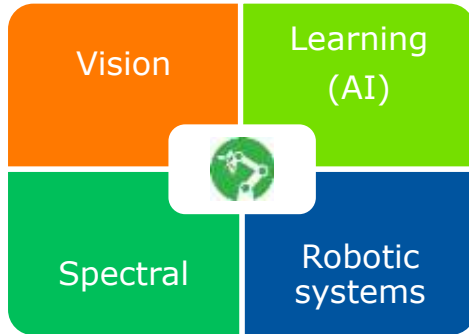
Investment Themes

- Connected circularity
- The protein transition
- Digital twins

Wageningen University & Research is working on

**SUSTAINABLE
DEVELOPMENT
GOALS**

Expertise & Propositions Agro Food Robotics



Optimal breeding performance



Circular agrifood Systems



Hands-free production



Objective product & process quality



Ethics and uptake ecosystems



Veranderende markt

- Toenemende variatie en verpakkingseenheden
- Kleine "batches" en kleine "runs"
- Frequente levering
- Noodzaak voor operationele flexibiliteit
- Voedselverspilling
- Druk op logistiek





Processed

- Massive land-use
 - Harvest peak
 - Low value/m²
 - Low labour input
 - Bulk storage
 - Low product variety
 - Raw material
- Value chain impact**
- Max. Yield & Quality
 - Rural Impact
 - Slow value chain
 - Long term contracts



Fresh



- Minimum land-use
 - Multiple harvest seasons
 - High value/m²
 - High labour input
 - Limited storage options
 - High product variety
 - End product
- Value chain impact**
- Yield, Quality, speed of delivery, reliability of delivery
 - Safe, trustworthy food
 - Fast value chain
 - Daily trade

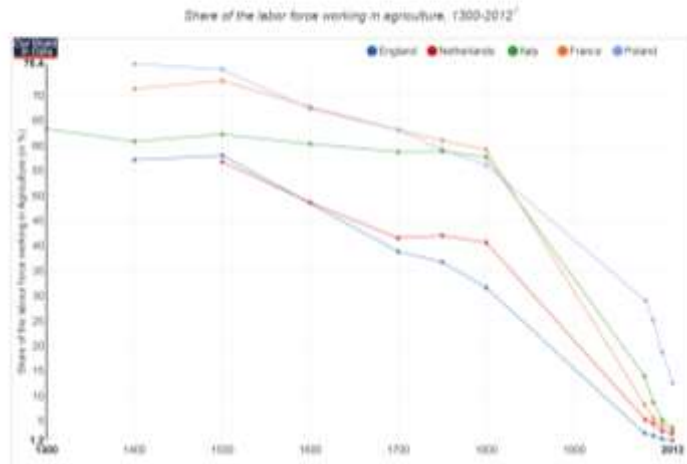
Fruits & Veggies



Ag-Employment

- 2/3 Japanese farmer is 60+
- China 5% in 2042

1.1 Long-Run Perspective: 1300 to Today

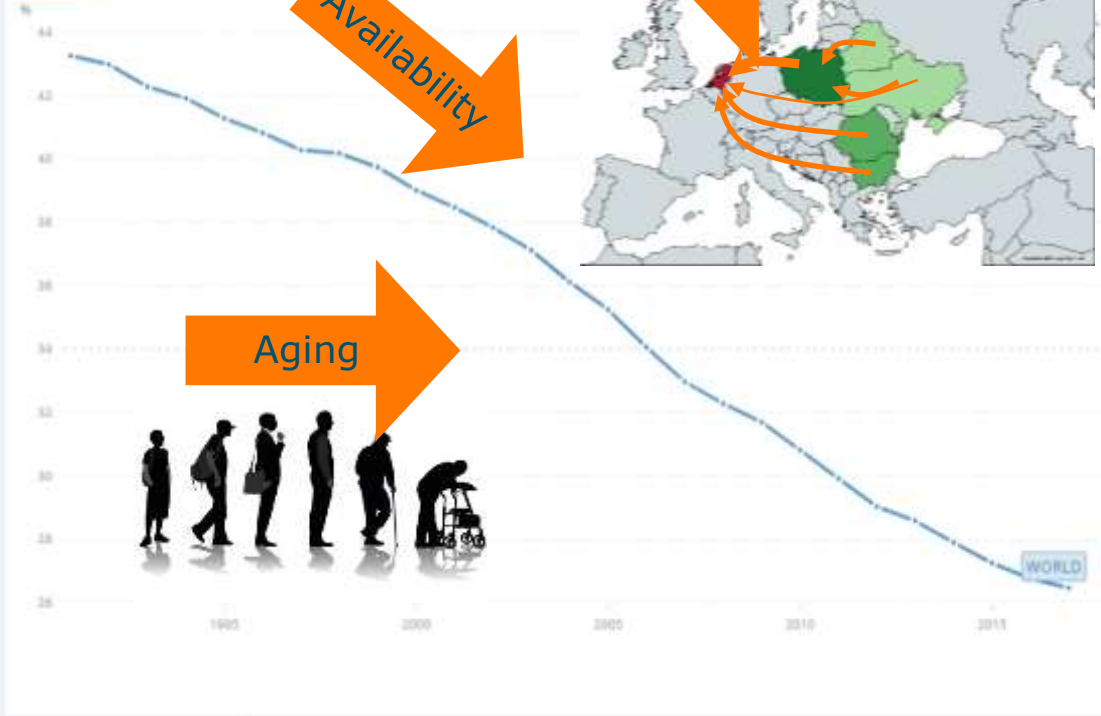


Employment in agriculture (% of total employment) (modeled ILO estimate)

International Labour Organization, ILOSTAT database. Data retrieved

License: CC BY-4.0

Line Bar Map



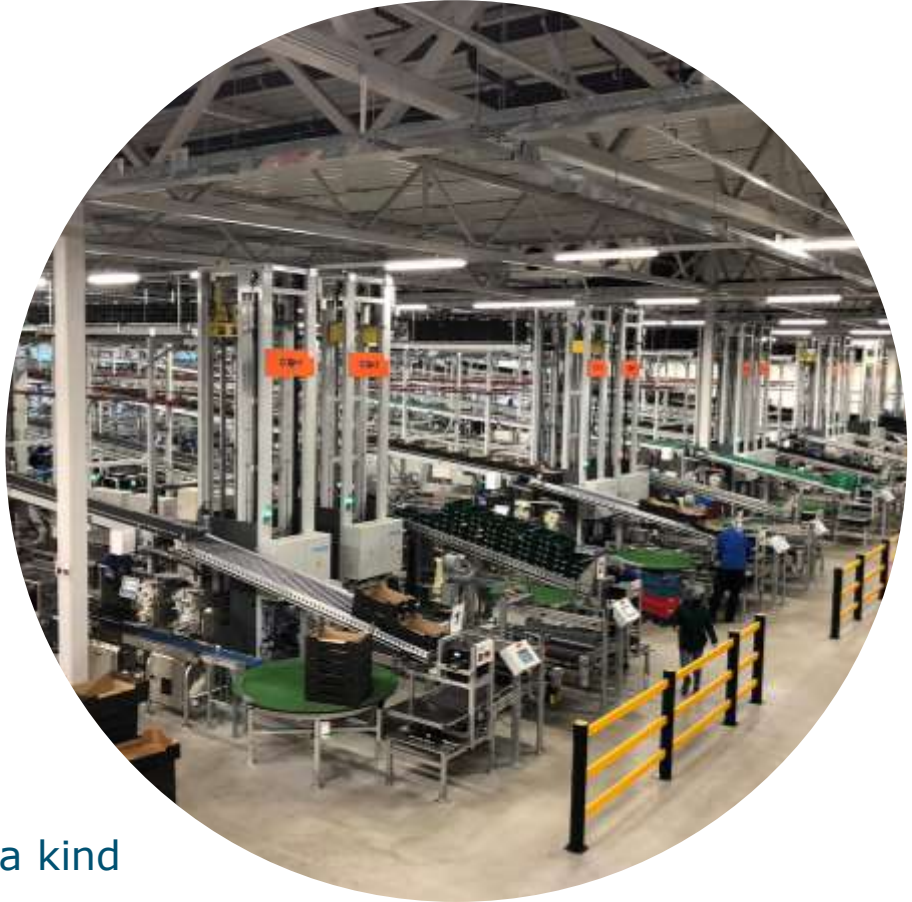
Verschuivingen

- Schaalvergroting in hoogvolume lijnen (processed?)
- Ketenverkorting richting producent
- Schaalverkleining local for local
- Vers dichterbij consument – korte snelle ketens



Lijn uitdagingen

- Contaminatie-risico's
- Reinigen
- Tracking & tracing
- Footprint
- Flexibiliteit
- Storingen
- Productwisselingen
- Arbeid optimalisatie
- Op- en afschalen
- Dure IT en investeringskosten, 1 of a kind





Robot concepten voor de toekomst

- Minimaliseer food contact parts
- Batches, meerdere functies integreren
- Bin-picking
- Werkbereik controle/sturing
- Data gedreven
- Slimme foutafhandeling
- Schaalbare systemen
- Wheel in wheel out systemen
- Logistieke robots ipv banden



Status chicken breast May 2016



Robotic Bin Picking of Chicken Breasts Project "PicknPack"



For more info, contact:
Gert.Kootstra@wur.nl

LACQUEY
Robot grasping solutions



WAGENINGEN UR

For quality of life







Food Safety

Equipment / Hardware Hygienic Design Criteria

Machinery directive
2006/42/EC

Process Hygiene Food Processing Criteria

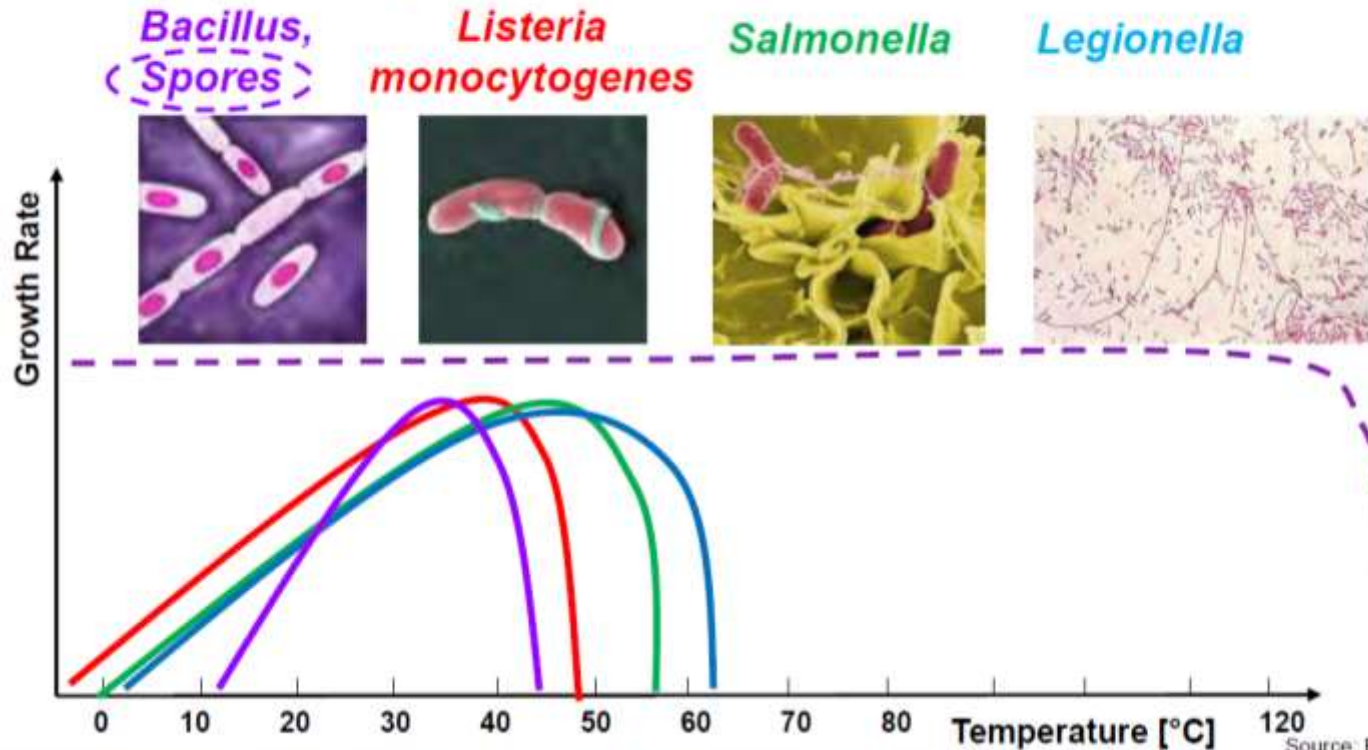
EU-regulations:

RE (EC) 178/2002
RE (EC) 852/2004
RE (EC) 2073/2005

- Regulation (EC) 1935/2004 - on materials and articles intended to come into contact with food
- Regulation (EU) 10/2011 Plastic materials in food contact
- Regulation (EC) 2023/2006 - on good manufacturing practice for materials and articles intended to come into contact with food

What MO need in order to multiply?

Influence of temperature on growth rate



Clean In Place delta robot

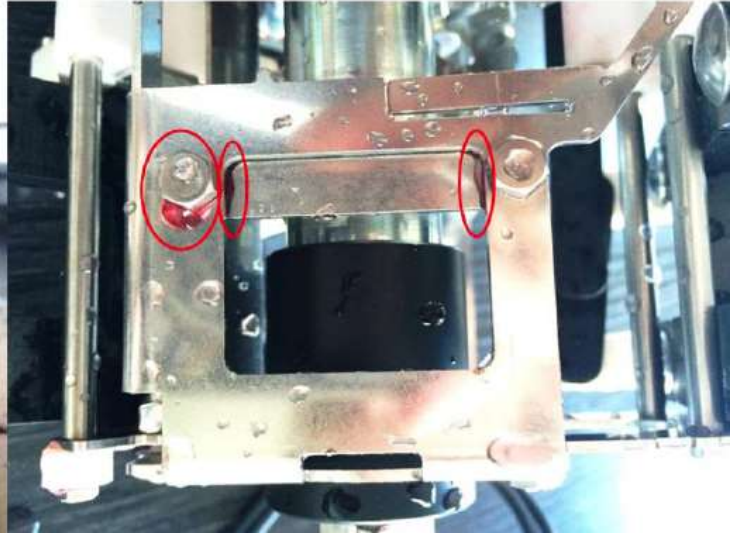
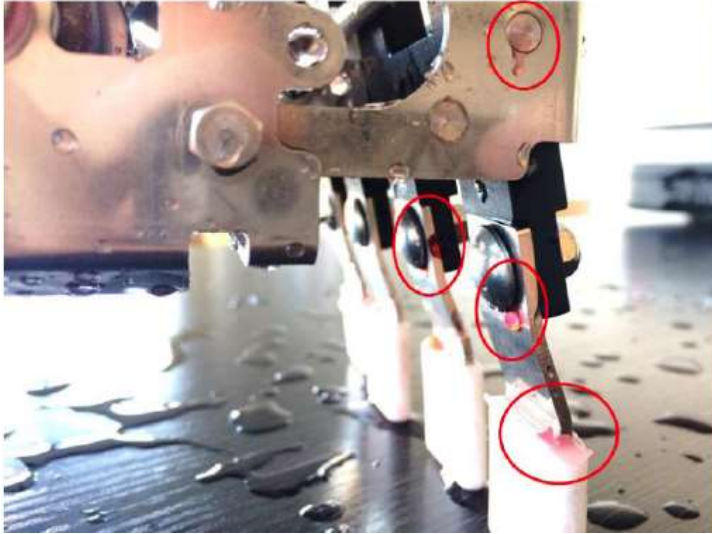




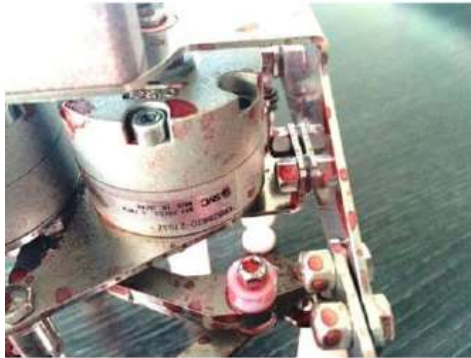
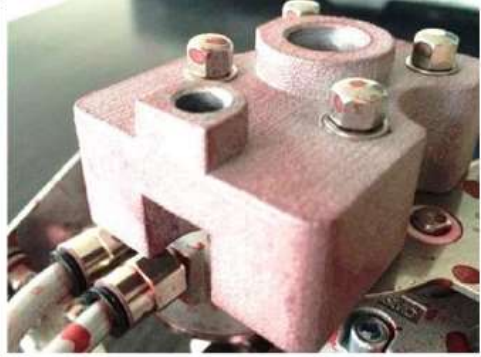
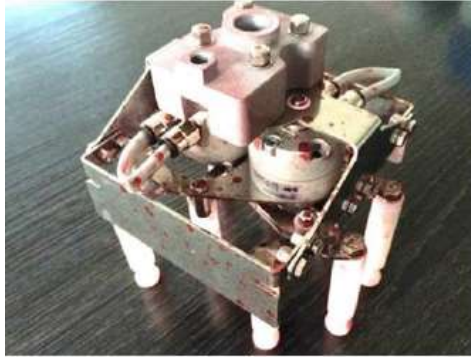
Cleaning & hygiene tests by Fraunhofer



Cleaning tests with RET



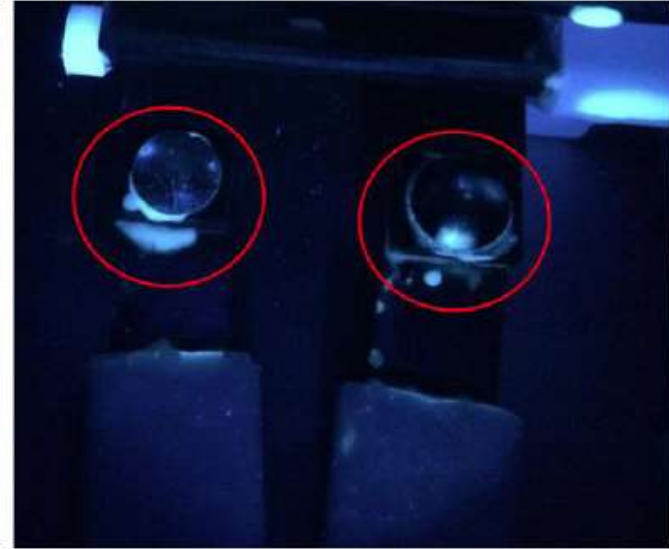
Cleaning & hygiene tests



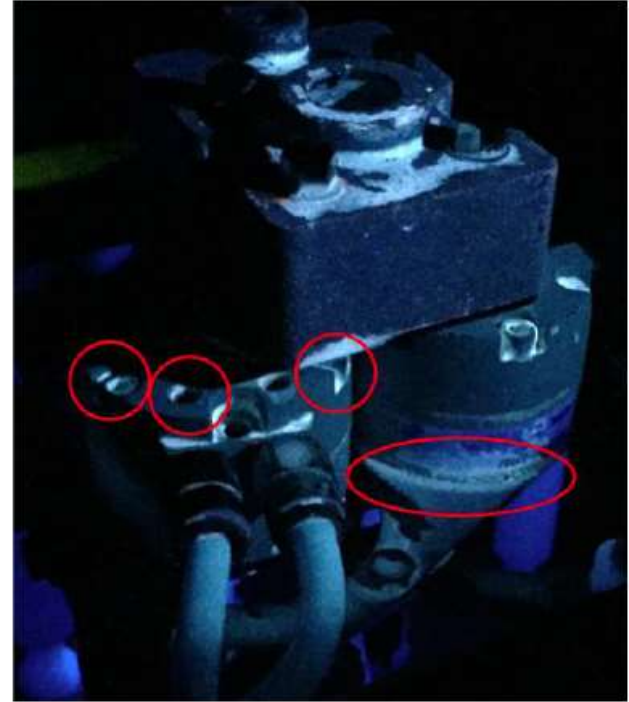
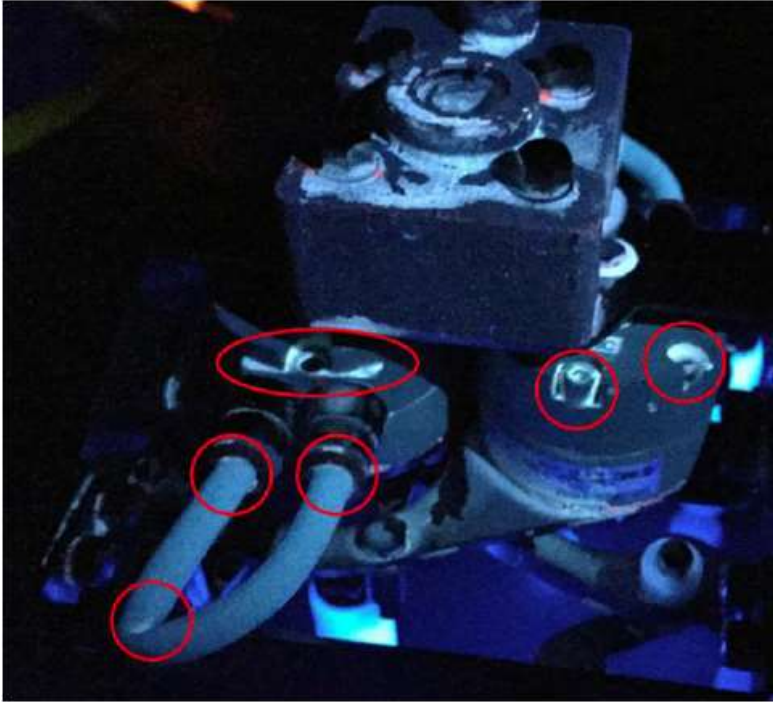
Cleaning tests with RET



Cleaning of custard & UV



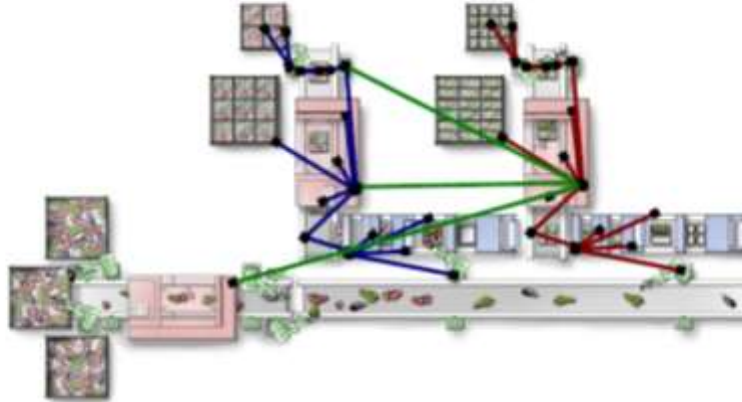
Cleaning of custard & UV





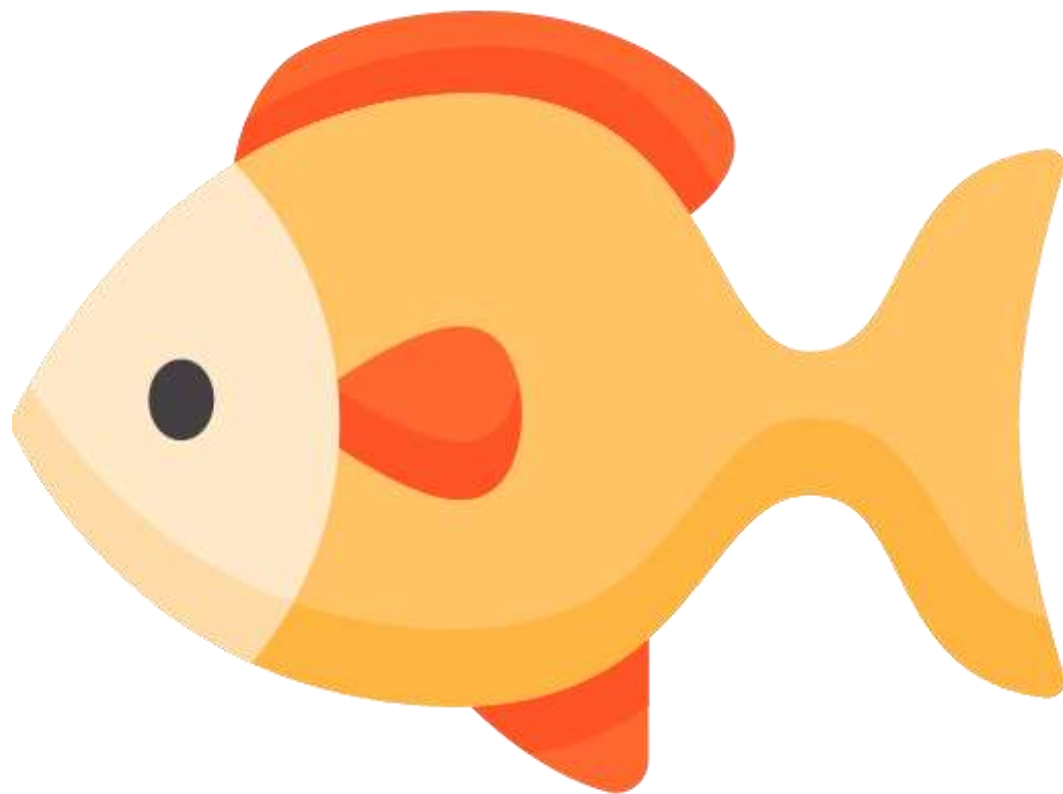
Data connection variability

Communication structure $\neq$ mechanical interconnections!



Semantische lijnsturing

- Auto discovery van software modules
 - Geen netwerk adressen nodig
 - Aanroepen via symbolische namen
 - Line controller checkt iedere module voor operatie (stoplight)
- Productie specifieke configuratie van modules
 - Handled @ line-controller
 - Stored in de line-database (Vendor neutral model)
- Software compositie gebaseerd op ontology
 - Processes, products and machines in a formal way
 - Modules, devices and components
- Back-tracing to all production steps
- Whisper & shout messages
- Drie communicatie niveaus Operatie, T&T, Datadriven

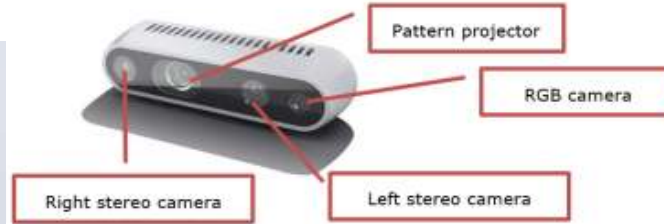


FDF Prototype in Den Helder



Fully Documented Fisheries

Diffuse illumination



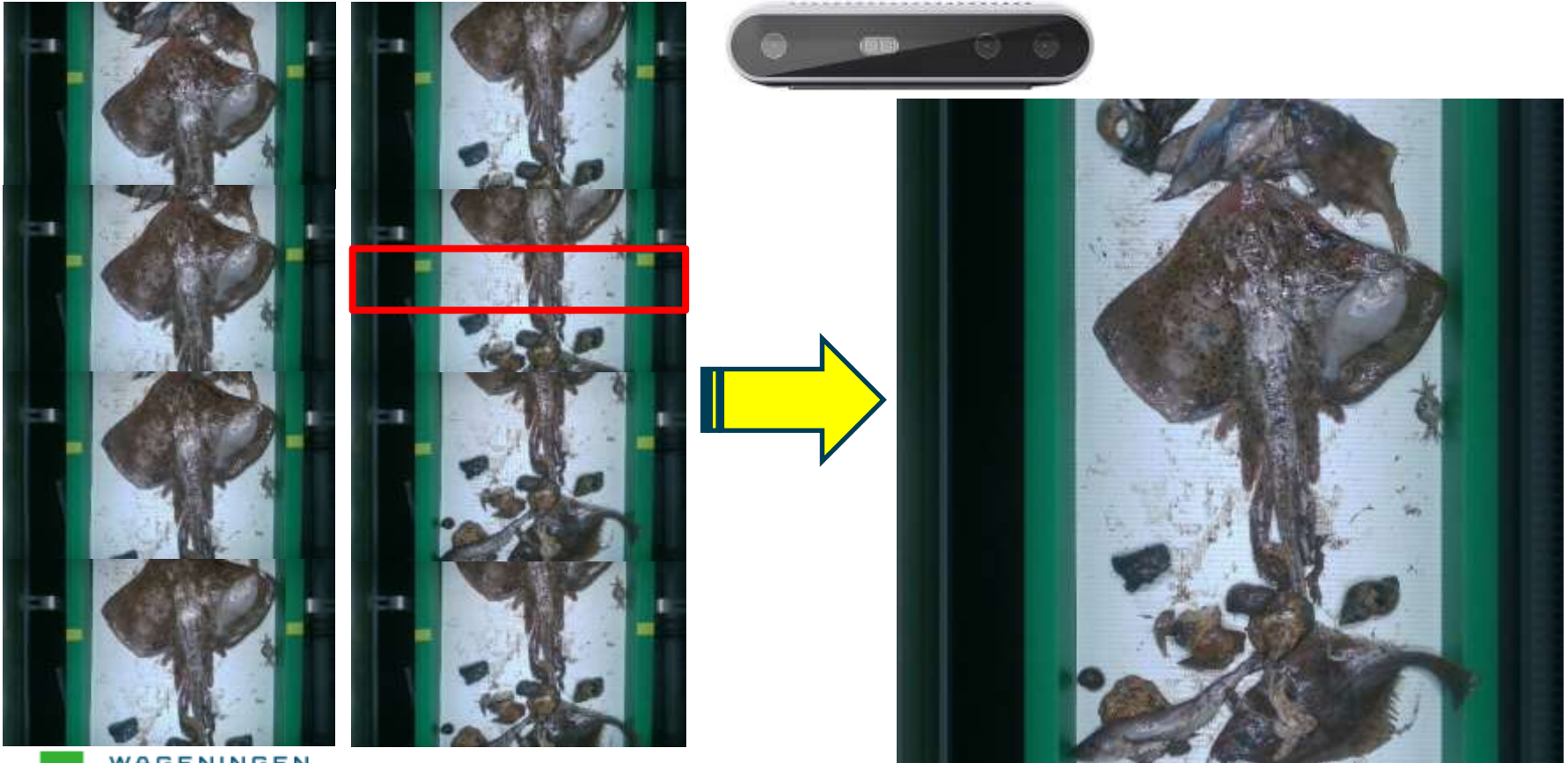
Intel RealSense Camera D435

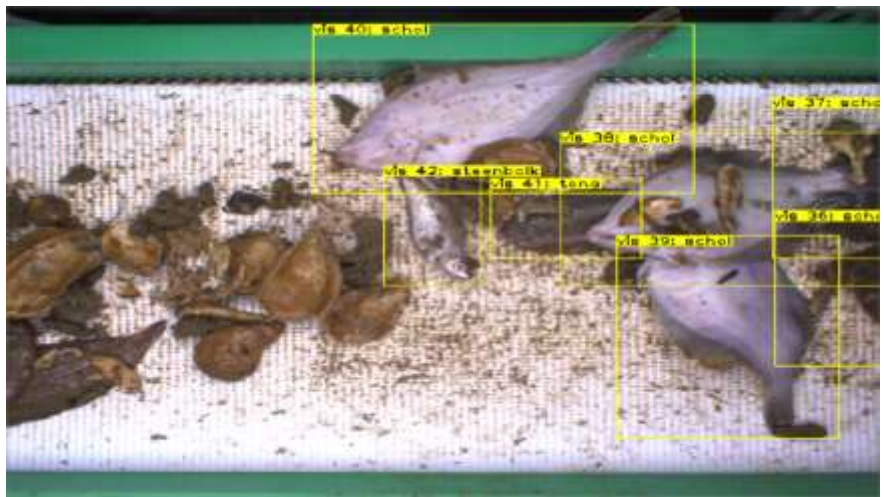
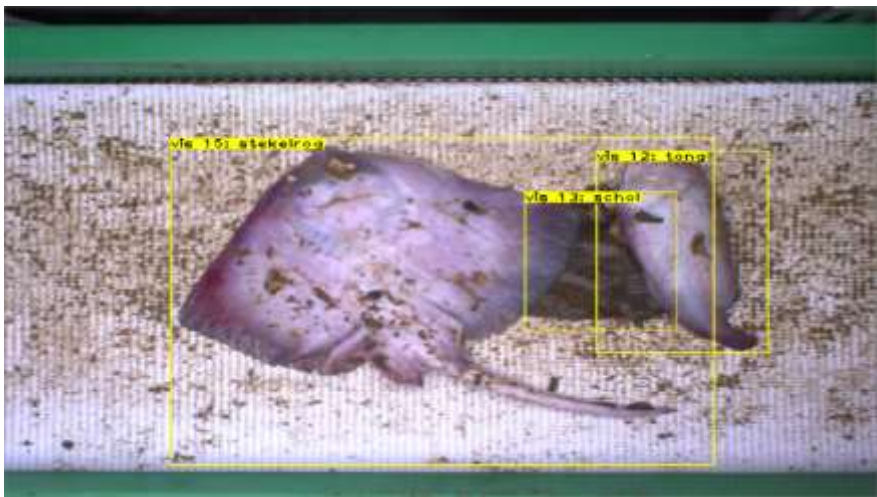


Famos Industrial Camera D435e

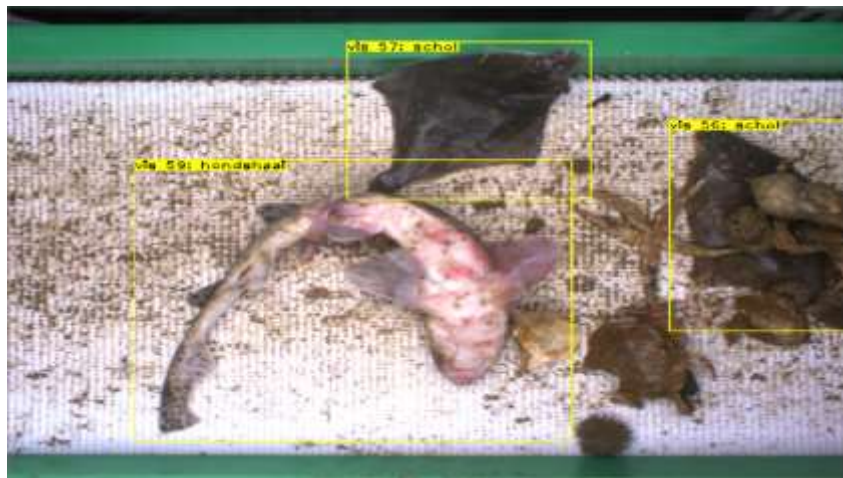


Image overlapping: Matrix Image -> Line Scan





- Classification with YOLOv3



fish 1: plaice

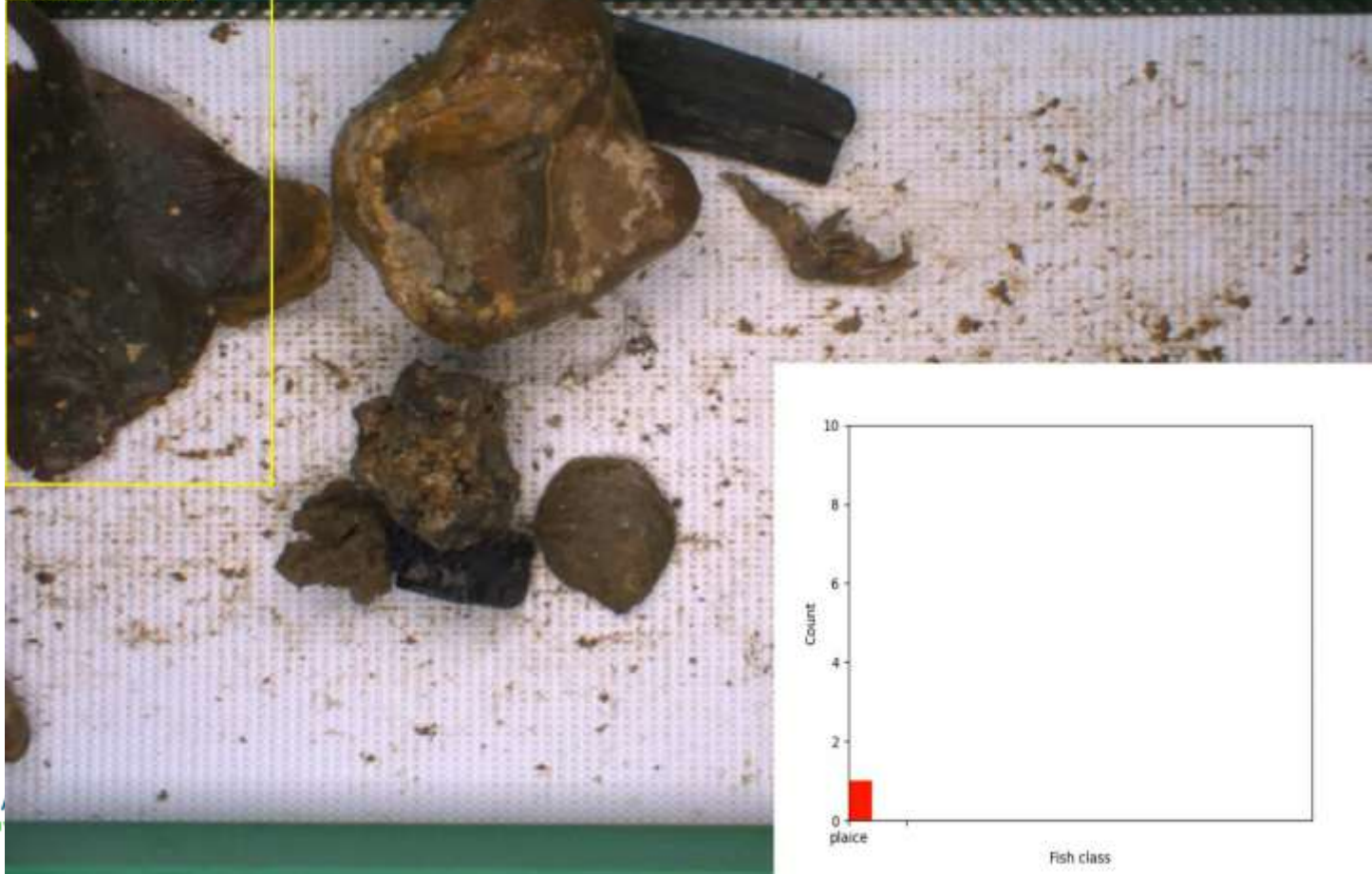
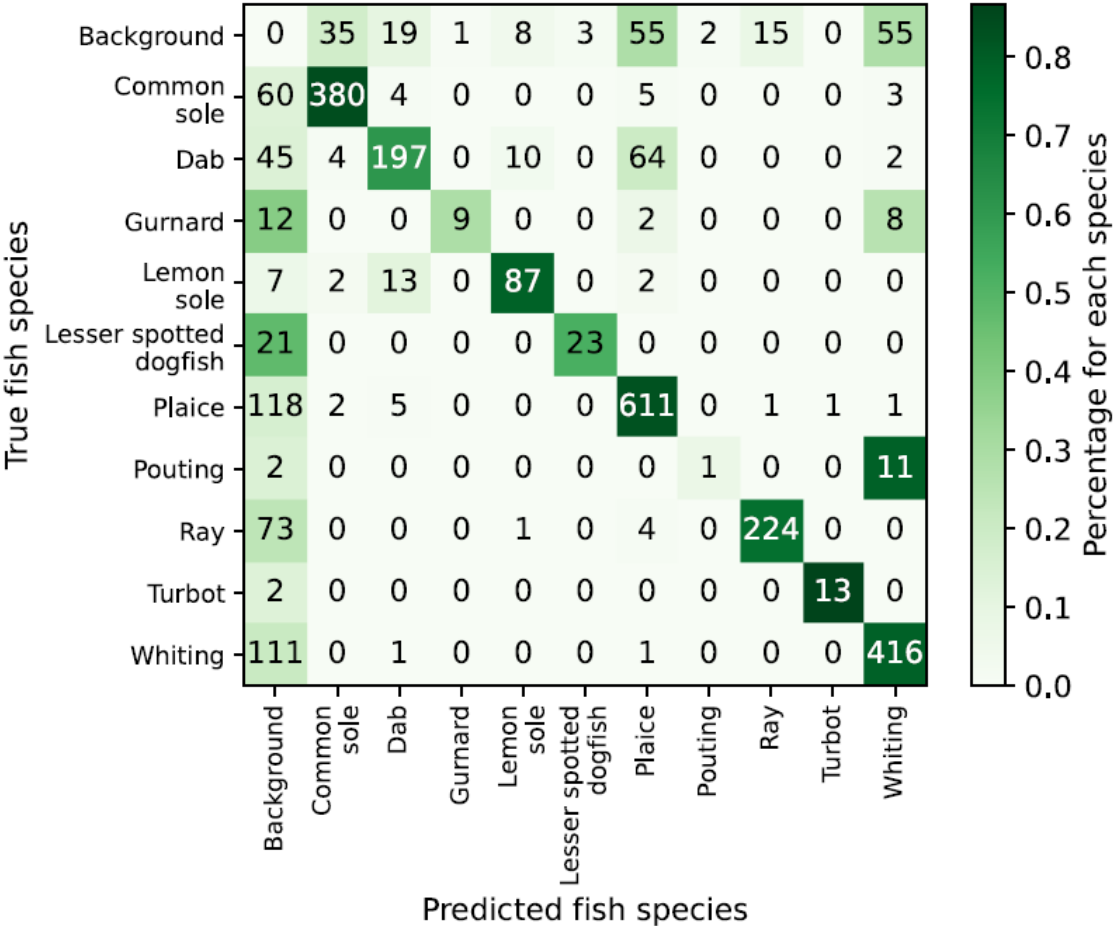


Table 5. Confusion matrix of the detections in the test dataset. The cell colours are the percentages (for each fish species), using the scale on the right.

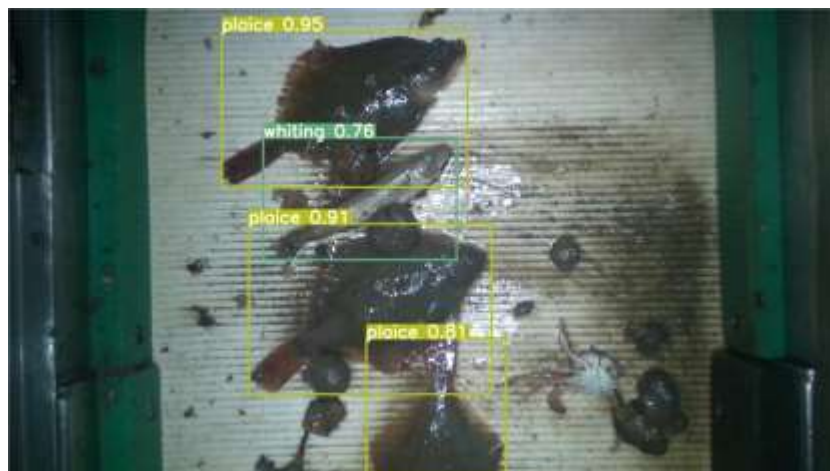


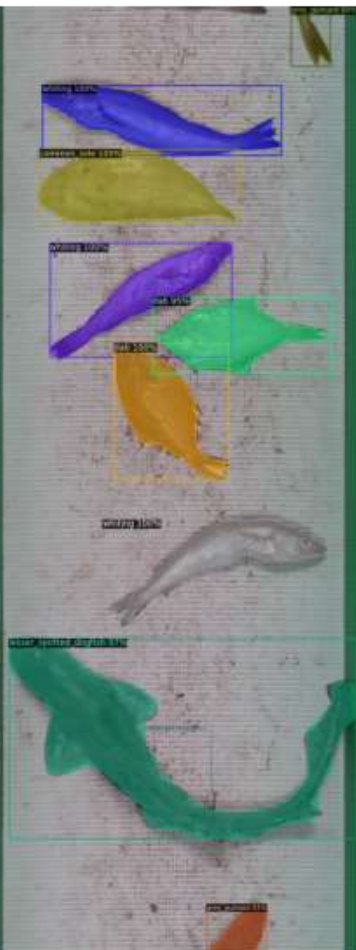
Gewicht



Onboard test



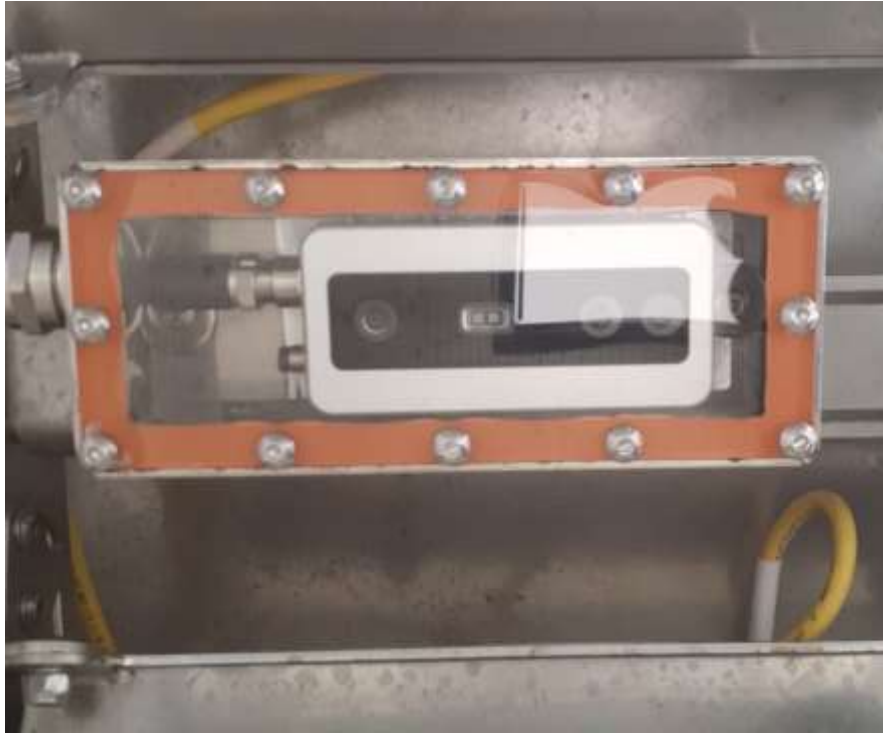




Example of image acquired during the onboard tests



Check camera & illumination



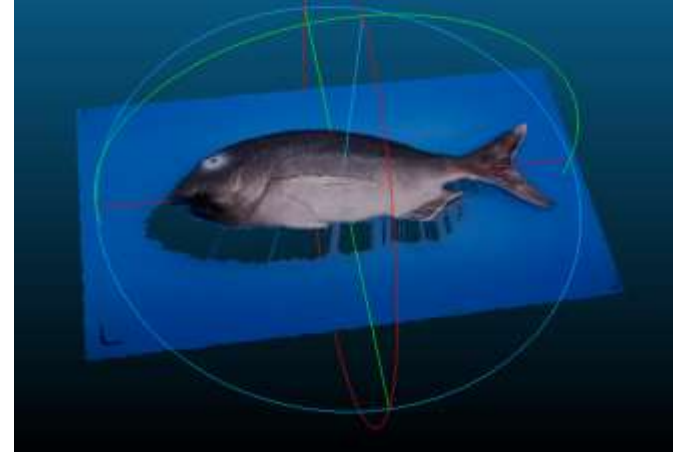
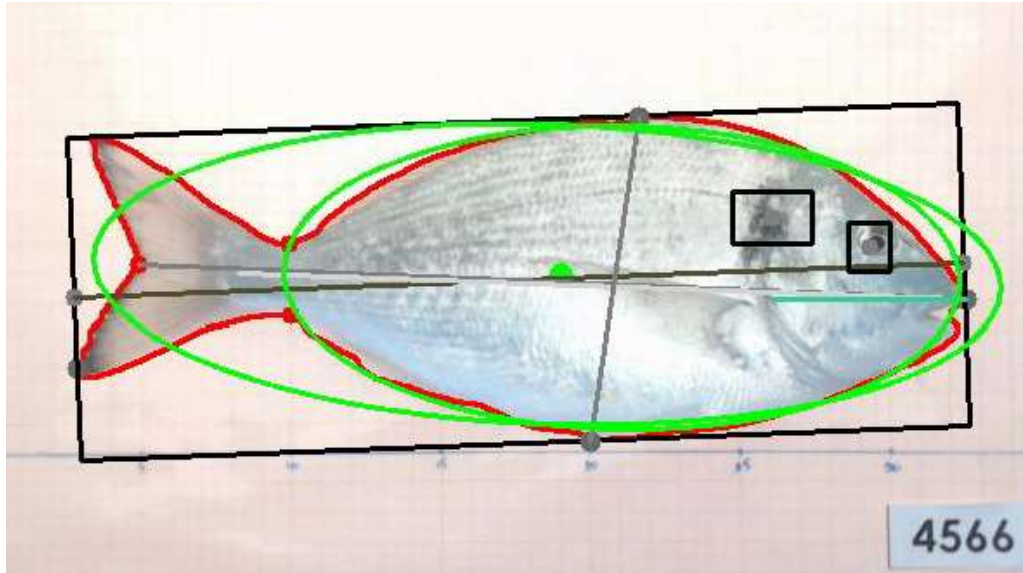


AquaIMPACT EU project (automatic phenotyping)



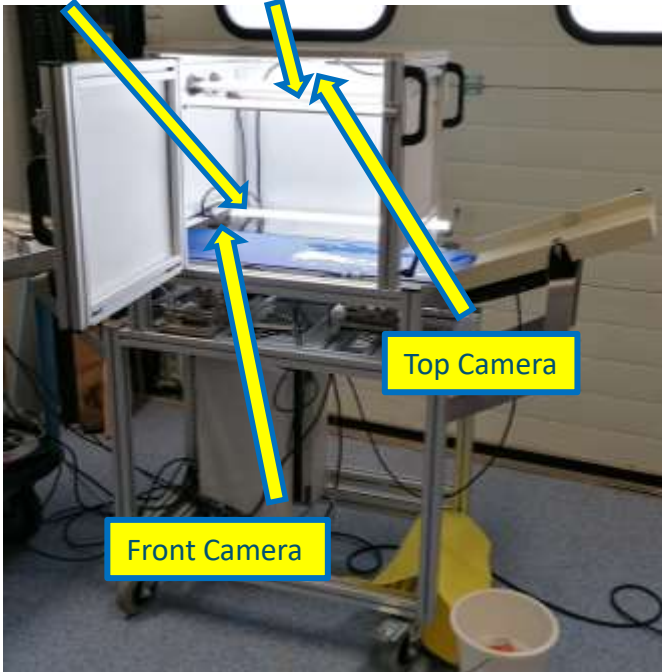
AquaIMPACT
Nutrition and breeding

- Genomic and nutritional innovations for genetically superior farmed fish to improve efficiency in European aquaculture



Phenotyping prototype using machine vision

Diffuse illumination



Intel RealSense
Camera D435



Frmos Industrial Camera
D435e

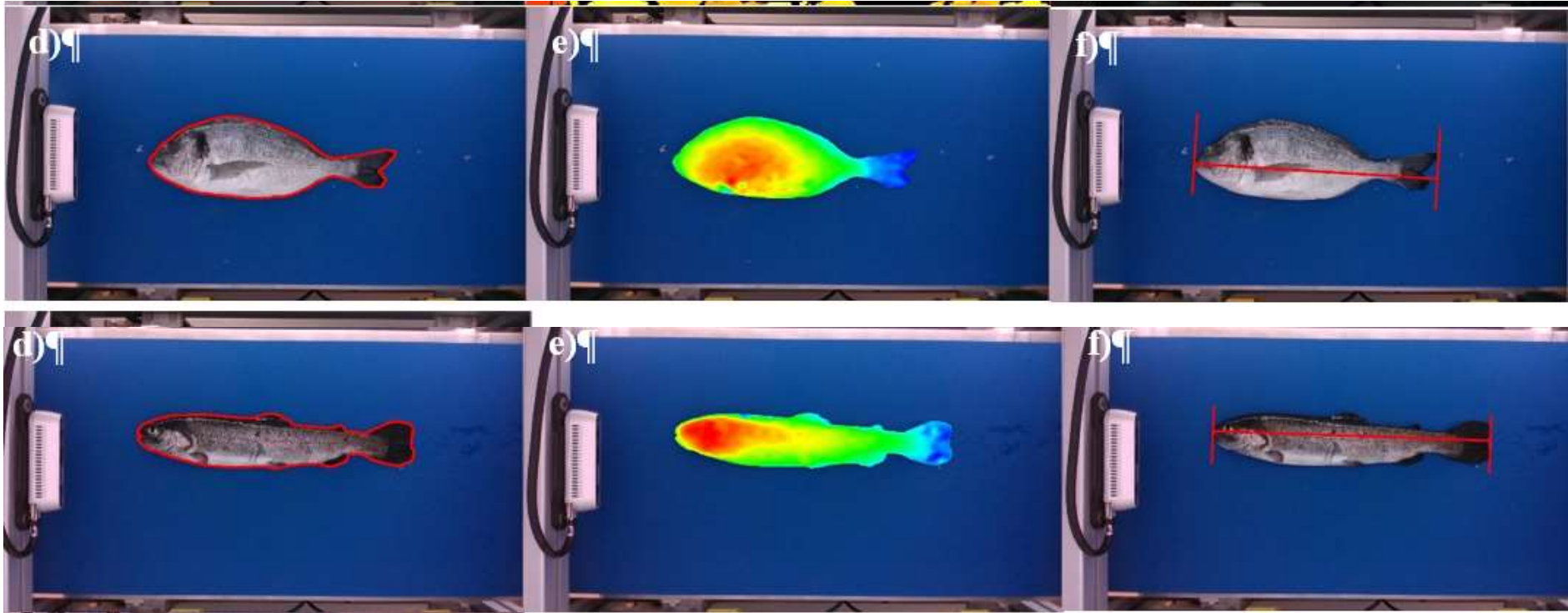


Top camera

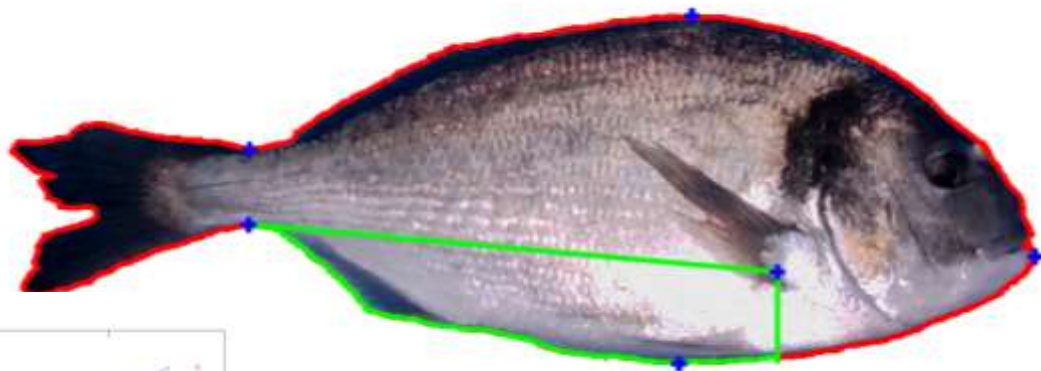


Front camera

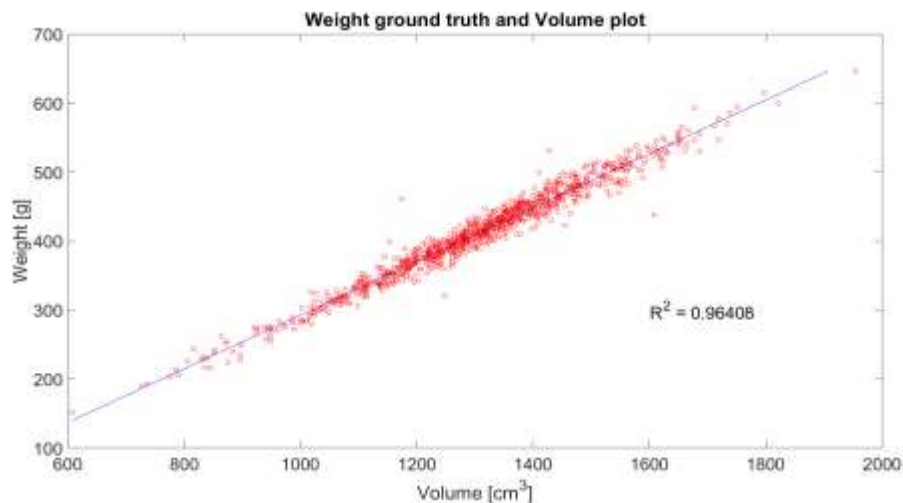
Examples of basic image processing operations



Automatic extraction of landmarks



Gilthead seabream



CUDMed0009

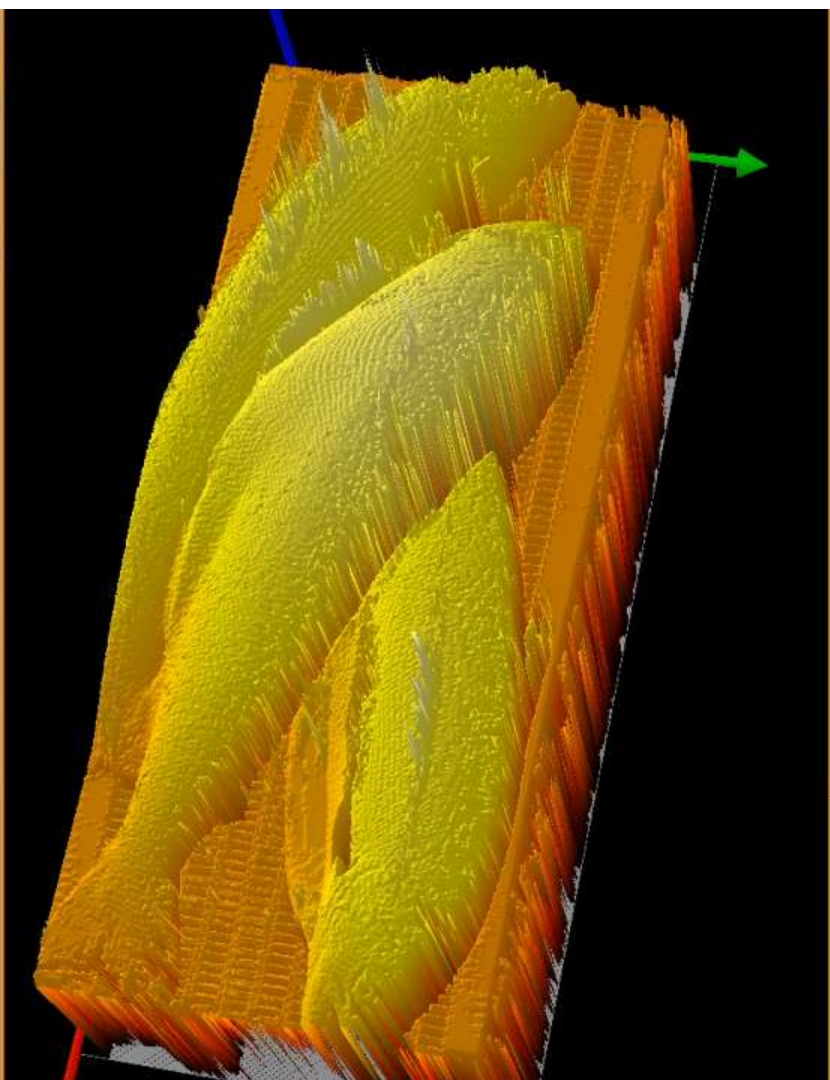


Study on vision controlled fish and meat picking robot

- Possibilities to automate the bin picking process using deep-learning computer vision and robotics.
- The environment is very hostile (wet, dirty, cold...).
- There is a high variation in the products, even within one variety, concerning shape, material properties, stiffness.

- Whole salmon:



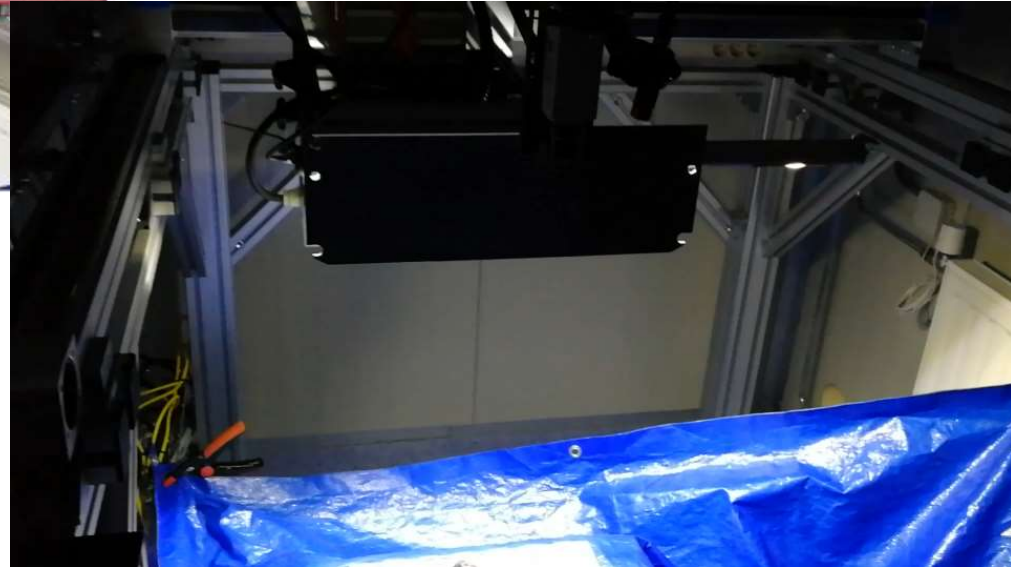
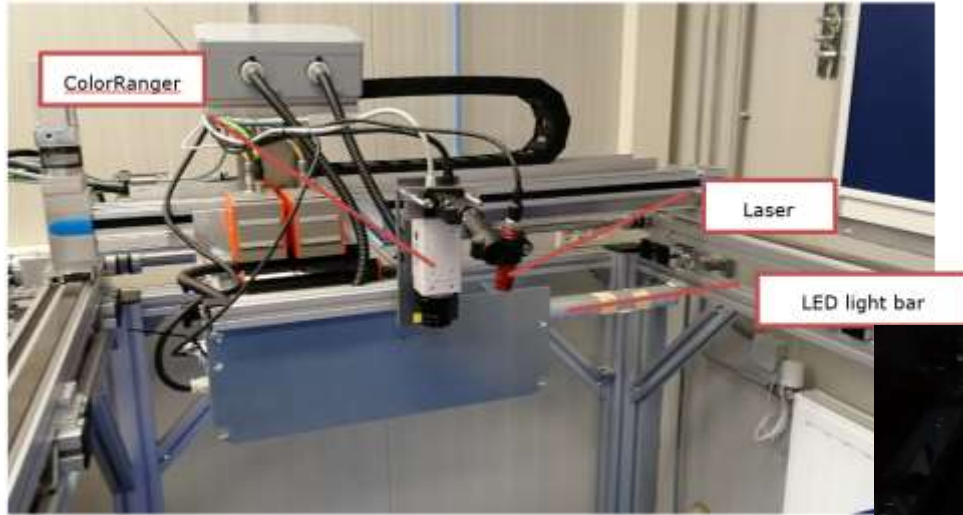


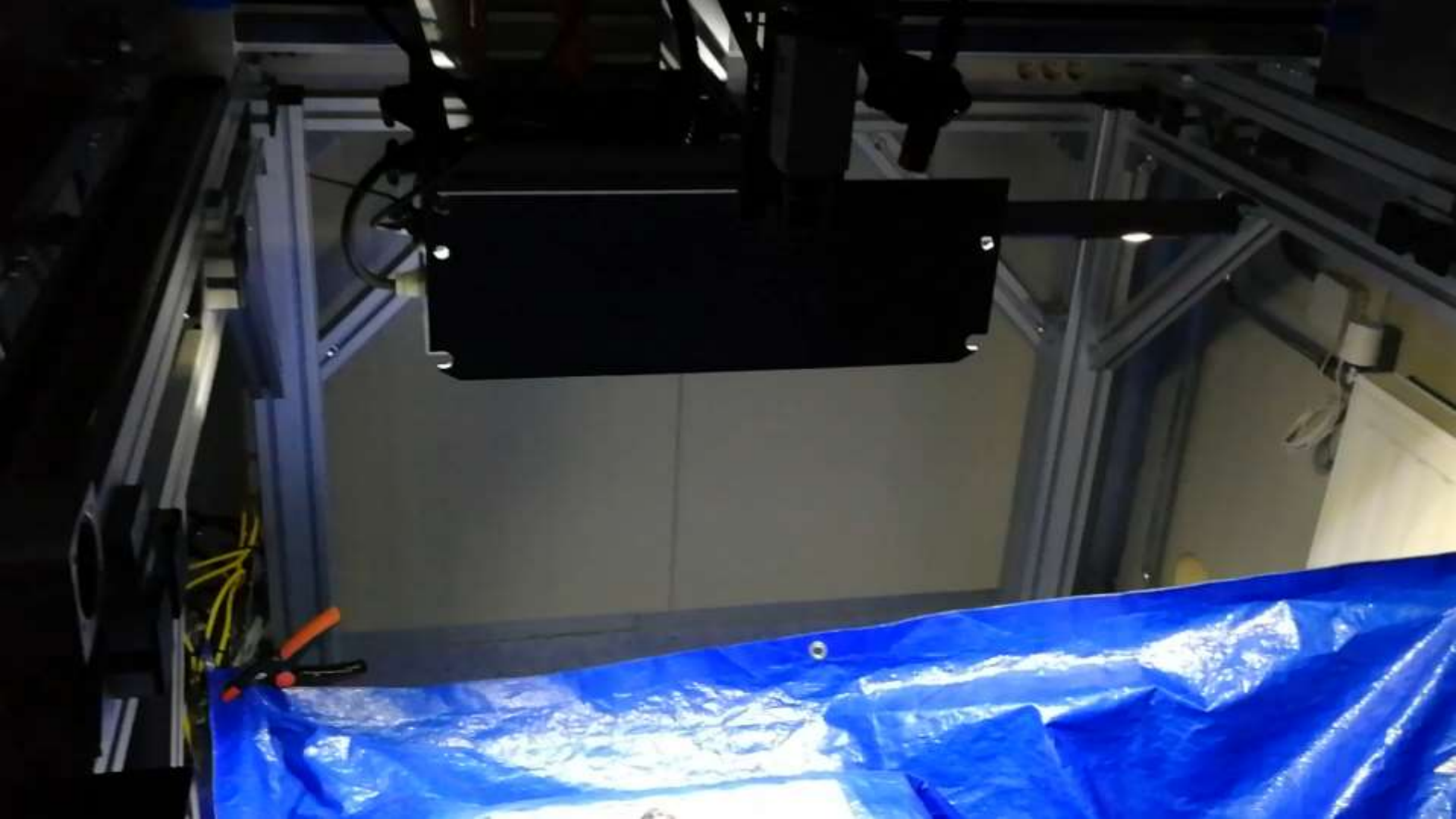
Different RGB-D camera systems investigated

- Example registered colour and depth image
- Deep-learning 3d object pose estimation

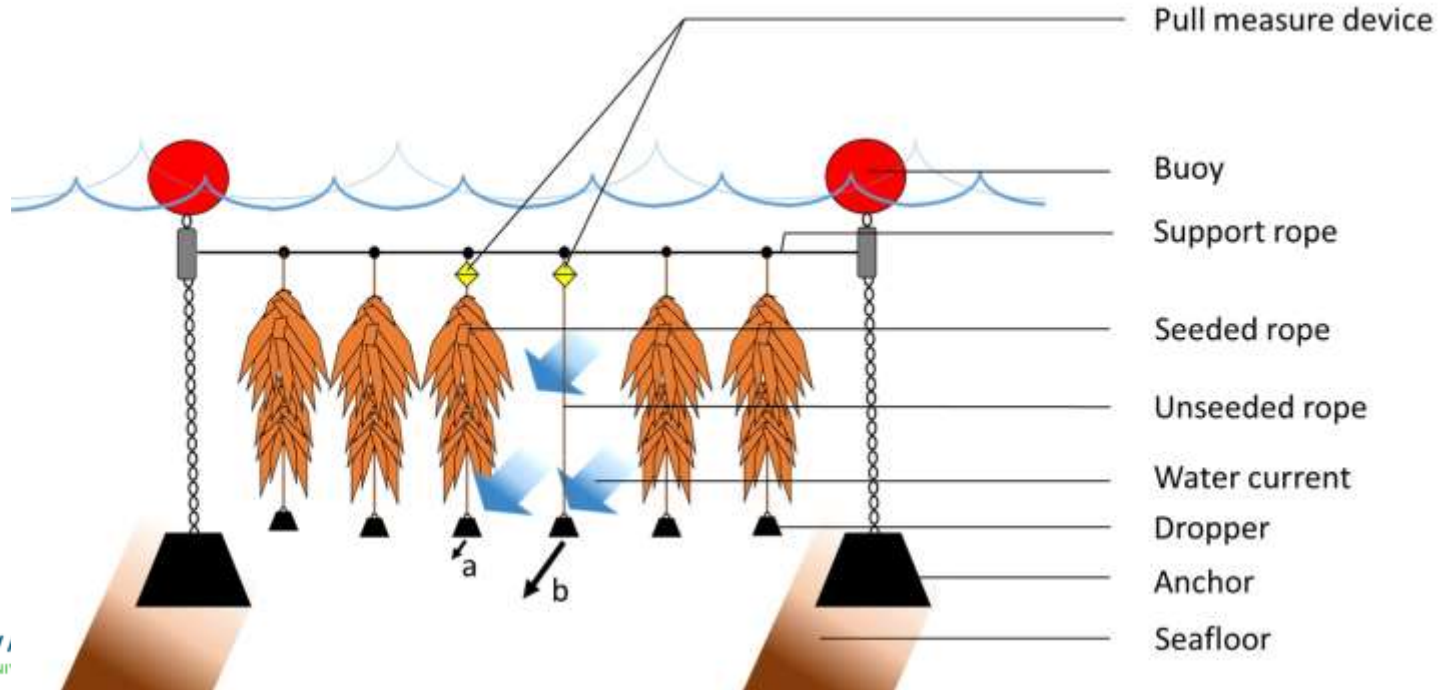


3D image acquisition using Sick colour ranger camera





Monitoring seaweed farms



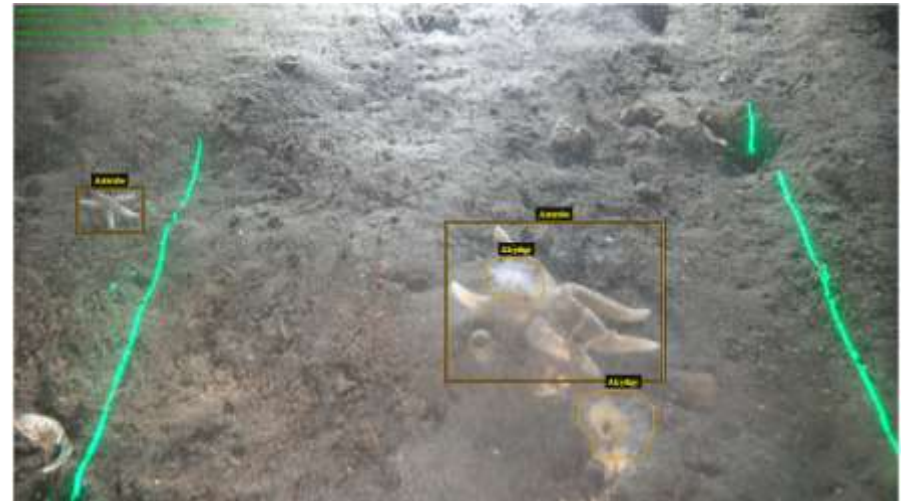
Monitoring seaweed farms

Extra funding was attracted from AGRO and WMR to do experiments:

1. June experiments of biomass estimation using sonar at 'de noordzee boerderij'.
2. October: adding drag forces tools to the Noordzee boerderij's farm
3. Literature research on visual estimating protein content and contamination using multispectral data.

Annotaties tbv training

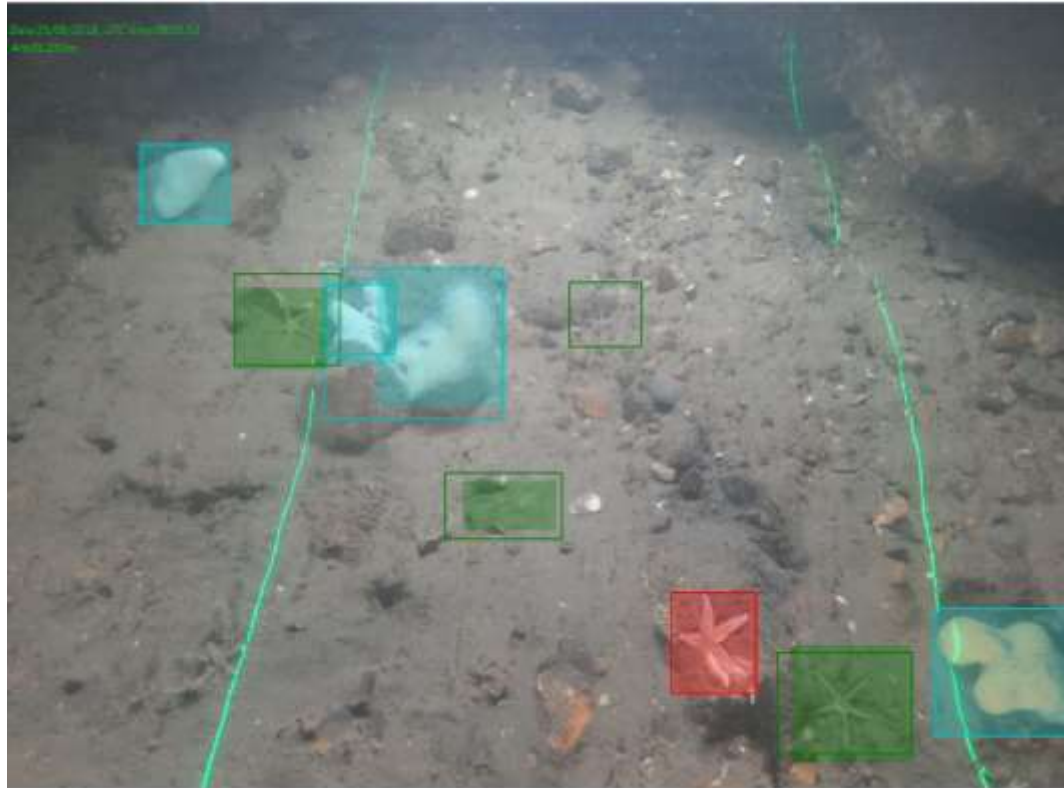
Klaverbank test case



Annotaties tbv training

Klaverbank test case





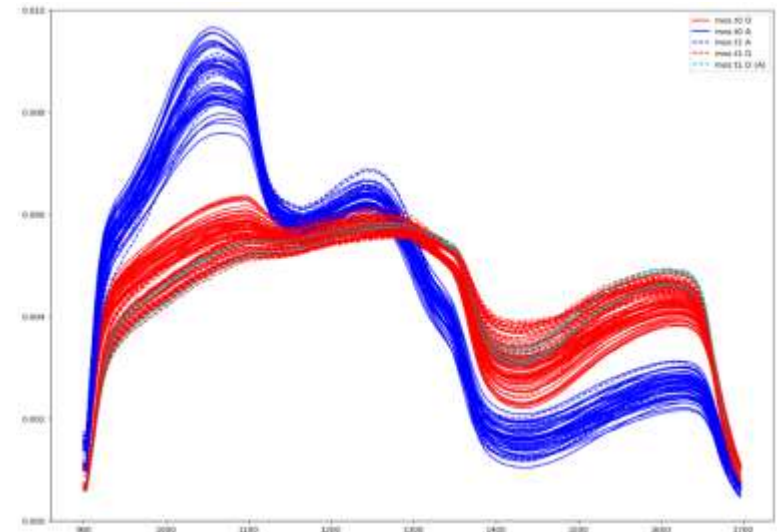
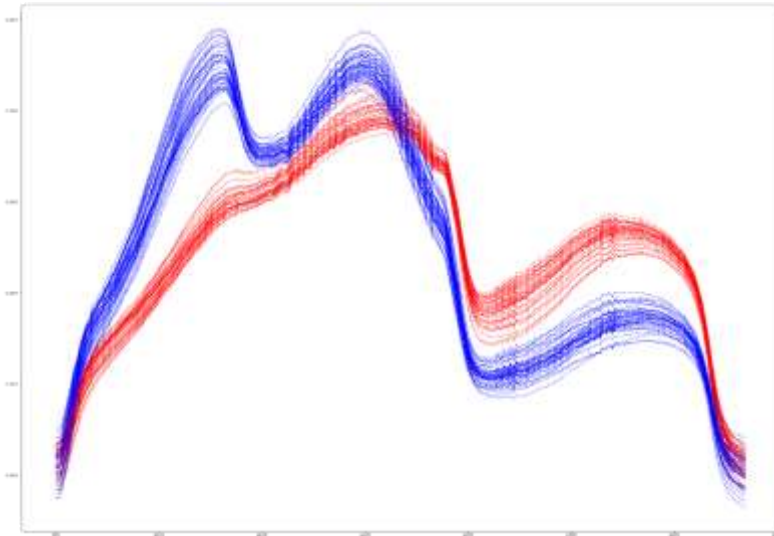
levend – dood

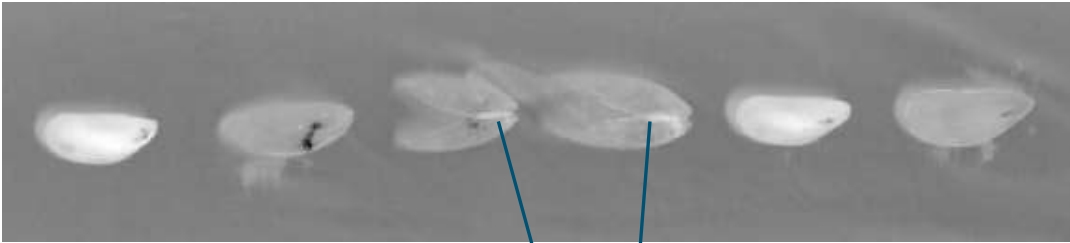
levend/dood exp



Resultaten mosselen

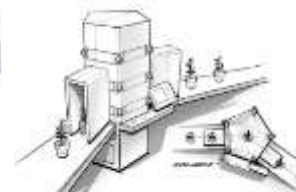
levend/dood exp





- Levend versus dood duidelijk te zien.
- Organisch materiaal detecteerd?

3D herkenning







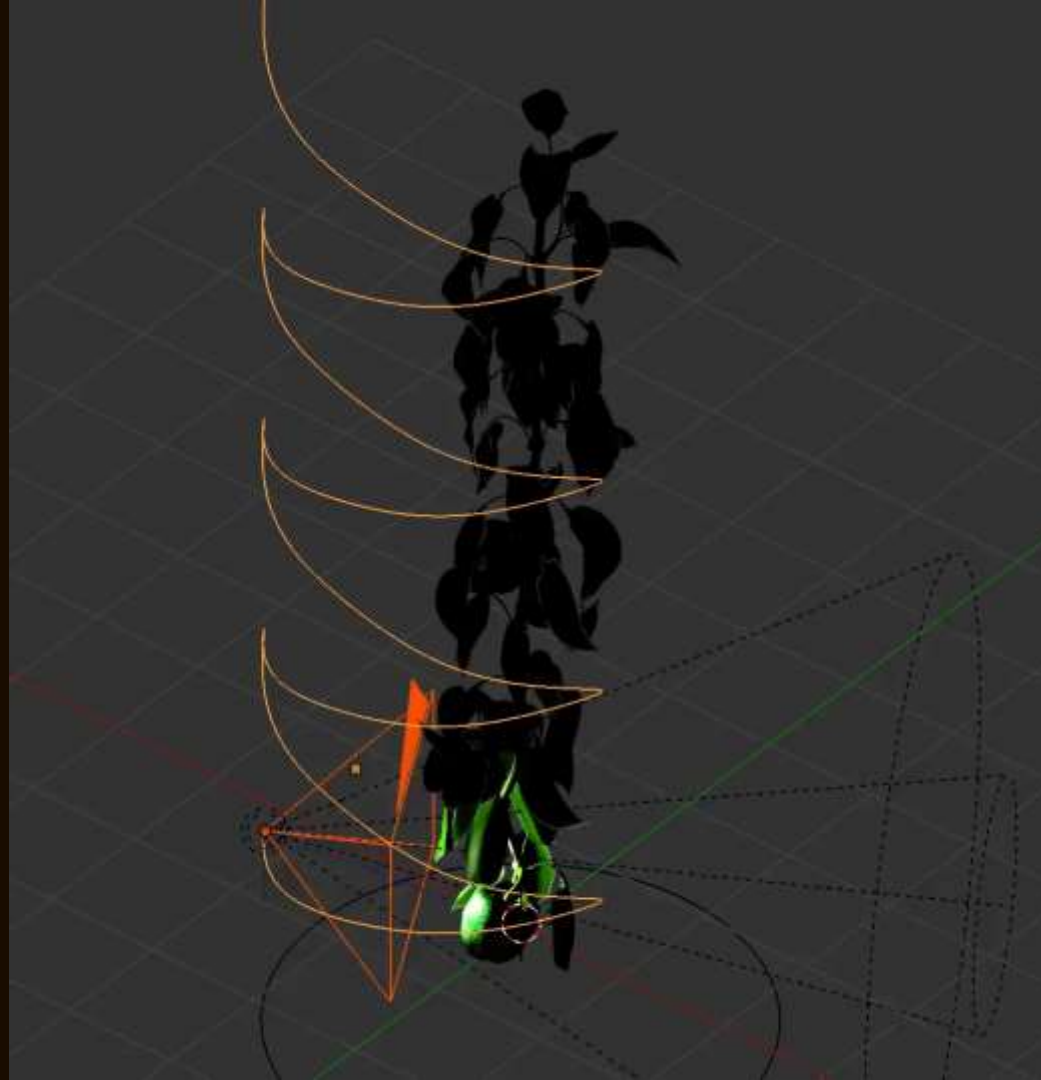
Robots in de tuinbouw/kas





The Good Dinosaur, Pixar, 2015

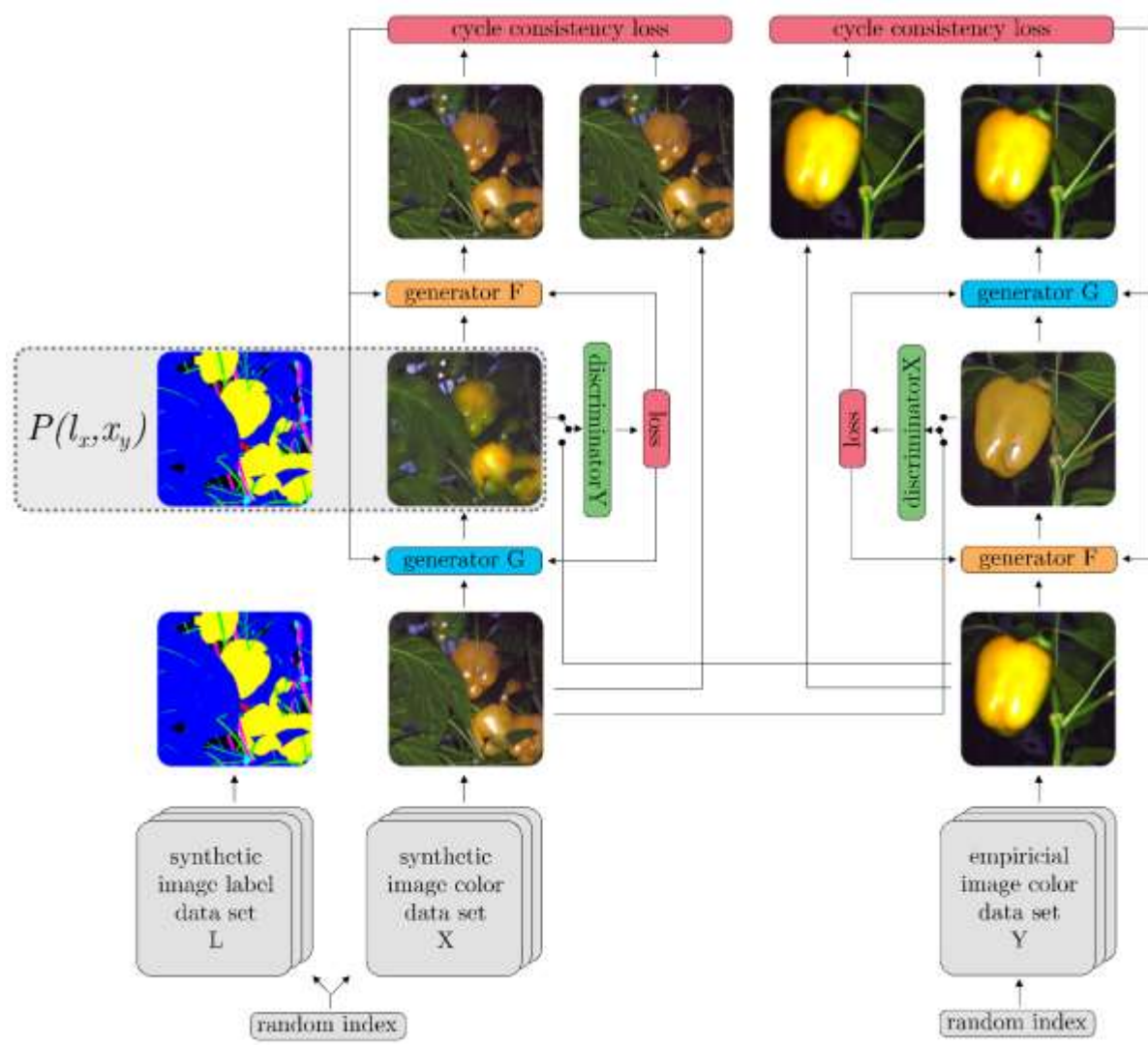




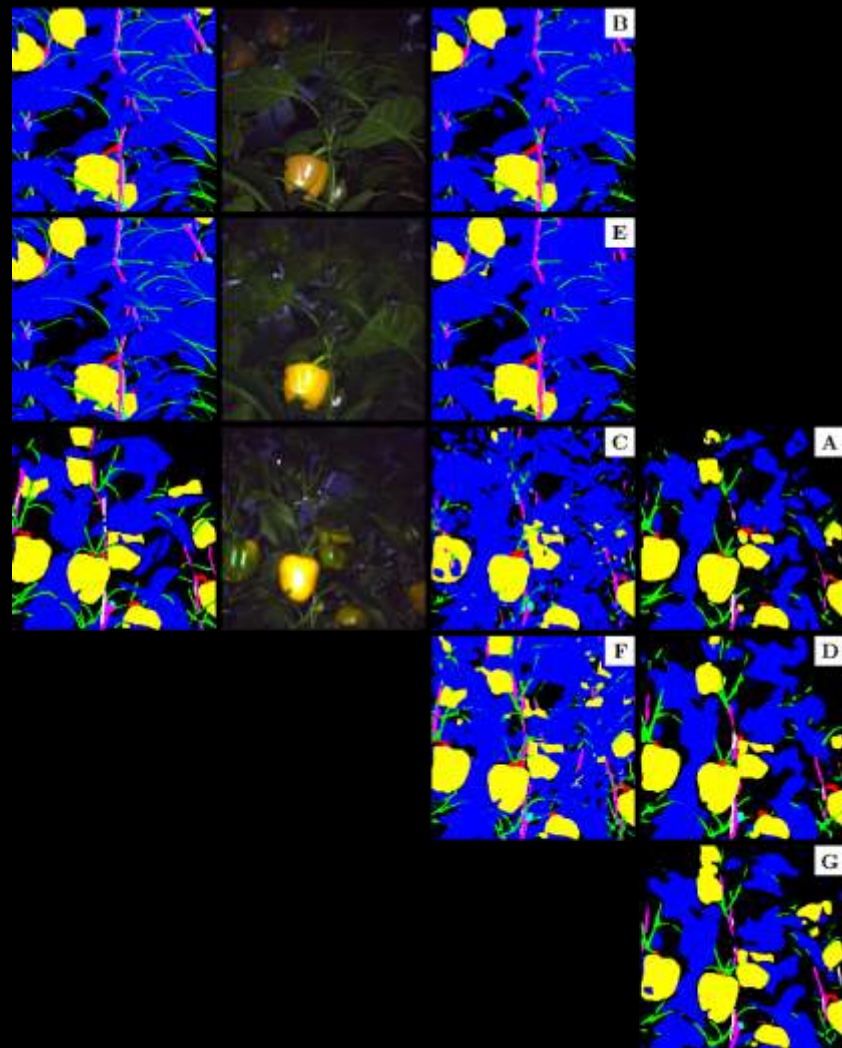


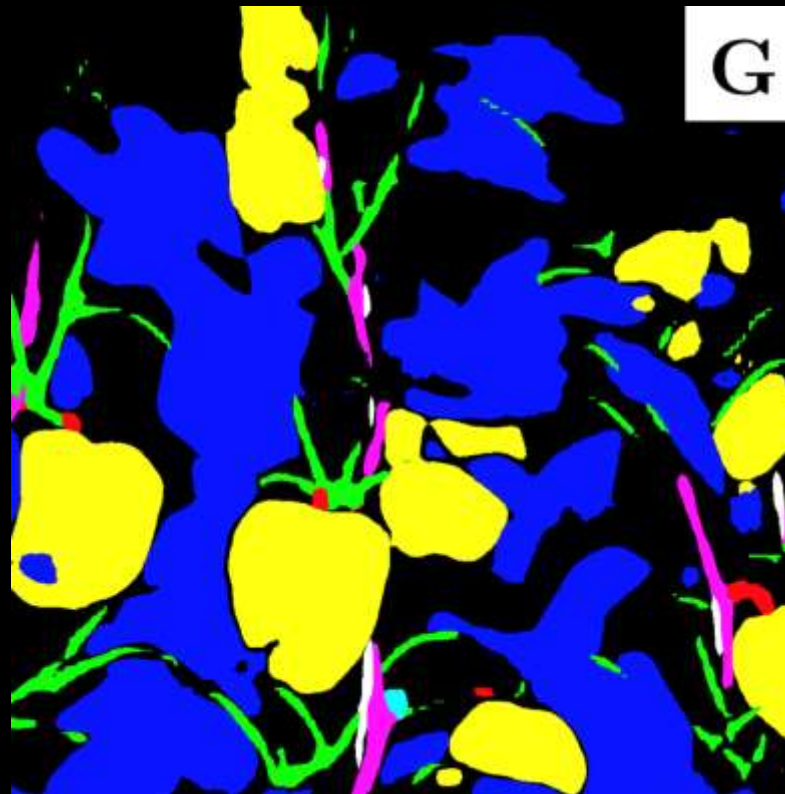












Target approach using visual servoing

- A modular software framework was developed and implemented for eye-in-hand sensing and robot motion control.



Special Issue: Robotic Agriculture

Research Paper

Design of an eye-in-hand sensing and servo control framework for harvesting robotics in dense vegetation

Ruud Barth ^{a,b,*}, Jochen Hemming ^b, Eldert J. van Henten ^c

^a Harvard University, 60 Oxford Street, Cambridge, Massachusetts, United States

^b Wageningen University & Research Centre, Greenhouse Horticulture, P.O. Box 644, 6700 AP, Wageningen, The Netherlands

^c Wageningen University & Research Centre, Farm Technology Group, Droevendaalsesteeg 1, 6708 PB, Wageningen, The Netherlands



Sweeper 



Trimbot2020



x4

A photograph of a backyard garden. In the foreground, there are several raised garden beds made of dark material, some containing green plants and others with vertical stakes. A small, light blue, kidney-shaped pool is in the middle ground. In the background, there is a playground with a slide and a building with a blue and white facade. A white fence is visible on the left. The text 'x4' is overlaid in red in the bottom left corner.

That's all

Erik.Pekkeriet@wur.nl

