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HORIZON 2020

The EU Framework Programme for Research and Innovation

Sweeper

A Sweet Pepper Robotic Harvester

"Digitising agriculture and food value chains"

Session: Digital solutions to meet agriculture challenges

Jos Balendonck

Brussels, November 17th, 14:00-15:30h

Robotics Use Case (Innovation Action)

Technology transfer using **leading edge science and technology**, a targeted effort will aim at **introducing, testing and validating** promising and innovative **robotics solutions** in industrial and service sectors. The focus on **robust operational deployment** of these robotic solutions, based on performance objectives, metrics, and user needs. The strong **involvement** of all **relevant stakeholders** in the value chain is essential.

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High-tech greenhouse industry

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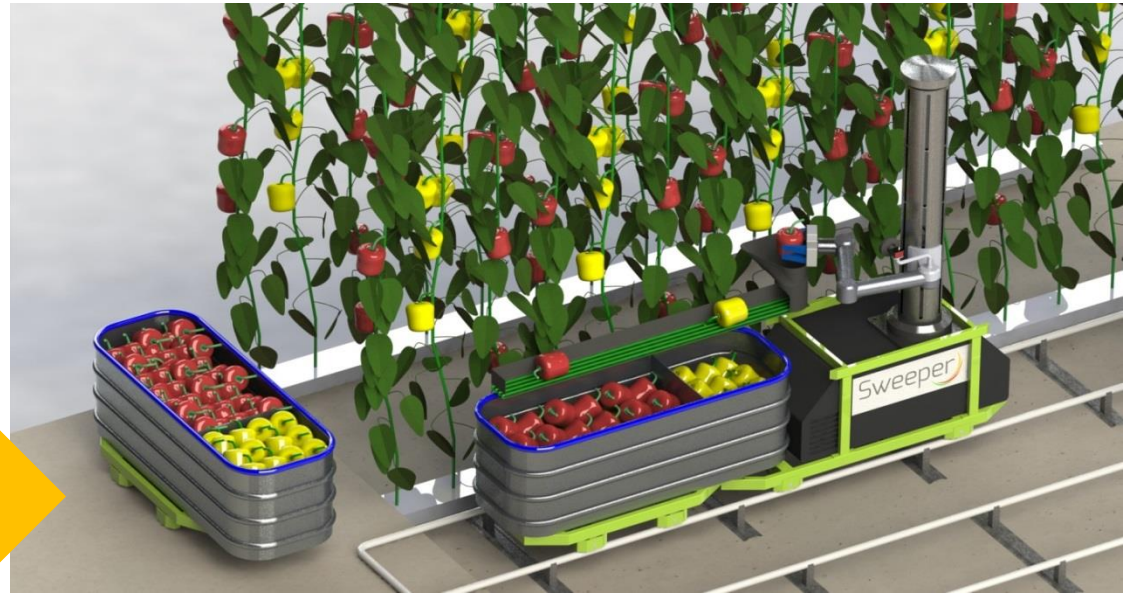
Case: Sweet Pepper Harvesting



SWEEPER's **main objective** is to put the **first generation greenhouse harvesting robots onto the market**. Until now this has never been achieved and it will ensure Europe's leading role in agricultural robotics.

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Main challenges for robotic harvesting

- Unstructured environment
  - Delicate product
  - Limited space
  - Occlusion
  - Fruit clustering
- Detection
  - Target and non-target
  - Ripeness and quality
  - 3D localization
- Economic feasibility
  - Harvesting success rate (no damage)
  - Cycle time

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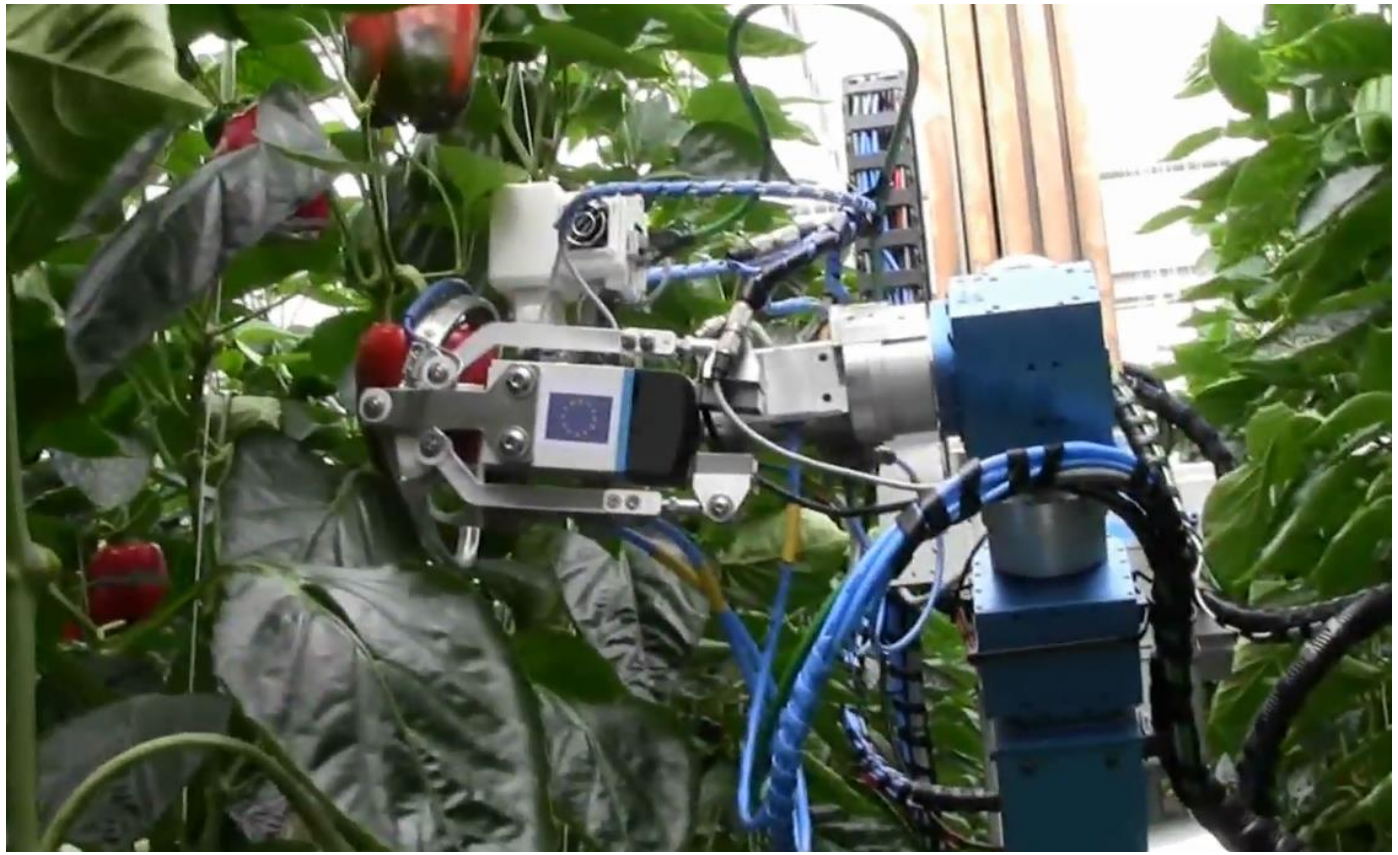
Lessons learned

- **Manipulator**
  - 6 DOF off the shelf robot arm
  - Robotic Operating System (ROS)
  - Mobile platform + post-harvest logistics
- **End-effector (grasp/cut)**
  - lip-type, smaller/light-weight
- **Camera system**
  - Ripeness and localization
  - 3D camera + illumination
- **Model based vision and control**
  - deep learning, obstacle avoidance
  - eye-hand coordination (visual servoing)
- **Economic evaluation**
  - adapted crop morphology (crop management)



CROPS GA 246252

www.crops-robots.eu

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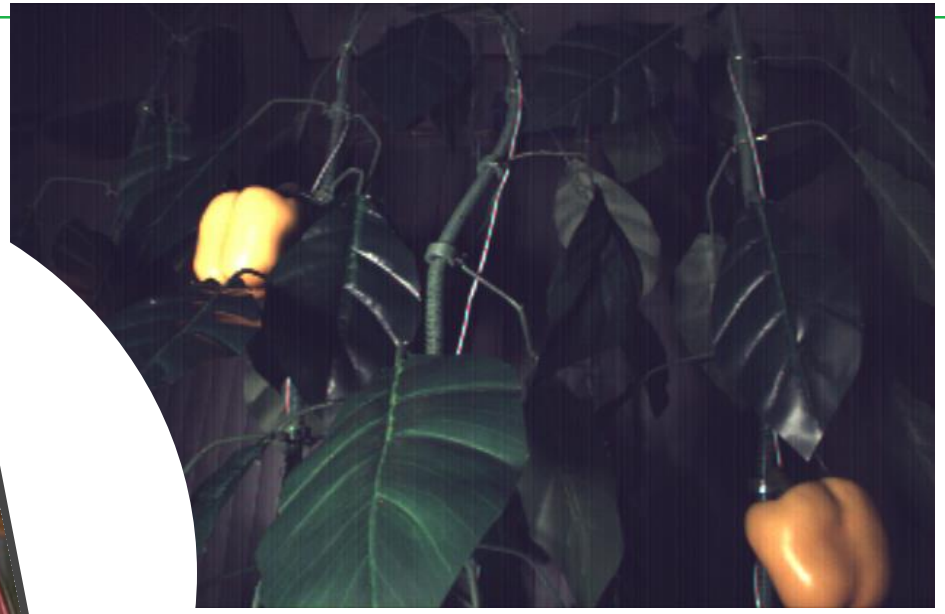
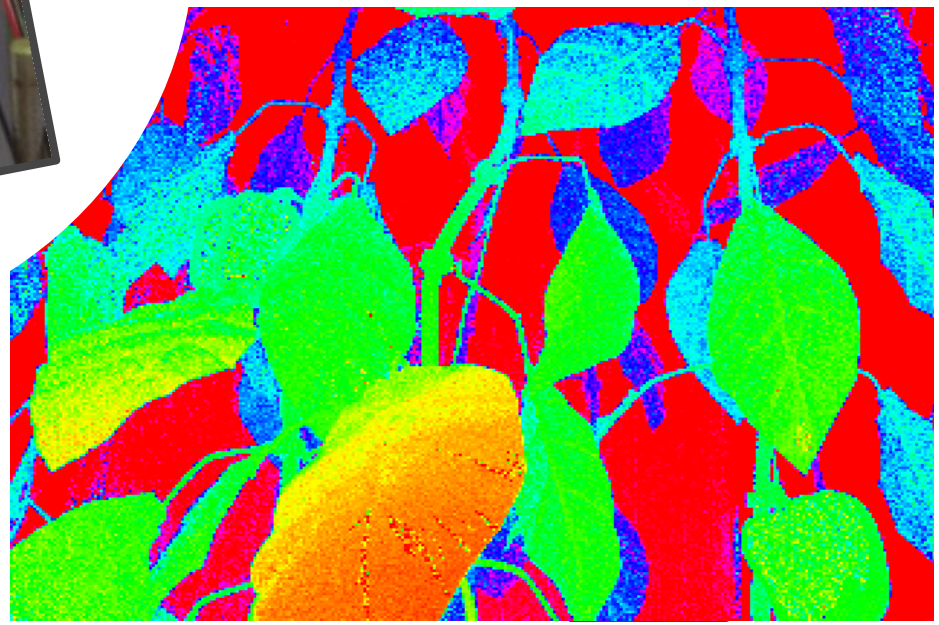
Advanced camera sensor

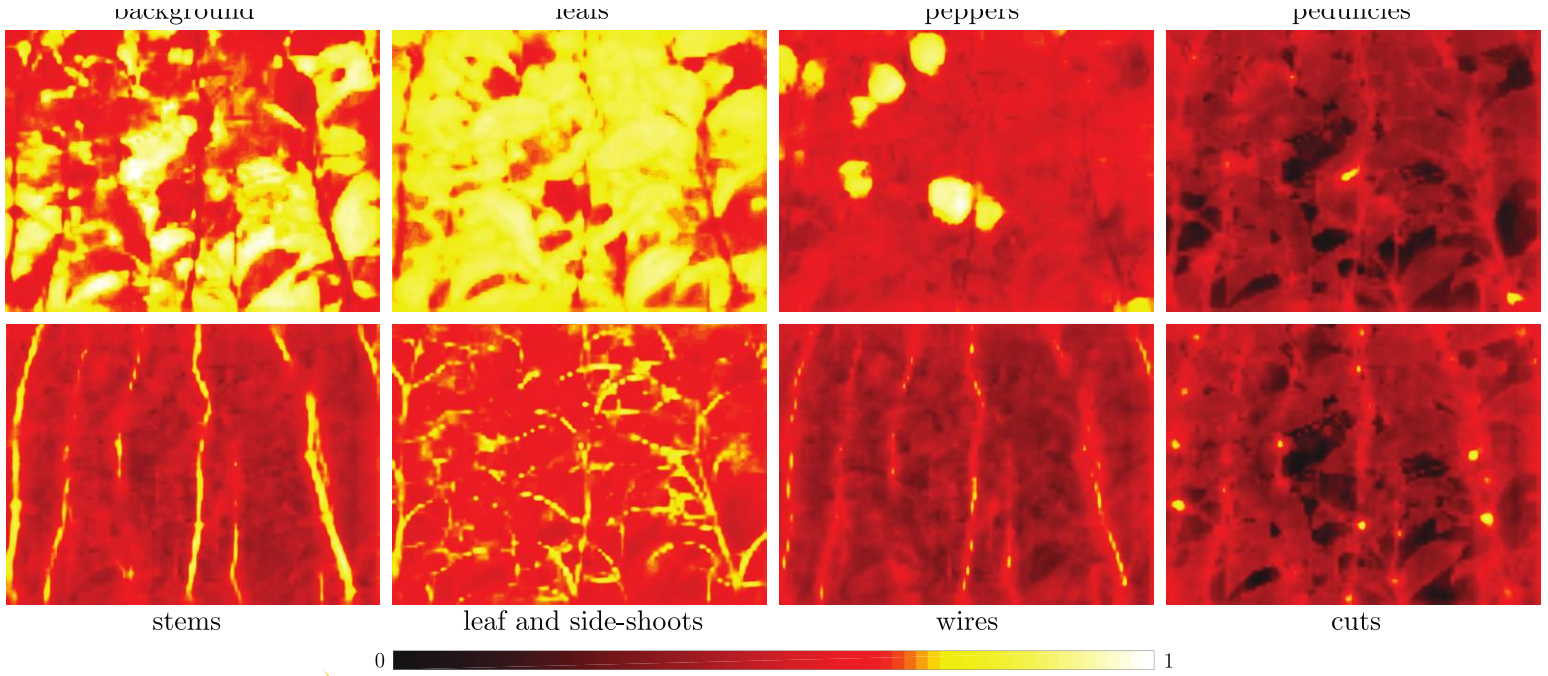
- One camera, placed in the end-effector
- Strobed active LED illumination
- Combined 3D data and colour image

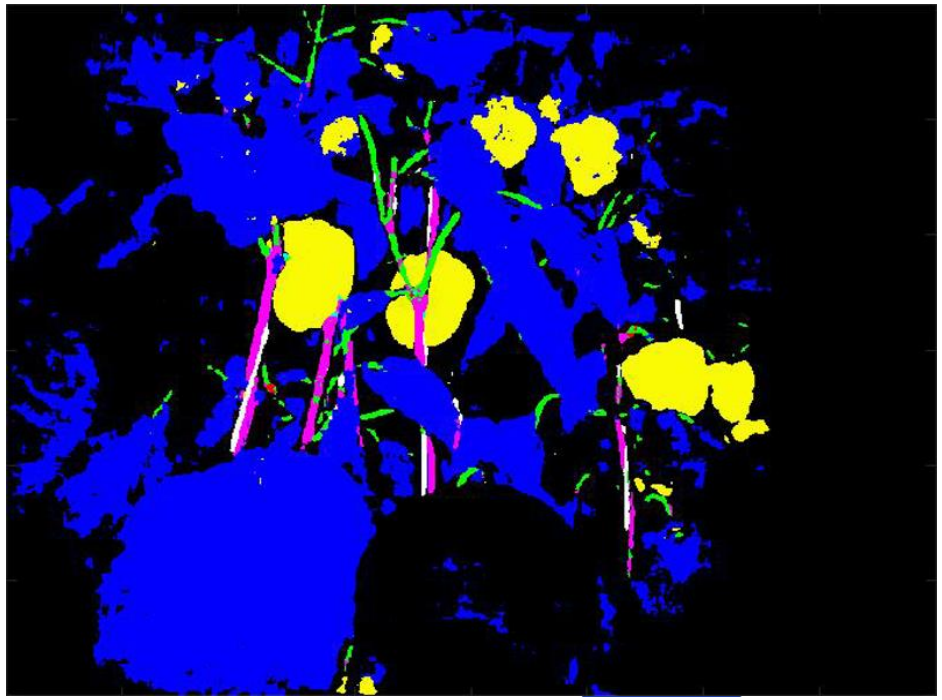




Deep-Learning for plant part localization

- **Need:** Large annotated datasets
- **Approach:** Synthetic dataset to bootstrap the model
- **Result:** Trained network for real-time obstacle detection and to determine best end-effector alignment





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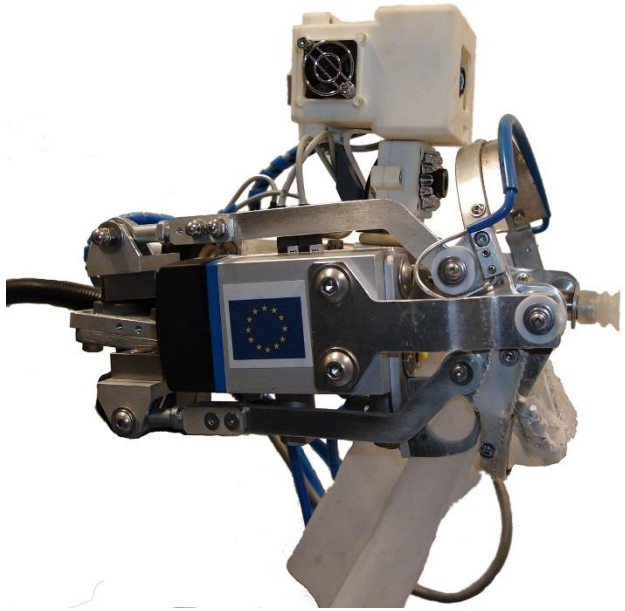
Real-time target approach using visual servoing

Software framework for **eye-in-hand sensing** and robot motion control



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Society and it's ideas about agriculture robots

- **Growers:** skilled labour, cost and availability
  - Need for economic feasible robotics concepts
  - More management information
- **Workers:** hard work (hot, humid)
  - Make work less hard:
    - robots assist in repetitive work under harsh conditions
  - Change work type to a higher level:
    - supervision of robots
- **General public:** afraid to loosing jobs
  - Create new jobs:
    - appeal to human intelligence and expertise
    - human/robot collaboration

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Precision farming requires digital solutions

- Treatment of individual plants on a row or m2
  - AGV, Mobile platforms, drones, master-slave
  - From arable-crops towards horticulture
- HiRes Crop/field status (sensors, IoT, cloud computing)
  - Crop yield, diseases, phenotyping (for breeding)
  - From monitoring data towards management information (DSS)
- Precision application/treatment equipment (robots)
  - Fertilisers, spraying, crop protection, weeding, selective harvesting

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Future research topics

- **Deep-learning** (to support navigation in unstructured environments)
- **Crop monitoring** (for early detection of diseases/pests and crop quality/yield)
- Combine **robotic** developments with **plant breeding** expertise (to enhance robotic performance)
- **Human-robot collaboration** (safe robot-assisted human work to reduce workload/environmental issues)

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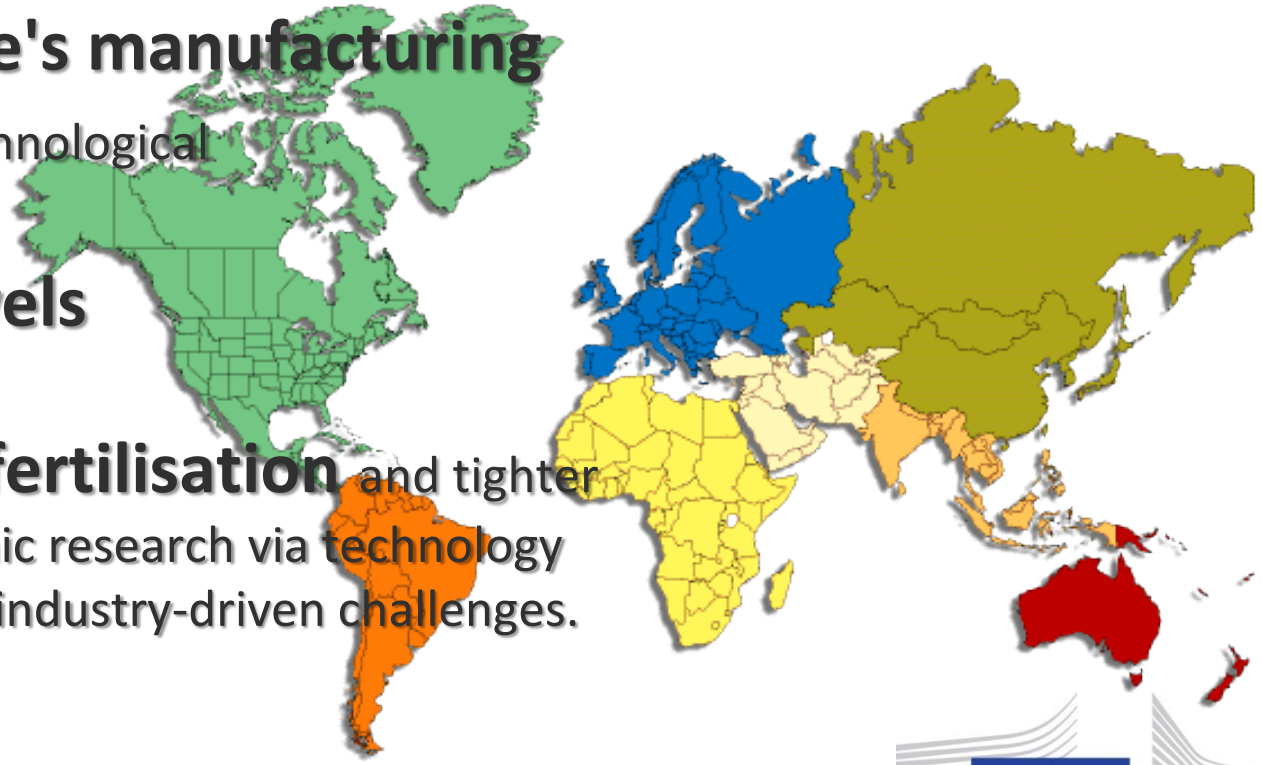
Expected impact

- **Increase Europe's market share in industrial robotics** to one third of the market and maintain and strengthen Europe's market share of 50% in professional service robotics by 2020.
- **Improve competitiveness of Europe's manufacturing** sector, in particular **SMEs**, address pressing technological challenges and the effect of an aging workforce.
- **Improve Technology Readiness Levels** of robotics technologies.
- **Increase Industry-Academia cross-fertilisation** and tighter connection between industrial needs and academic research via technology transfer, common projects, scientific progress on industry-driven challenges.



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Thank you for your attention

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