# Stichting NIOC en de NIOC kennisbank

Stichting NIOC (www.nioc.nl) stelt zich conform zijn statuten tot doel: het realiseren van congressen over informatica onderwijs en voorts al hetgeen met een en ander rechtstreeks of zijdelings verband houdt of daartoe bevorderlijk kan zijn, alles in de ruimste zin des woords.

De stichting NIOC neemt de archivering van de resultaten van de congressen voor zijn rekening. De website www.nioc.nl ontsluit onder "Eerdere congressen" de gearchiveerde websites van eerdere congressen. De vele afzonderlijke congresbijdragen zijn opgenomen in een kennisbank die via dezelfde website onder "NIOC kennisbank" ontsloten wordt.

Op dit moment bevat de NIOC kennisbank alle bijdragen, incl. die van het laatste congres (NIOC2023, gehouden op donderdag 30 maart 2023 jl. en georganiseerd door NHL Stenden Hogeschool). Bij elkaar bijna 1500 bijdragen!

We roepen je op, na het lezen van het document dat door jou is gedownload, de auteur(s) feedback te geven. Dit kan door je te registreren als gebruiker van de NIOC kennisbank. Na registratie krijg je bericht hoe in te loggen op de NIOC kennisbank.

Het eerstvolgende NIOC vindt plaats op donderdag 27 maart 2025 in Zwolle en wordt dan georganiseerd door Hogeschool Windesheim. Kijk op www.nioc2025.nl voor meer informatie.

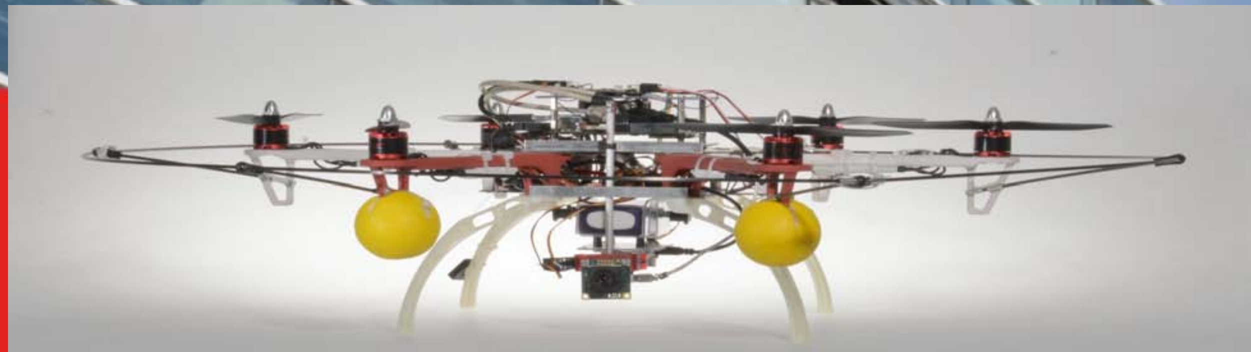
Wil je op de hoogte blijven van de ontwikkeling rond Stichting NIOC en de NIOC kennisbank, schrijf je dan in op de nieuwsbrief via

www.nioc.nl/nioc-kennisbank/aanmelden nieuwsbrief

Reacties over de NIOC kennisbank en de inhoud daarvan kun je richten aan de beheerder:

R. Smedinga kennisbank@nioc.nl.

Vermeld bij reacties jouw naam en telefoonnummer voor nader contact.



# Smart Vision for Unmanned Aerial Vehicles (UAVs)

## NIOC 2015, Enschede

**24 April 2015**

**Jaap van de Loosdrecht**
**Lector Computer Vision**
**NHL Kenniscentrum Computer Vision**

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# Overzicht

- What is Computer Vision?
- NHL Centre of Expertise in Computer Vision
- Taxonomy Unmanned Vehicles
- Drones in civil applications
- Smart Vision for UAVs
- Twirre architecture for autonomous UAVs
  using interchangeable commodity components
- Future work

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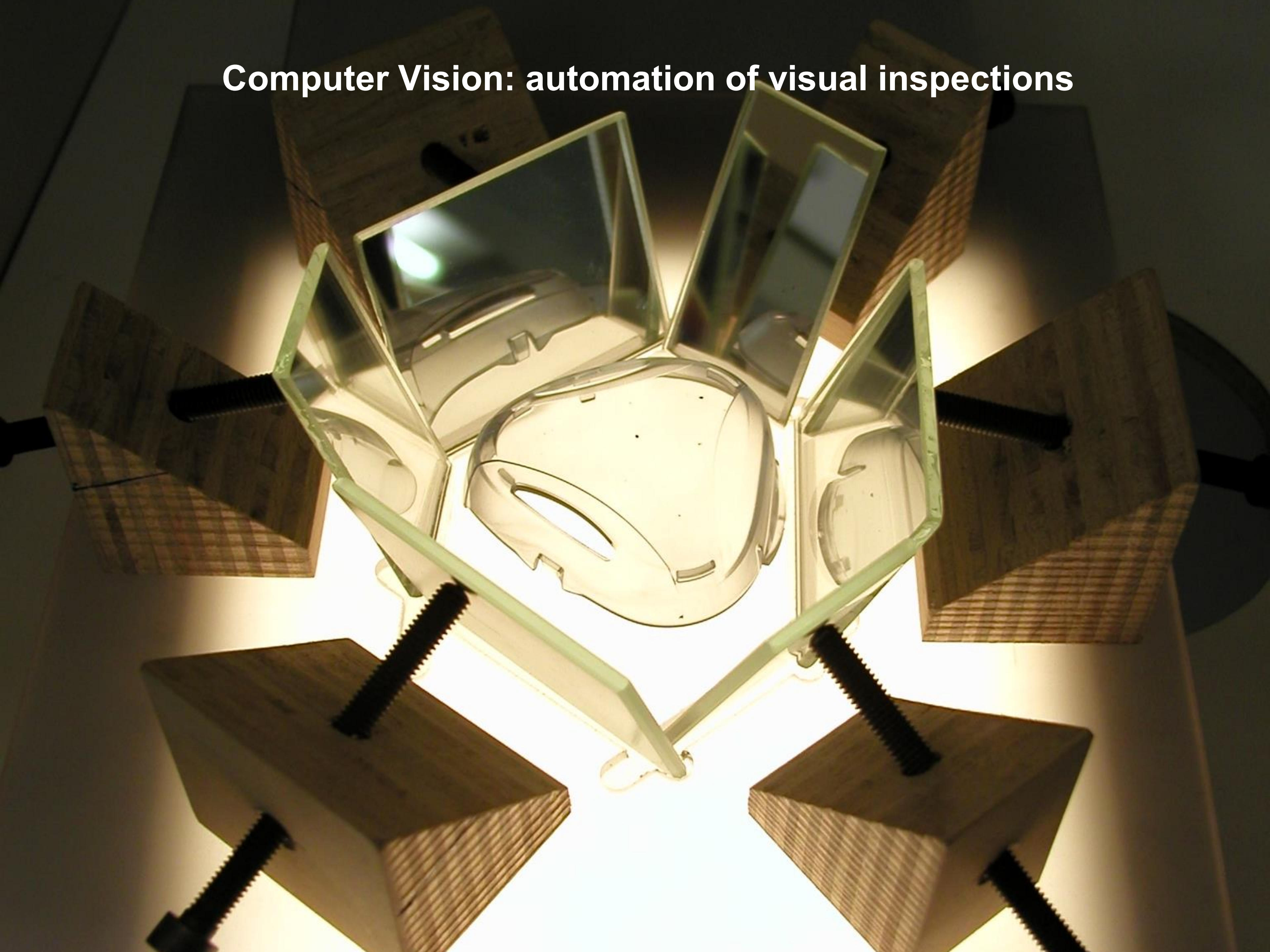
# Computer Vision: automation of visual inspections



# Inspection of protectors for shavers

# NHL Centre of Expertise in Computer Vision

- More than 18 years THE centre of expertise in Computer Vision for Universities of applied science in the Netherlands
- Best practices:
  - More than 200 feasibility studies for the industry (> € 5.000.000,-)
  - Unique course material for Universities of professional education
  - One week course for the industry (17x)
  - Knowledge societies with national recognition
    - Cluster Computer Vison Noord Nederland (45)
    - Platform Beeldverwerking HBO (11)
  - Bridge between fundamental research of universities and the industries by performing applied research projects

# NHL Centre of Expertise in Computer Vision

**Main focus:**

- Computer Vision

**Specialities:**

- Data analysis (PCA, LDA, Neural networks, Support vector machines, Genetic algorithms, etc.)
- Acceleration algorithms using multi-core CPUs and GPUs
- Data fusion

# NHL Centre of Expertise in Computer Vision

- Established in 1996

- Sub division of NHL University of applied sciences, department of Engineering
- 1 Manager (1 fte)
- 1 Researcher (1 fte)
- 4 Project engineers (3.5 fte)

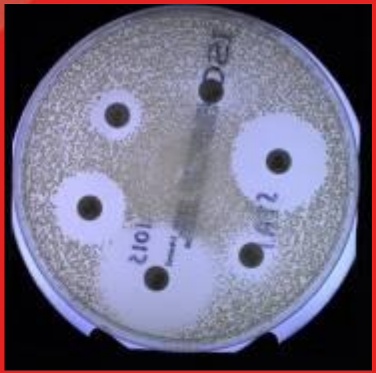
- Students placement- or graduation assignment
  Total from start: 450 from the Netherlands and 45 from abroad

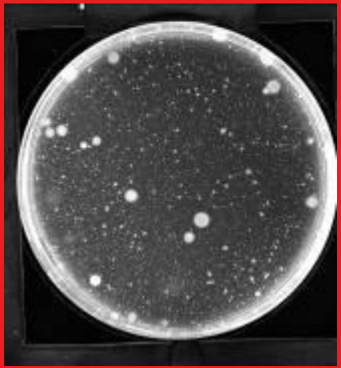
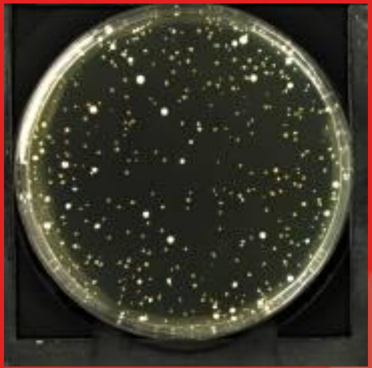
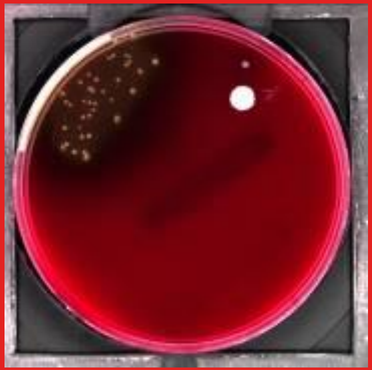
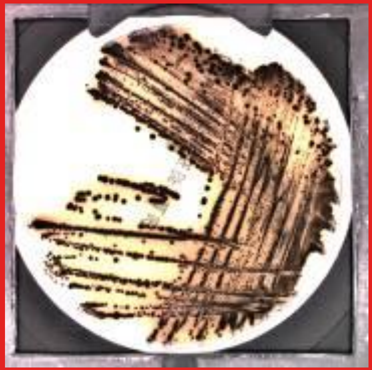
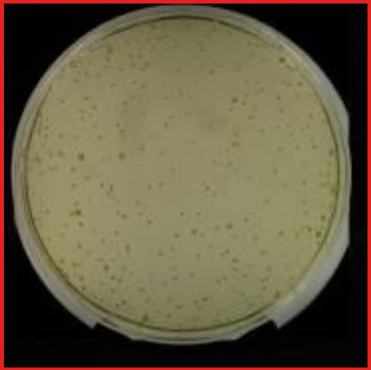
# Equipment

**The strength of the centre of expertise is knowledge and equipment for the total chain of:**

- **Lighting**
- **Cameras**
  **(UV, VIS, NIR, SWIR, LWIR (thermographic), hyper-spectral, surround, 3D, high speed, LIDAR)**
- **Optics**
- **Algorithms for image processing and data science**
- **Embedding in systems or other software**

# Micro biology, petri dishes




# 23rd European Congress of Clinical Microbiology and Infectious Diseases, Berlin 27-30 April 2013

# End-user trainable automatic antibiotic-susceptibility testing by disc diffusion using machine vision

K. Dijkstra[1], M. Berntsen[2], J. van de Loosdrecht[1] and W. J. Jansen[1]

1) NHL University of Applied Sciences, Center of Expertise Computer Vision, Leeuwarden, The Netherlands. 2) BD, Drachten, The Netherlands.

## Objectives

BD Kiestra provides a workflow where digital images of Petri-dishes used in antibiotic susceptibility testing by disc diffusion can be automatically analyzed using machine vision algorithms.

The objective of this study is to develop and test a system which automatically optimizes a zone measurement algorithm to yield results close to zone measurements of a human end-user.

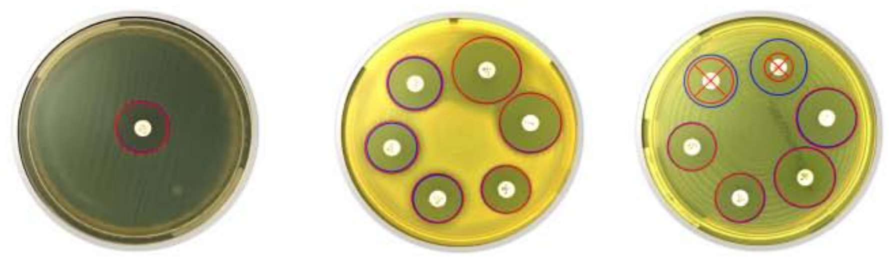
## Methods

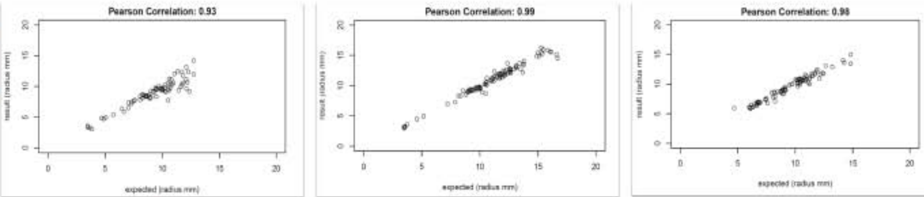
The main design principle is that the lab technician does not have to know anything about machine vision to train the system. Technical configuration is handled by Artificial Intelligence.

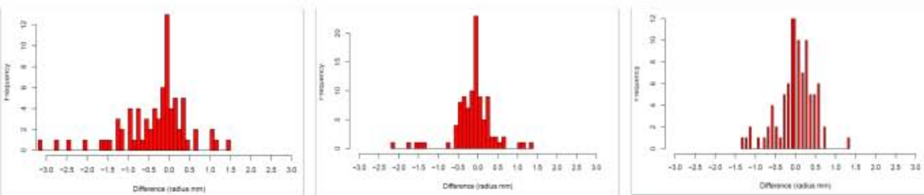
Three digital image sets of Petri-dishes using different illuminations from two European microbial laboratories have been selected from the daily routine to test the system. Evaluation is performed using a two-fold cross-validation.

## Results

Blue and red circles are manual and automatic measurements respectively.
Crossed circles are automatically rejected measurements.





| Accepted: | 76 of 76 zones | Accepted: | 100 of 100 zones | Accepted: | 96 of 152 zones |
|---|---|---|---|---|---|
| Correlation: | 0.93 | Correlation: | 0.99 | Correlation: | 0.98 |

## Conclusions

An end-user trainable machine vision system for measuring zones is presented and compared to manual zone measurements.

The proposed method shows excellent correlation between manually and automatically measured zones.

In low contrast image environments the system adapts by automatically rejecting more zones maintaining high Pearson correlation.

BD Kiestra™

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# UAV


Fixed wing


Drone


Quadrocopter

Helicopter


Hexacopter

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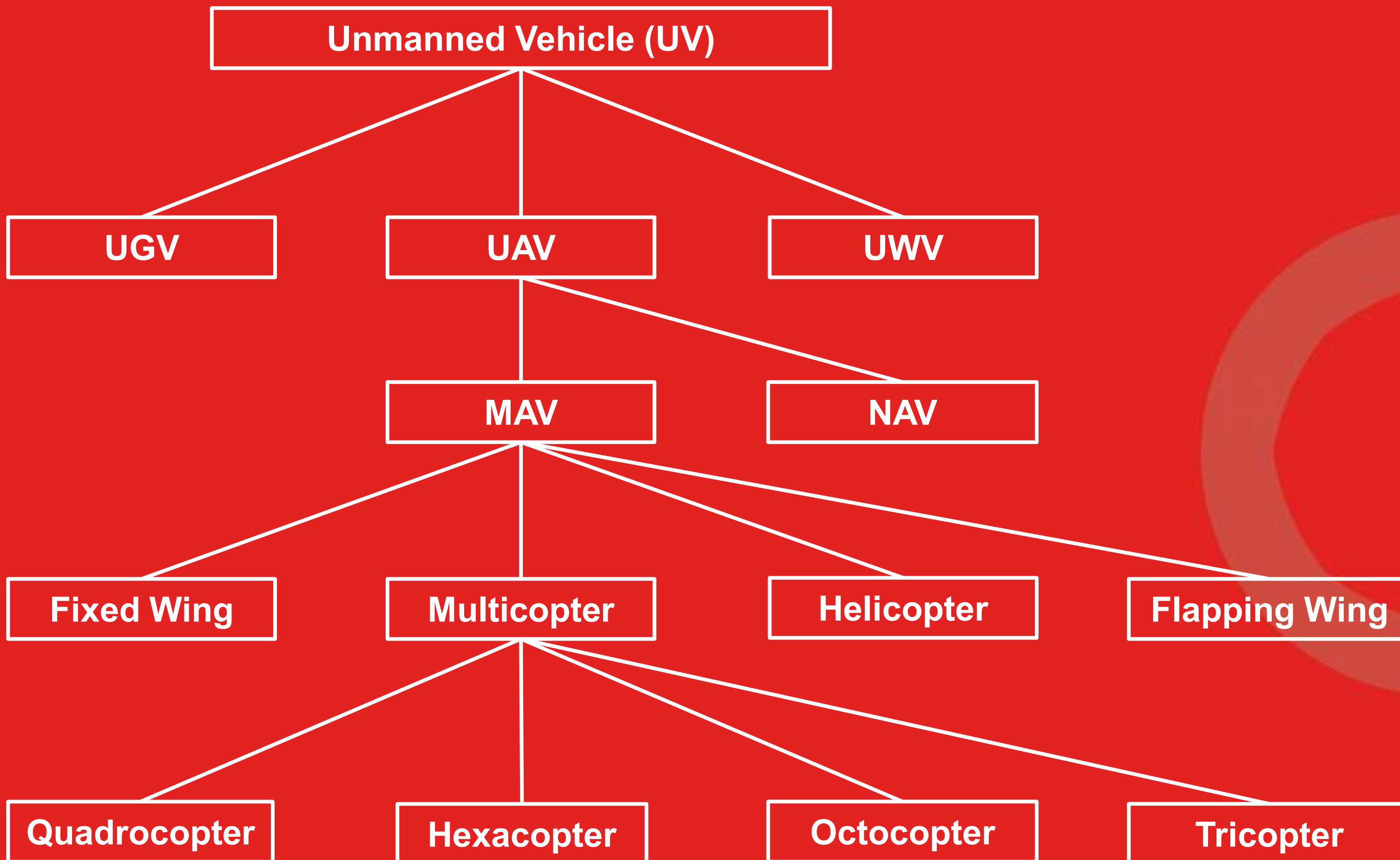
# Taxonomy of Unmanned Vehicles

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# Drones in civil applications with cameras

- Commercial services using drones operated by ground pilots using GPS-waypoints
- Commodity products, example: DJI Phantom

# Automatic flying with GPS way-points

From GPS position to GPS position at specified height and speed


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# Drones in civil applications

- Inspection wind turbine blades

- Inspection of agricultural fields

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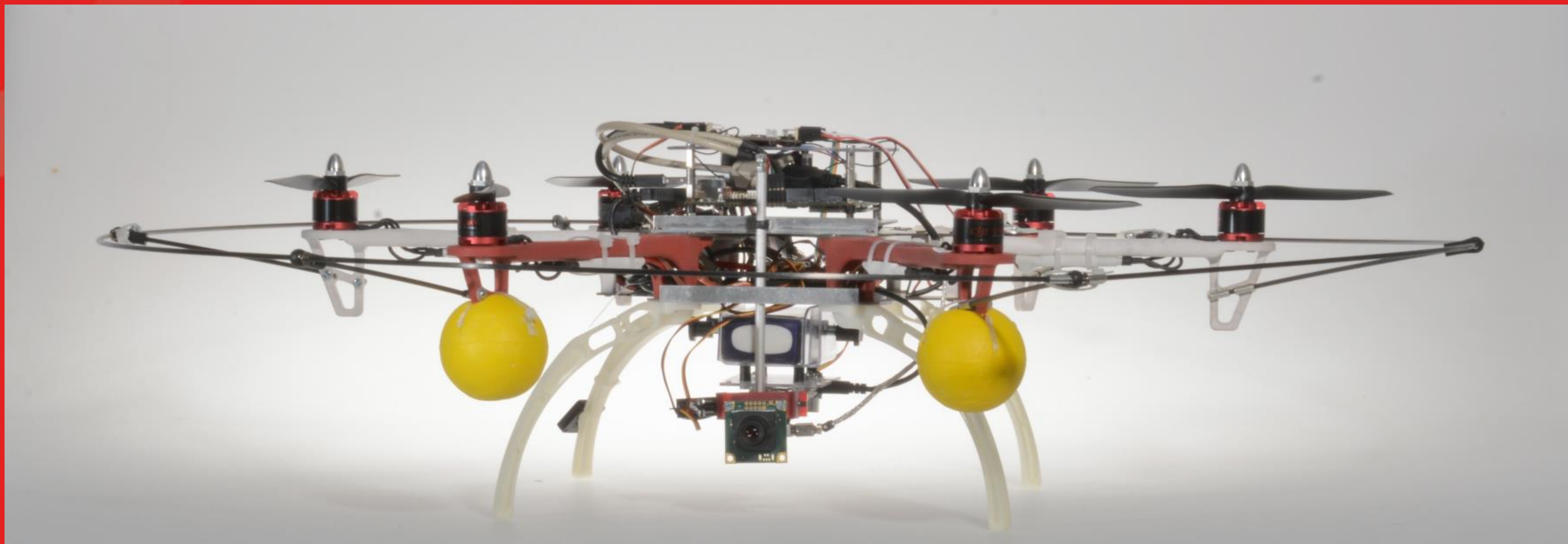
# Smart Visions for UAVs



- RAAK SIA MKB project
- September 2014 – September 2016
- 15 companies and institutions
- Business opportunities:
  - Wind turbine blade inspection
  - Detection and inspection of fires
  - Inspection of agricultural fields
  - Inspection of ditch cleaning

SiA
Nationaal Regieorgaan Praktijkgericht Onderzoek

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# Smart Vision for UAVs

Research questions:

- Can UAVs be applied to acquire images with the required quality for the specified inspections?
- Can the inspections of those images be automated?
- Can the flying process be aided and/or automated?
- Is it possible to comply with the legislation for professional usage of UAVs?

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# Smart Vision for UAVs

**Points on the horizon:**

- **A higher accuracy of position location than now is possible with standard GPS and maps**
- **Autonomous flying of missions under supervision of ground pilot who only has to intervene  in case of emergencies**
- **Automatic (real-time) processing of image data to process or business support information**

# Smart Vision for UAVs

| **Four Business Opportunities:** | | **Research question** | **Research question** | **Research question** | **Research question** |
|---|---|---|---|---|---|
| **1. Wind turbine blade inspection** | Service DroneView | Droneview<br>NHL | NHL<br>RacePlan<br>IDI Snowmobile | Droneview<br>NHL<br>Avans<br>Tryage | NLR<br>(NHL) |
| **2. Detection and inspection of fires** | ITS<br>BON | Droneview<br>NHL | NHL<br>IDI Snowmobile<br>Spacemetric | Droneview<br>NHL<br>Tryage | |
| **3. Inspection of agricultural fields** | HLB<br>Ana Vita<br>Dacom | Dutch Drone Company<br>NHL | NHL<br>NLR<br>Spacemetric<br>RacePlan | Dutch Drone Company<br>NHL<br>Avans<br>Tryage | |
| **4. Inspection of ditch cleaning** | HiView<br>Wetterskip | HiView<br>NHL | NHL<br>Spacemetric<br>IDI Snowmobile | HiView<br>NHL<br>Tryage | |
| **Research question =>** | | **Image acquisition** | **Automation of image inspection** | **Automation of flying process** | **Legislation** |

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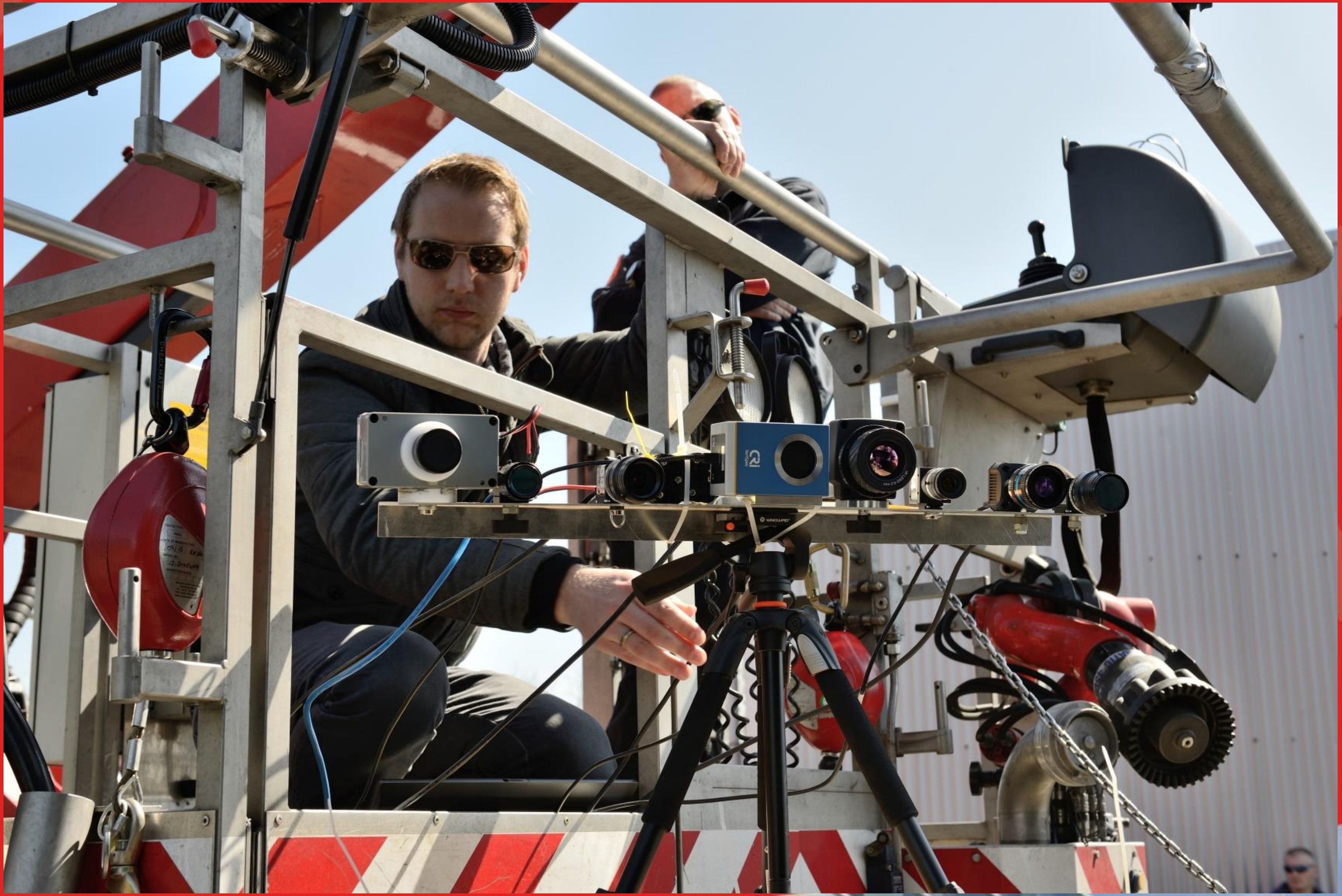
# Test Brandweer Oefencentrum Noord (Wijster)



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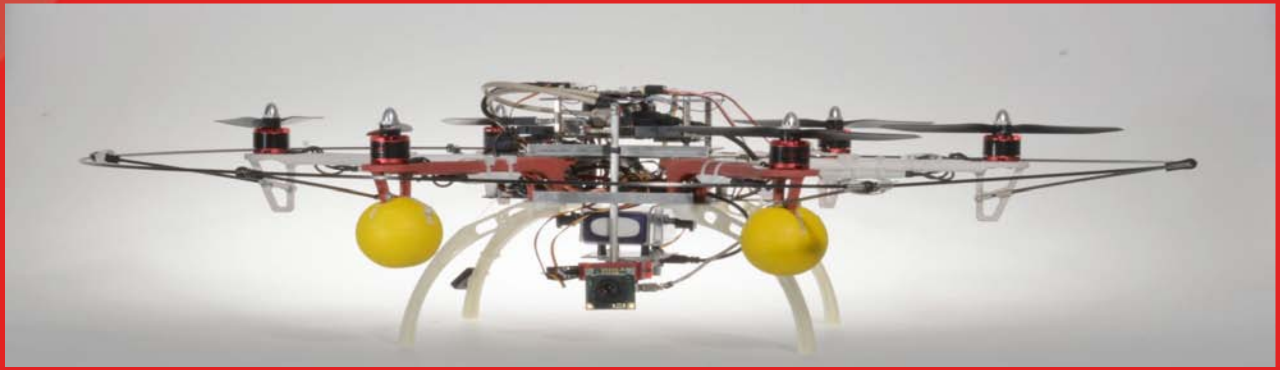
# Twirre architecture for autonomous UAVs using interchangeable commodity components



**Starting points**

- On board intelligence
- No development of hardware, UAVs and flight controllers
- No development of software flight controllers
- Standard components
  - Low cost
  - Exchangeable
  - Upgradeable
- Reliable switch between manual and autonomous operation

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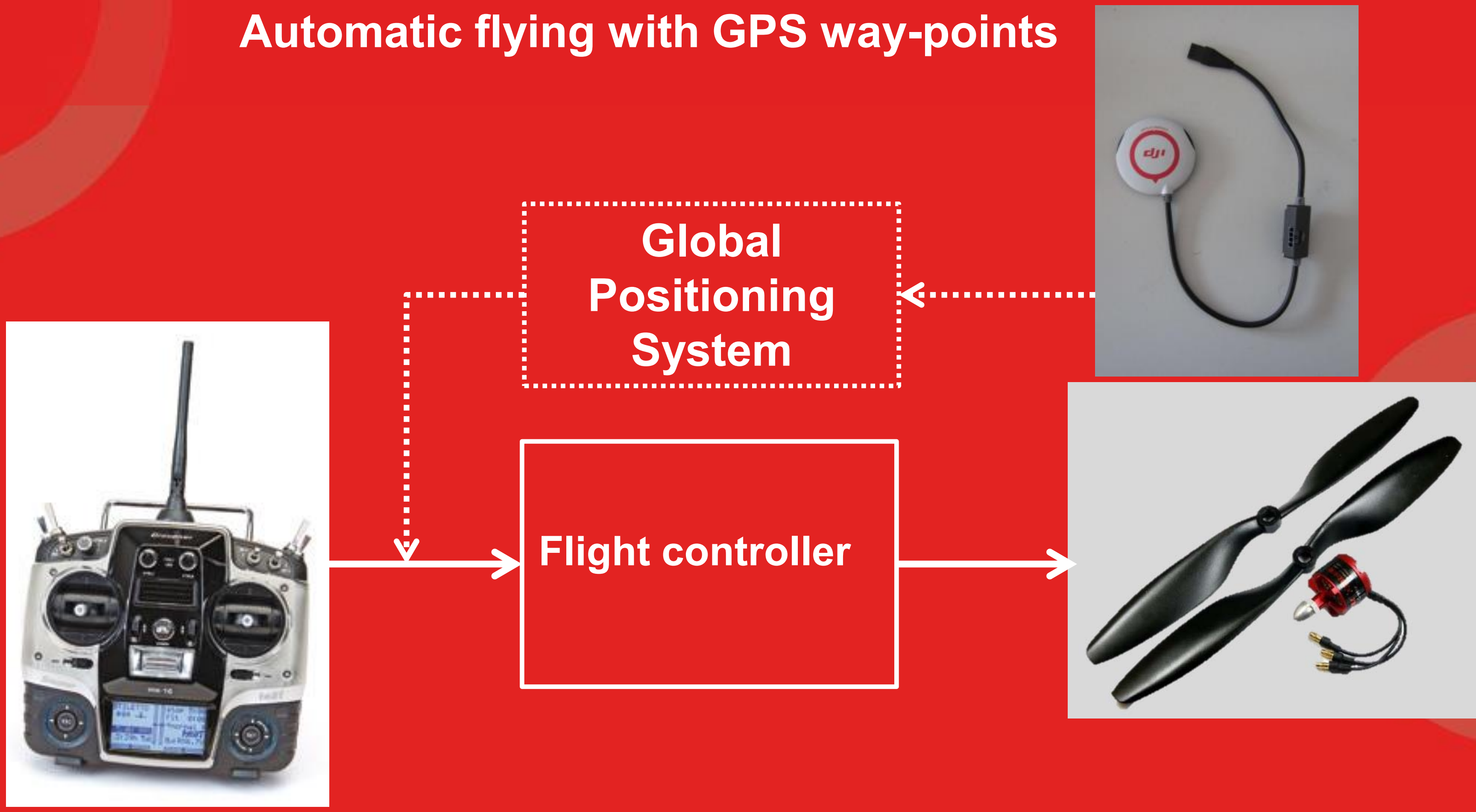
# Automatic flying with GPS way-points

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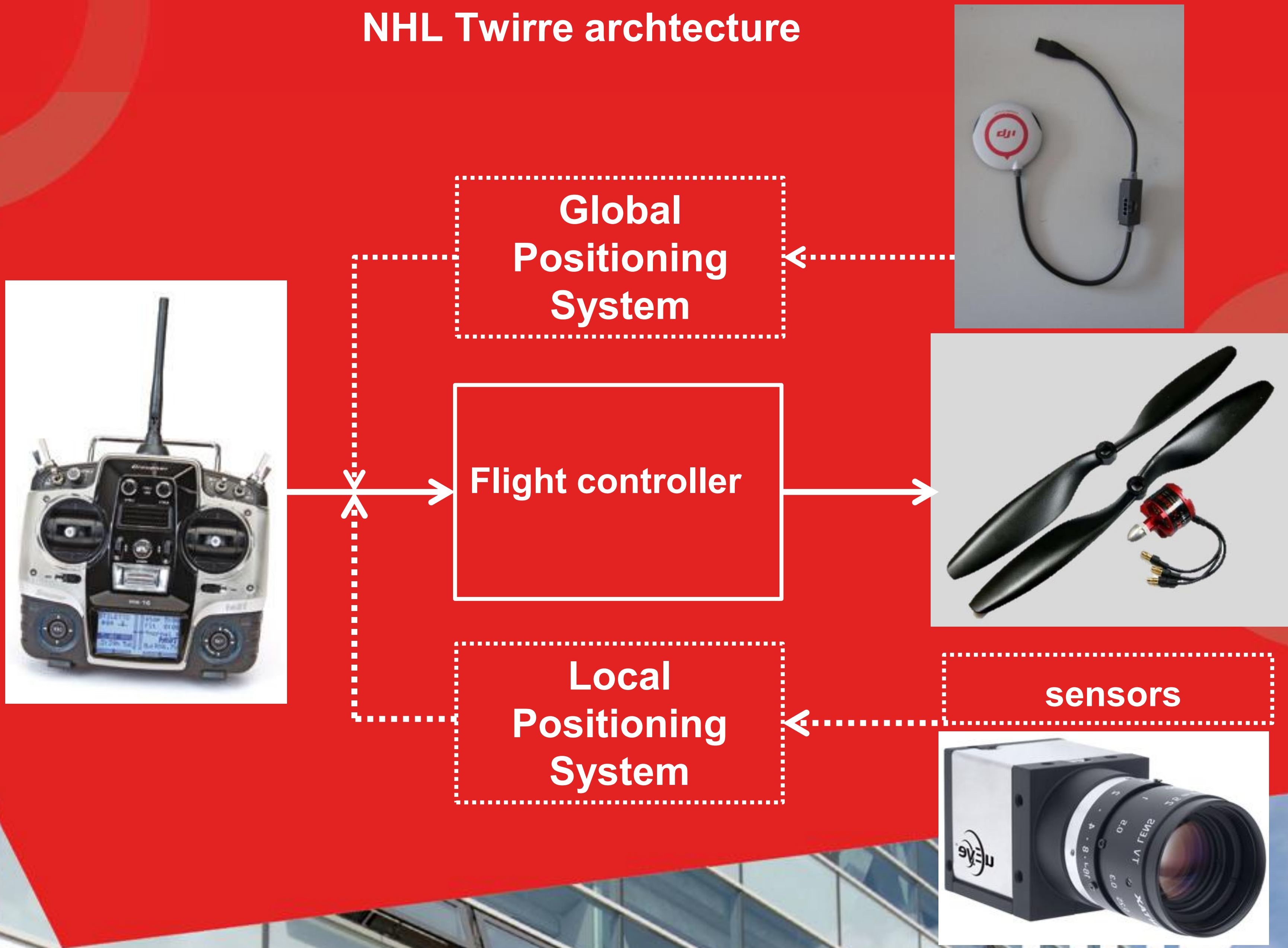
# NHL Twirre archtecture

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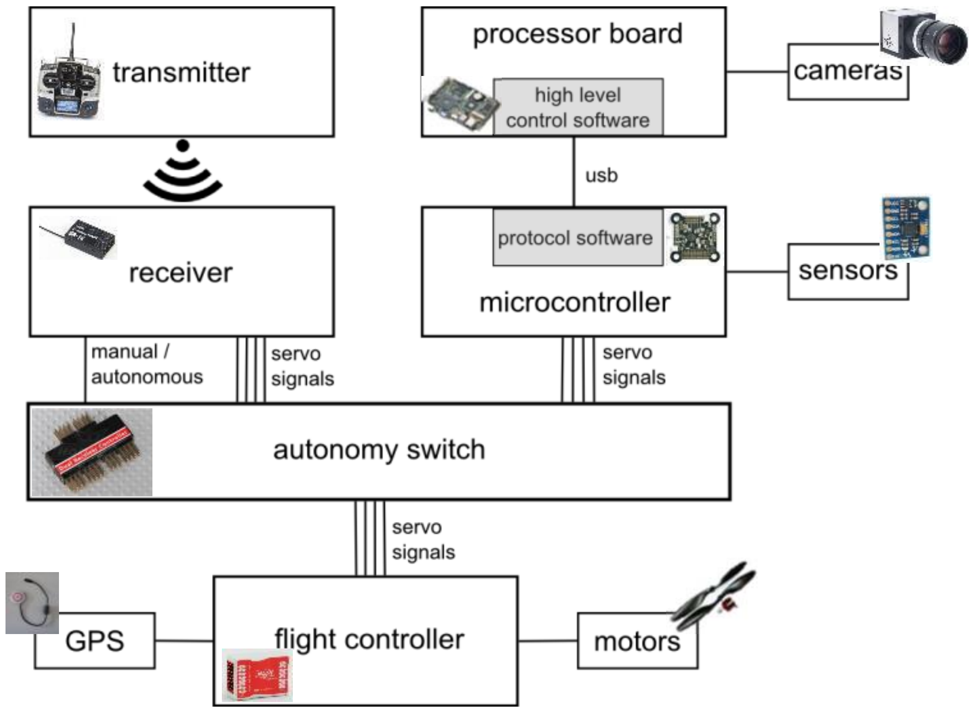
# Twirre architectuur




**Autonomous and Manual control pipelines**

**GPS-enabled and GPS deprived flight**

**Cascade control system**

**Low level = flight controller**

**High level = Simulates stick input from human pilot**

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# Twirre architecture

Cascade control system:

- Low level = flight controller
- High level
  - Simulates stick input from human pilot
  - Implemented in Twirre and runs on processor board

- Building high level control system is (much) easier than low level
- Changing/updating to new/better flight controller is easy

# Hexa-copter

# Hexa-copter (indoor)


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# Twirre
## Architecture for autonomous mini-UAVs using interchangeable commodity components

J. van de Loosdrecht, K. Dijkstra, J.H. Postma, W. Keuning and D. Bruin
NHL University of Applied Sciences, Centre of Expertise Computer Vision (www.nhlcomputervision.nl)

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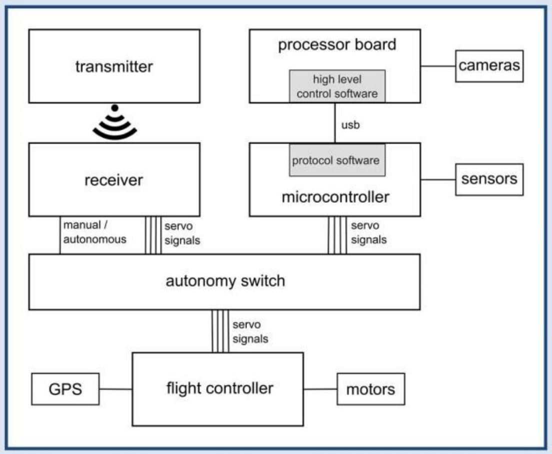
### Objectives

- All sensors and processing on-board
- Low-cost components
- Upgradable and extendable
- Useful in multiple applications
- Instantly and reliably switch between manual and autonomous control

### Example implementation


### Architecture

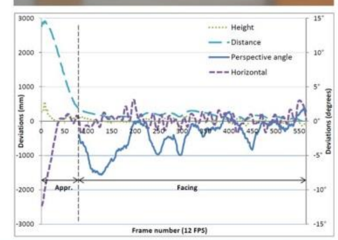



*Cascade control system*
- High level: simulation of human stick inputs
- Low level : exchangeable flight controller

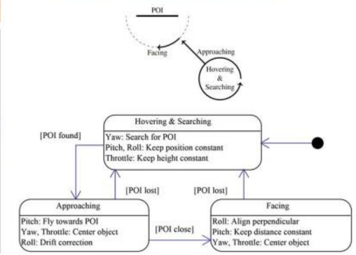
*Autonomy switch*
- In hardware only, no software involved

*Software*
- Mission and high level control system
- Portable C(++)

### Result of experiments




*State machine*
- Hovering & Searching
- Approaching Point of Interest
- Facing Point of Interest




### Conclusions

- Twirre architecture has been derived from objectives
- Low-cost multi-copters are implemented
- Successfully tested in GPS-deprived environment
- Autonomy switch is safe and reliable

### Future work

- Extract reusable software components
- Add extra sensors for increased robustness
- Extend state machine
- Release system software to public domain

International Micro Air Vehicle Conference and Competition (IMAV 2014)

**See for IMAV 2014 paper: www.nhlcomputervision.nl**

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# DJI S1000+

MTOW = 11 kg
Payload = 5 kg
Flight time = 30 min

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## Future work on Twirre

- Combining with other sensors like
  - RTK GPS
  - LIDAR
  - 3D cameras
- 32-bits Arduino
- Design and build generic building blocks for missions
- Integrating with commercial UAVs

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# Questions ?

For more information:

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