
# Artificial Intelligence for Image Analysis

*Professorship Computer Vision & Data Science*

Presentation for Samenwerking Noord
5 July 2023
*Dr. Klaas Dijkstra*

NHL STENDEN

# NHL Stenden

24000 STUDENTS

APPROX. 15% INTERNATIONAL STUDENTS

90+ STUDENT NATIONALITIES

MULTI CAMPUS UNIVERSITY

2250 ACADEMIC STAFF

DESIGN BASED EDUCATION

14 ACADEMIES

35 PROFESSOR-SHIPS

17 ASSOCIATE'S DEGREES

76 BACHELOR'S DEGREES

51 MINORS

20 MASTER'S DEGREES

# Academy Technology & Innovation

- **RESEARCH** (5 groups)
  - Water Technology
  - Smart Sustainable Manufacturing
  - Computer Vision & Data Science
  - Sustainable Polymers
  - Circular Plastics

- **EDUCATION** (1700 students)
  - Associate, Bachelor and Master degrees
  - Engineering
  - Built environment
  - Life Science & Technology

# Academy ICT-CT

- **RESEARCH**
  - Maritime Security
  - ISA Lab
  - Serious Gaming

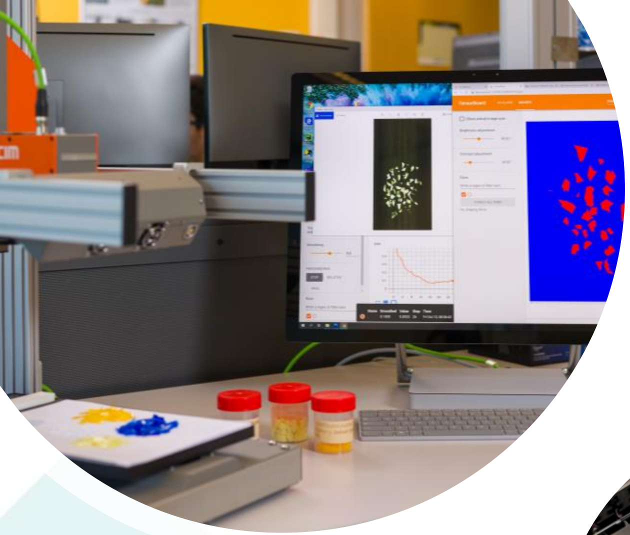
- **EDUCATION**
  - Associate, Bachelor and Master degrees
  - HBO ICT
  - CMD


# *Design Driven Innovation & Serious Gaming Research Group*

- Established in January 2023;
- Transdisciplinary design research for the challenges of an open, dynamic, complex and networked society;
- Ongoing design research projects in health Innovation, education development, transitions in agriculture and water management, governance, including two PhD-research programmes;
- We conduct research on and with artefacts and boundary objects and serious gaming, these boundary objects can be either analogue or digital in nature;
- We bring innovative and creative perspectives to the design process. We take a human-centred approach, focused on actionable insights and societal impact.

# Maritime IT Security Research Group

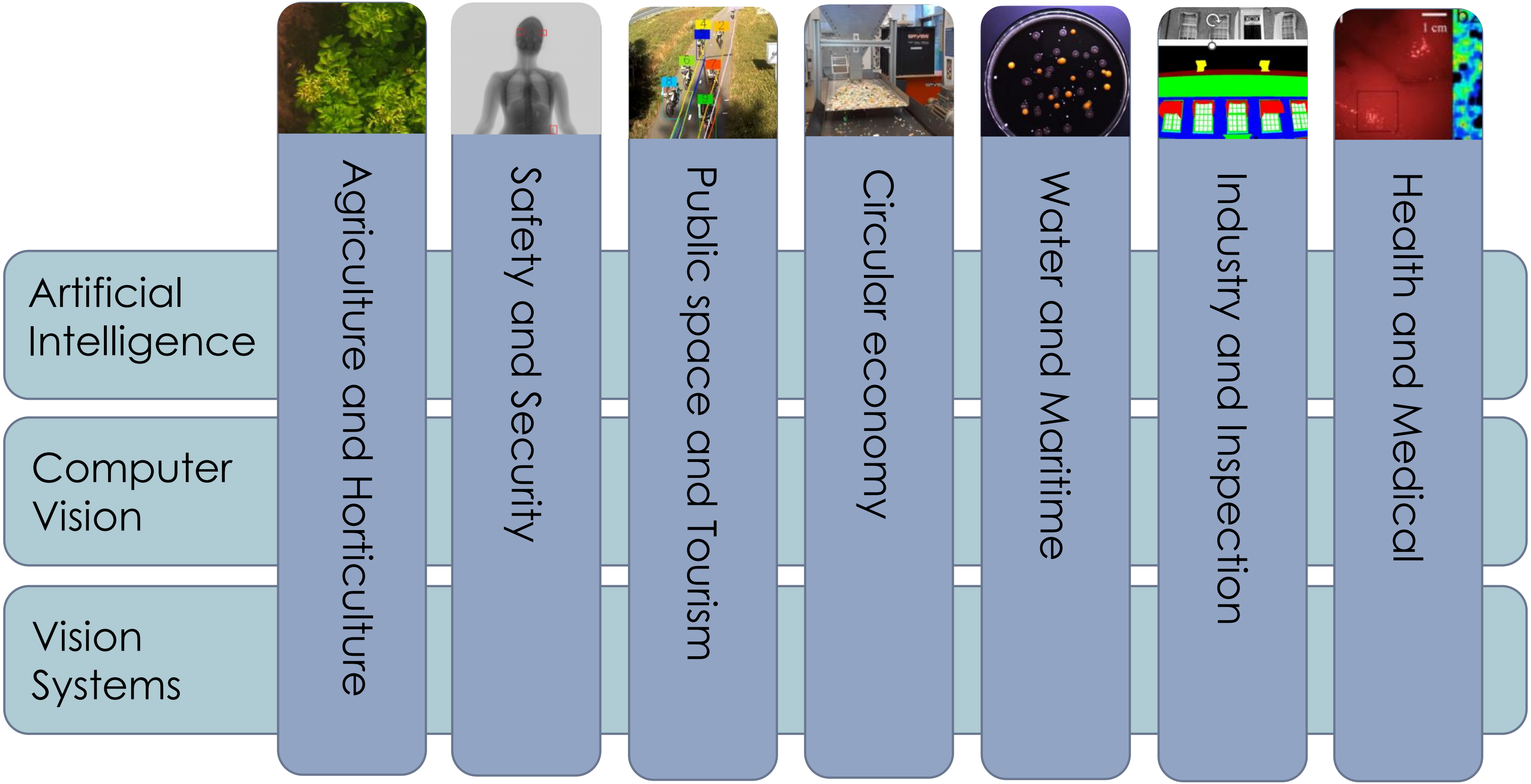
- Established September 2021
- Goal is to conduct impactful research into Cyber threats to the Maritime Transportation System (MTS)
- Our scope apart from traditional maritime activities includes inland waters, port facilities and other critical elements of the MTS
- This is achieved by leveraging our skills across disciplines within NHL Stenden in Ethical Hacking, Secure Programming, Serious Gaming, Maritime Technology, Maritime Officer Training, Marine Shipping Innovations and Cyber Safety
- Three major projects Maritime Cyber Incident Database, Ship Honeynet & Maritime Cyber Attack Simulations



- **Leeuwarden**
  - **CV&DS Lab**
    - High Performance GPU cluster
    - State-of-the-art vision hardware
  - **Education**
    - Minor and Master CV&DS
    - Master-Apprentice teaching
  - **Research**
    - Team of dedicated research staff
    - Feasibility studies for companies
    - Applied research projects

# Our mission is to

*"Share and broaden the collective knowledge on Artificial Intelligence and Computer Vision through cutting-edge applied research by solving real-life challenges together with students, researchers and companies."*


Artificial Intelligence
Computer Vision
Vision Systems
Agriculture and Horticulture
Safety and Security
Public space and Tourism
Circular economy
Water and Maritime
Industry and Inspection
Health and Medical

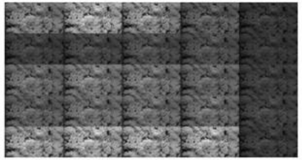
| | | |
|---|---|---|
| Artificial Intelligence | • Data shortage<br>• Explainable A.I. | • Anomaly detection<br>• Synthetic data |
| Computer Vision | • Image acquisition<br>• Pattern recognition | • Hyperspectral imaging<br>• Short-wave infrared |
| Vision Systems | • Software and optimization<br>• Prototyping | • Camera, optics, lighting<br>• Smart data |

# State-of-the-art vision hardware

Industrial, NIR, SWIR, LWIR, Hyperspectral, etc.

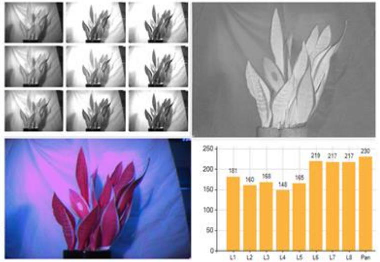
computer vision
& data science

## Snapshot Mosaic



**XIMEA 4X4-VIS**
- *470-630 nm*
- *16 Bands*

**XIMEA 5X5-NIR**
- *600-1000 nm*
- *25 Bands*

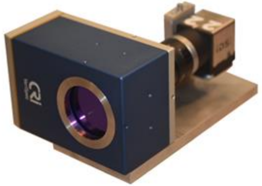


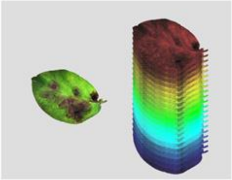
**SILIOS CMS-V**
- *550-830 nm*
- *9 bands*

## Linescan Hyperspectral

**Specim FX17**
- *900-1700 nm*
- *224 Bands*

## Liquid Crystal Tunable Filter





**PerkinElmer VariSpec VIS**
- *400-720 nm*
- *28 bands*

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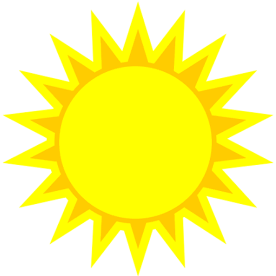
# Your own Virtual Machine

## High performance computing cluster

TWIRRE

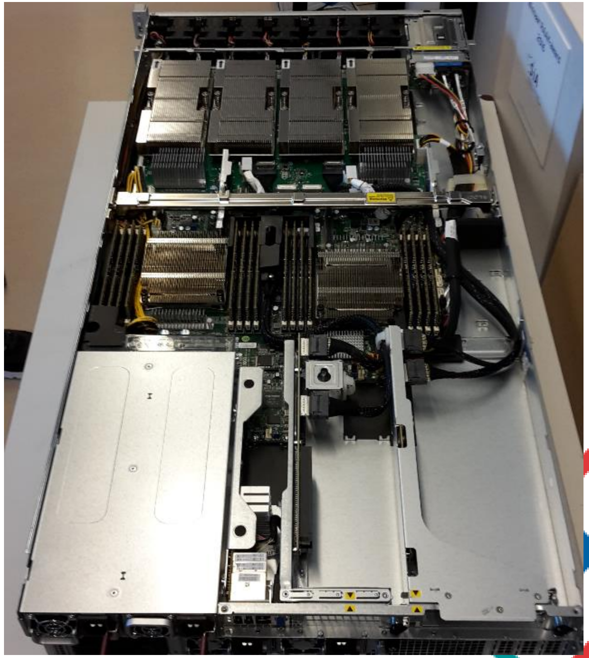
DEEP FRISIAN



SINNE

TOMKE & ROMKE

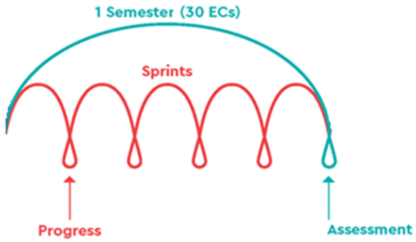
SYKLOAN



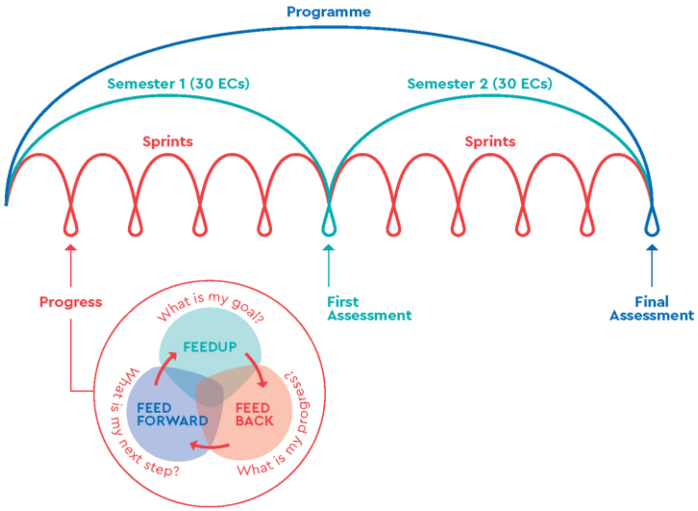
# Specialization

computer vision
& data science

## Minor
(Bachelor)

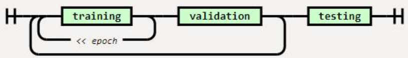



## Master
(Master of Science)

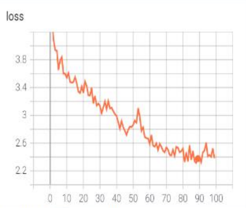


# Learn

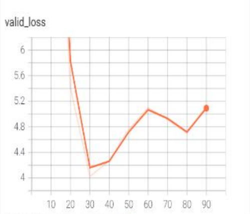
"Teach a system to detect and count potato plants in drone images, using deep learning."




First the network is trained and each 10th epoch the results are validated on a separate set. The model with the lowest loss on the validation set is saved to yolov5.pth (early stopping). The training and validation loss are shown in a tensorboard session. During validation one of the processed tiles for each minibatch is shown in tensorboard and after a few epochs. In our training session this looked like this [2].:



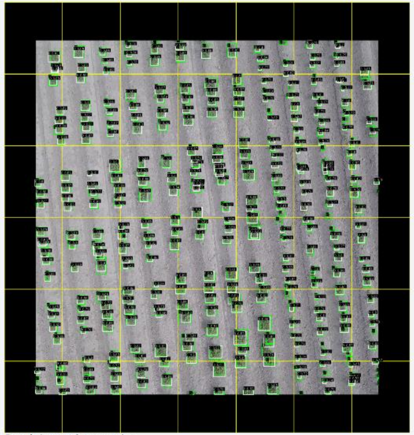

*Training loss per epoch*



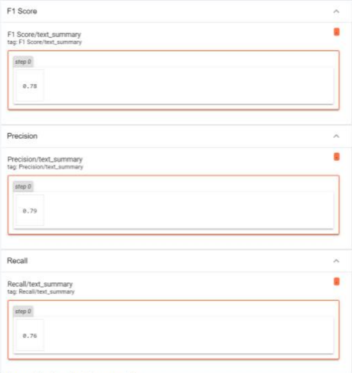

*Validation loss per epoch*

*One of the validation tiles shown in the tensorboard*

The testing pipeline loads the model and estimated bounding boxes on the full image. The testing pipeline outputs the metrics Precision, Recall and F1-Score. The results are shows in a tensorboard session. In our run the results liked like this:

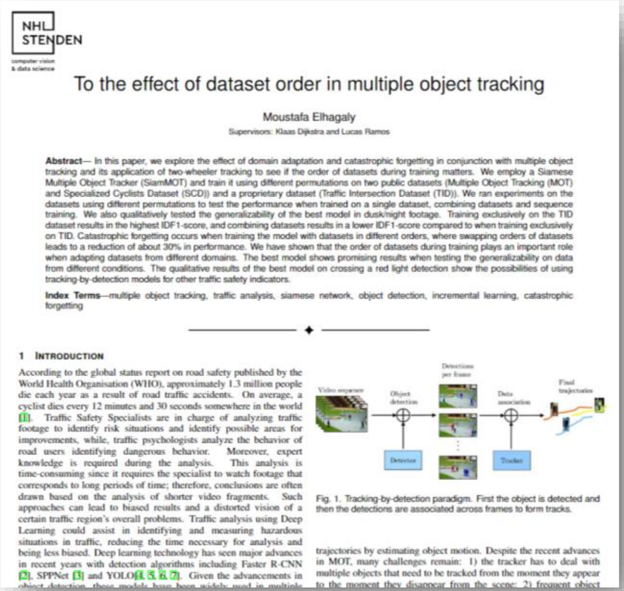


*Result image from testing*

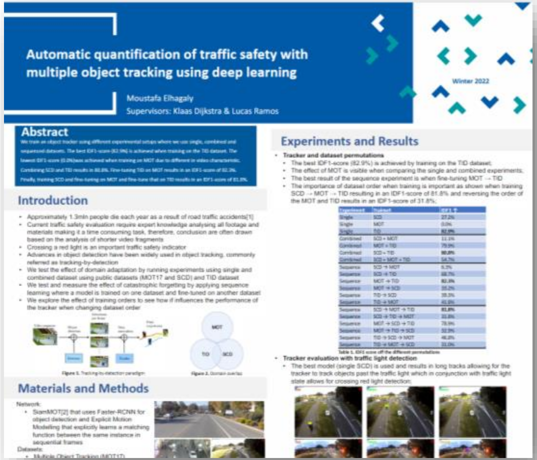



*Quantitative testing results*

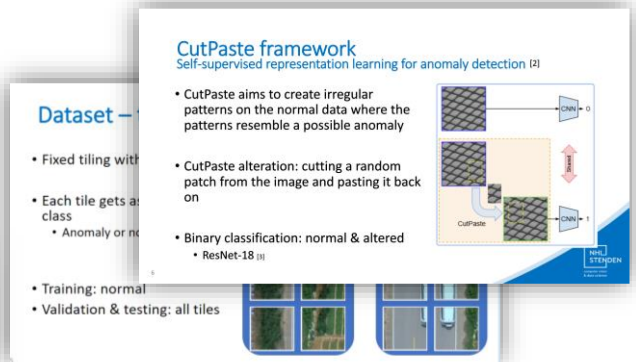
# Final products



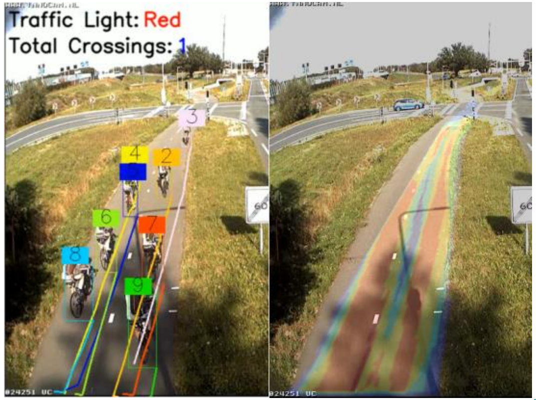

**Paper**




**Poster** on the Computer Vision & Data Science symposium



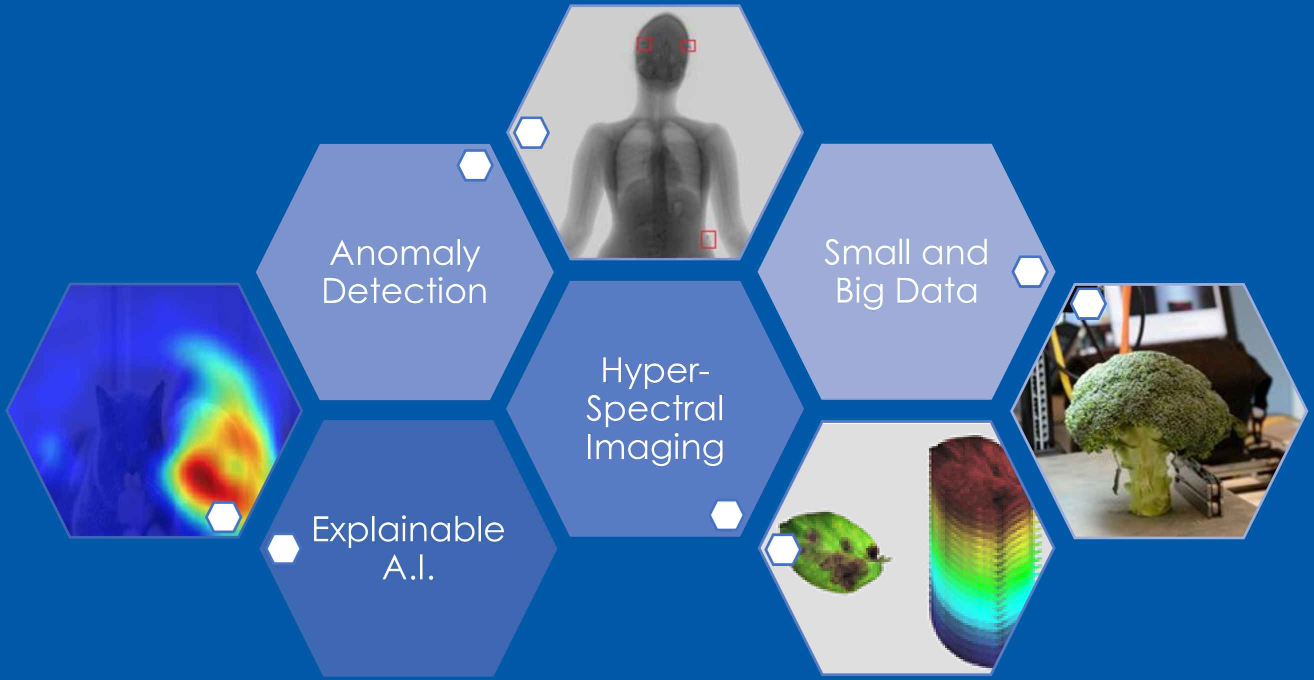

**Presentation** on the Computer Vision & Data Science symposium




**Proof of Concept**

# Project examples

Main strategic topics in A.I. for Image Analysis



# Counting potato plants

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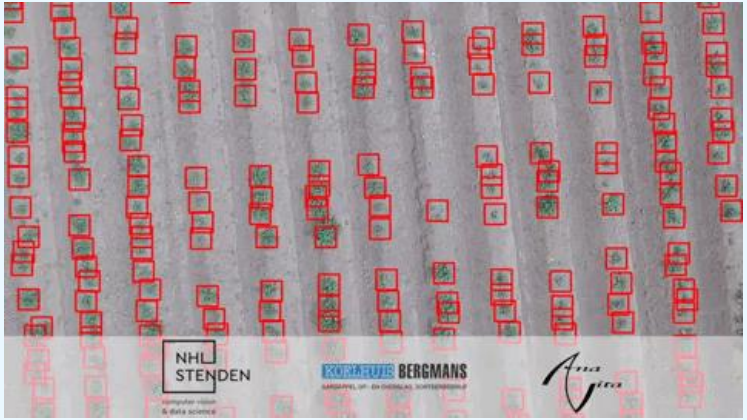
Crop-growth monitoring with commodity drones

CentroidNet: A Deep Neural Network for Joint Object Localization and Counting

K. Dijkstra, J. van de Loosdrecht, L.R.B. Schomaker and M.A. Wiering




| Model | Score |
|---|---|
| CentroidNet | **90.4%** |
| RetinaNet | 89.4% |
| YoloV2 | 88.8% |

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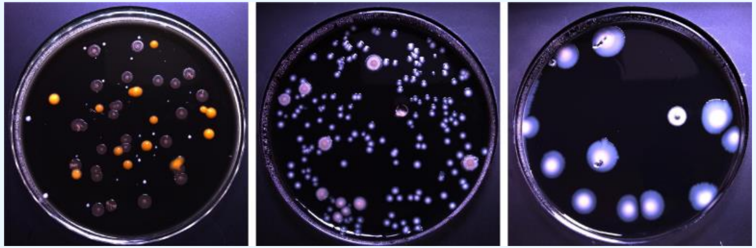
# Counting bacterial colonies

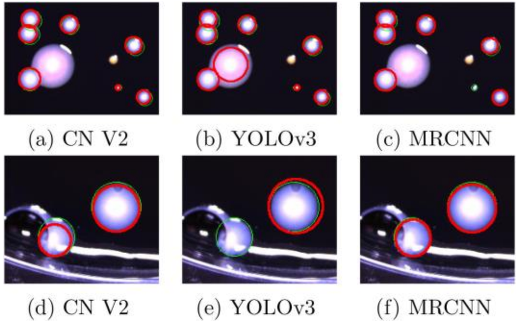
Legionella suspect determination

Vitens

CentroidNetV2: A hybrid deep neural network for small-object segmentation and counting

K. Dijkstra, A.W. Atsma, J. van de Loosdrecht, L.R.B. Schomaker and M.A. Wiering






| Model | Score |
|---|---|
| CentroidNetV2 | **92.6%** |
| FRCNN | 92.2% |
| YoloV3 | 92.3% |

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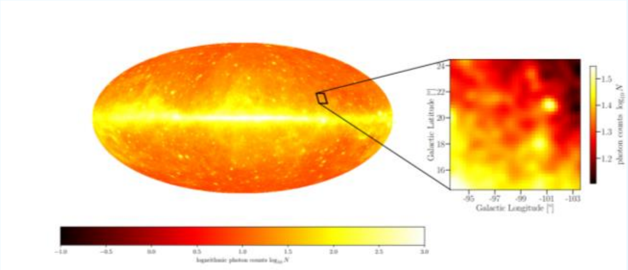
# Identification of point sources

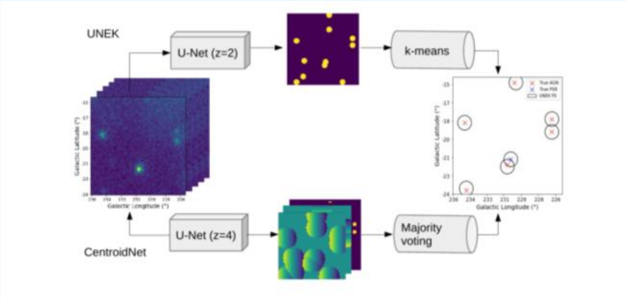
Radboud University

Nikhef

## Identification of point sources in gamma rays using U-shaped convolutional neural networks and a data challenge

Sascha Caron, Klaas Dijkstra, Christopher Eckner, Luc Hendriks, Guðlaugur Jóhannesson, Boris Panes, Roberto Ruiz de Austri, Gabrijela Zaharijas

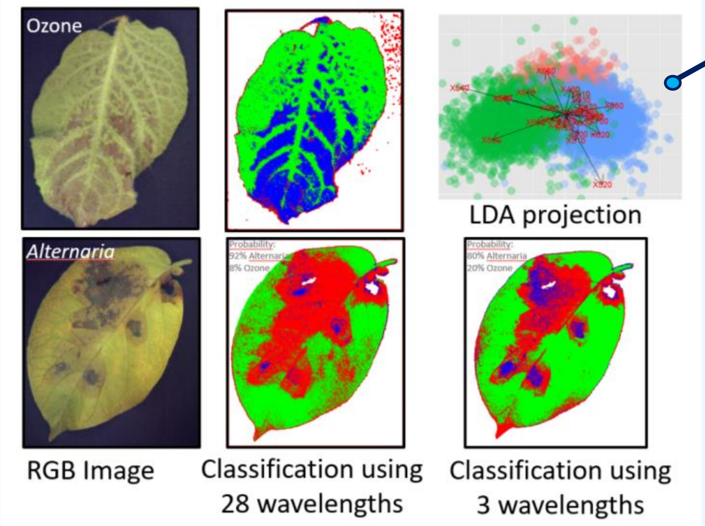


# Disease recognition

Hyperspectral frequency selection for the classification of vegetation diseases

K. Dijkstra, J. van de Loosdrecht, L.R.B. Schomaker and M.A. Wiering




Potato disease classification

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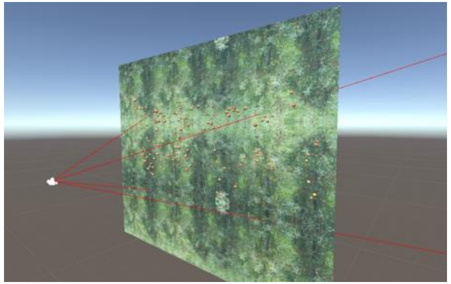
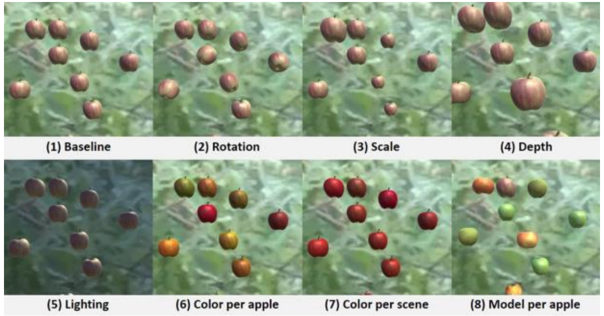
# Detect apples using synthetic data






Training

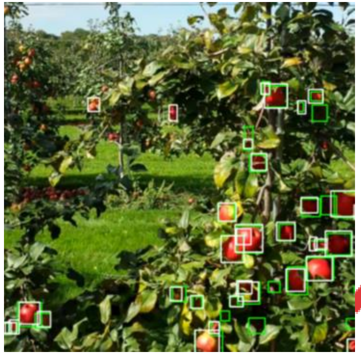
Detection

# Detect apples using synthetic data

An image says more than a thousand words

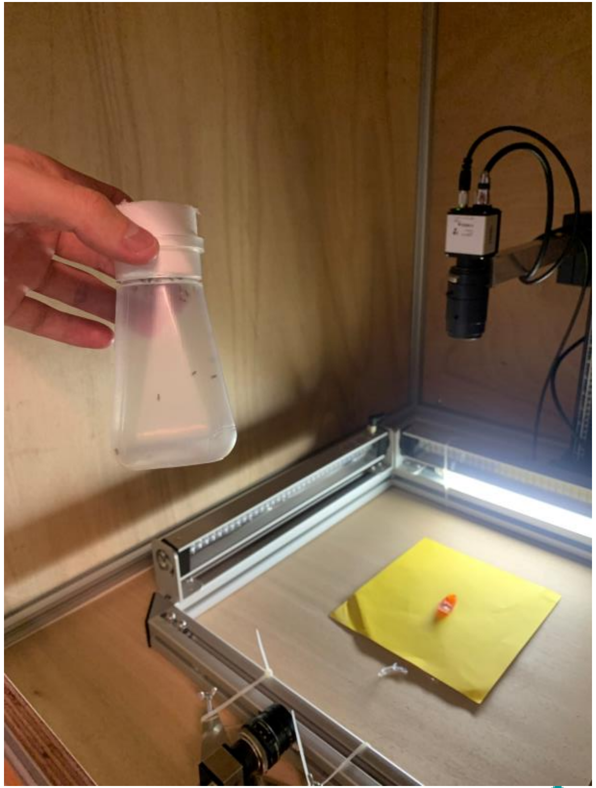
Condition on real

Train on fake



Test on real

# In-flight detection of Aphids in potato fields



GeJo Grading Services B.V.

Ana Vita

Fokkema Farming

GEORGE PARS GRAANHANDEL B.V.

Elyt. CONSULTANCY

Europees Landbouwfonds voor Plattelandsontwikkeling: Europa investeert in zijn platteland

# Collaboration examples