



HORIZON 2020



WAGENINGEN
UNIVERSITY & RESEARCH

The EU Framework Programme for Research and Innovation

- Testing and evaluation
- Pepper cutting tool
- Obstacle detection

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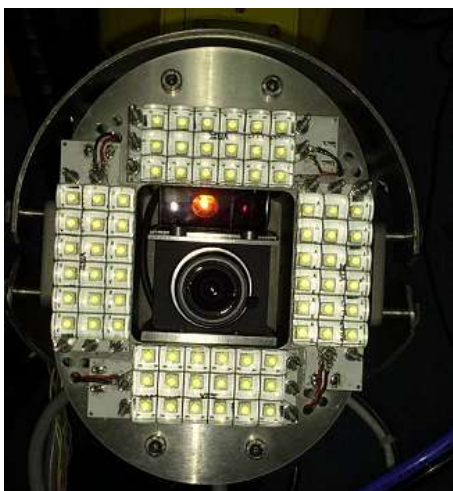
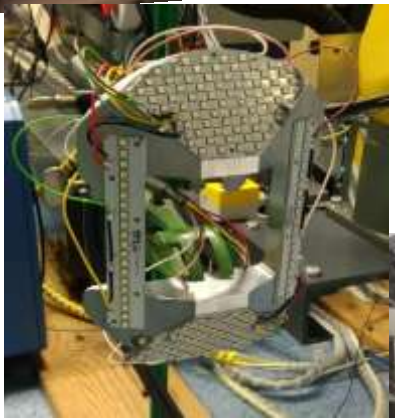
Sweeper

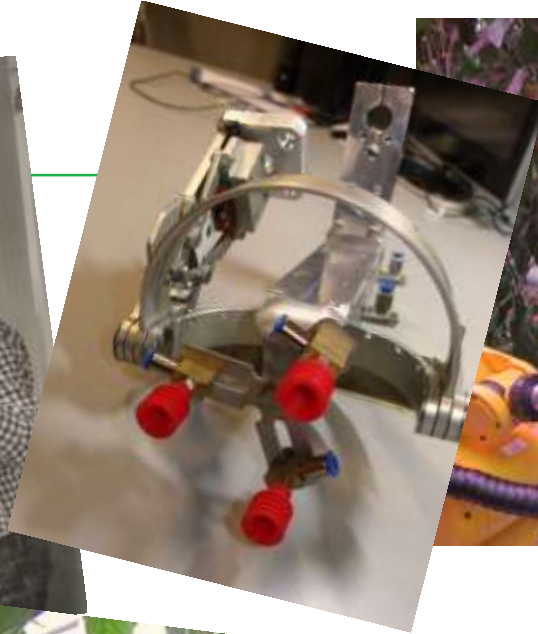
A graphic element consisting of several curved lines in yellow, orange, and red, resembling a stylized 'S' or a brushstroke, positioned to the right of the word "Sweeper".

Testing and evaluation

- Layout and definition of test scenarios and definition of performance measures.
- Performing experiments with modules and integrated system in the laboratory and the greenhouse.
- Analysing of experimental results.
- Performance determination of realized prototype.



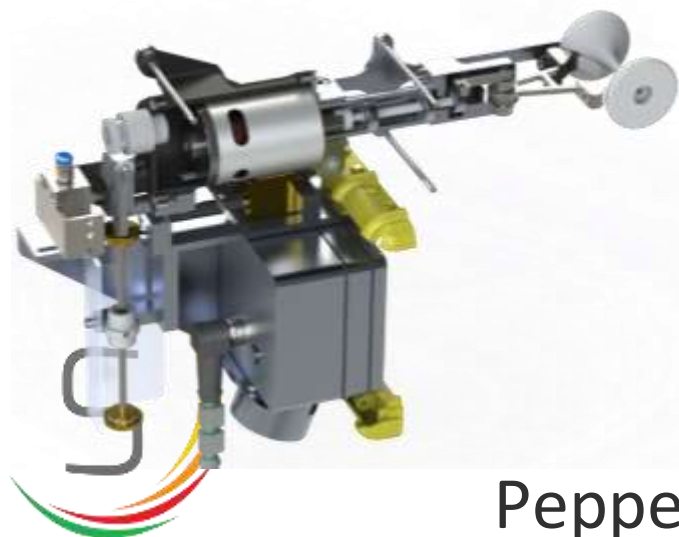
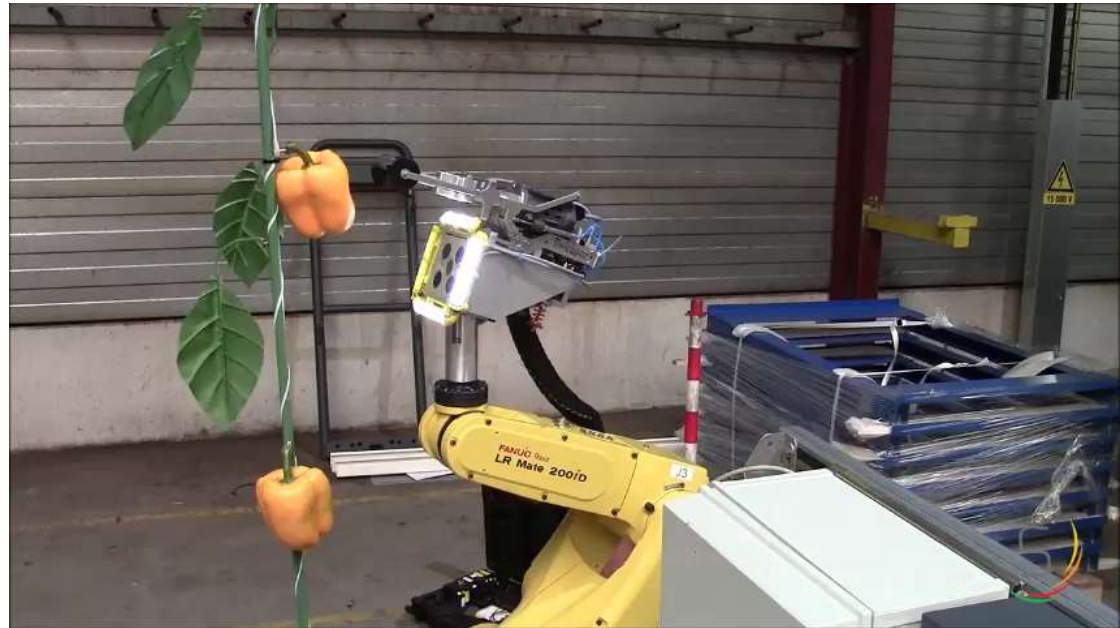
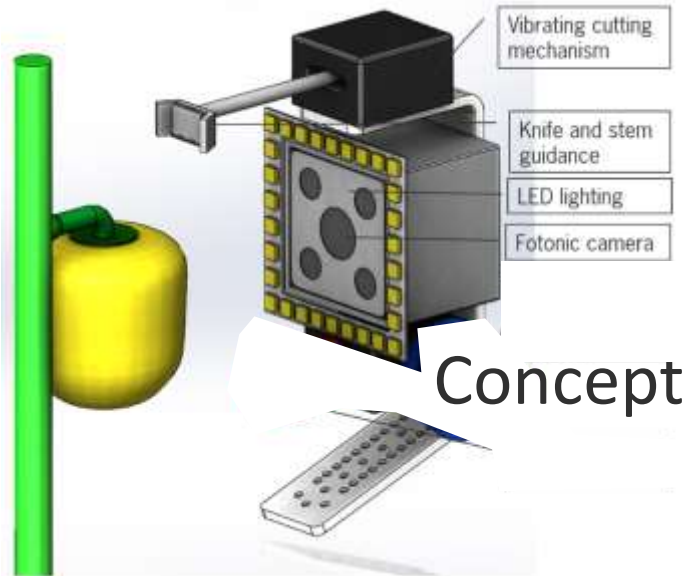








End-effector: cutting tool

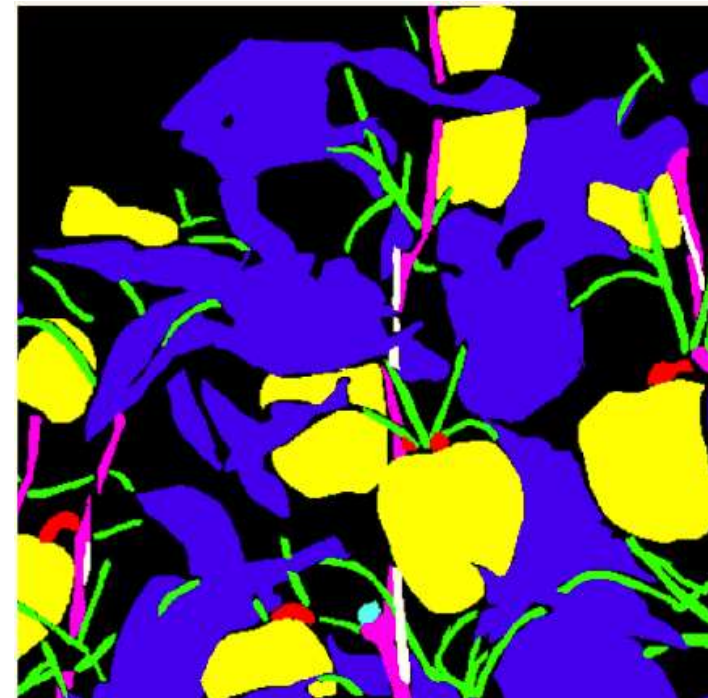
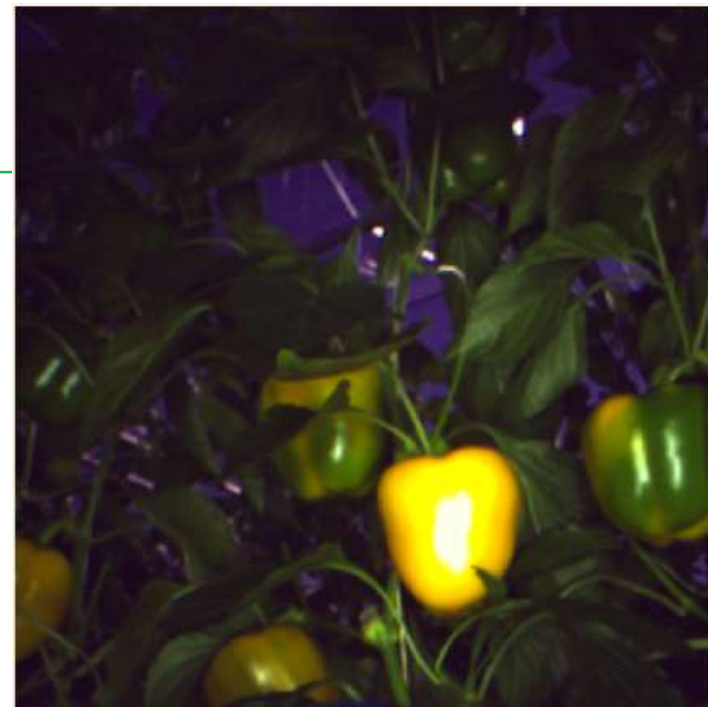


Final design
Pepper catching device added



Obstacle detection

- Deep Learning convolutional neural network (CNN) applied for sweet-pepper plant part segmentation
- Objective: plant main stem detection to calculate obstacle free approach direction for the robot



Real-time deployment

- Trained network is deployed for real-time determination of best end-effector alignment.



Simulation tool for economic viability

- A simulation tool for calculating the economic viability of the sweet pepper harvesting robot.
- Main factors:
 - Cycle time
 - Success rate
 - Economic life cycle
 - Number of operators.
 - Percentage of 2nd quality due to robotic harvest.

Automated harvesting of sweet peppers					
5.0 Basic information (Robot idea)					
Available working hours for robots					
Robot working hours per day	20	hr/day			
Robot days per week	6	d/week			
Production weeks	35	weeks			
Total	4200	hours			
Performance of robot			Required number of robots		
Average cycle time of one robot	10	sec/pc		Required robots	4.94
Success rate	60%			Number of Robots (Rounded)	5
Missed during peaks	11%			Required for peak	8.91
6.0 Labour Cost manual harvesting robot misses					
Missed fruits	47%				
Manual productivity missed peppers	117	kg/hr			
Costs per working hour	€ 16.50	/hr			
Labour costs on target production site	€ 216,741				
Difficulty factor missed fruits	1.46				
Peak labour					
Labour costs per m ²	€ 3.10	/m ² /year			
Labour costs per kg	€ 0.0661	/kg			
7.0 Labour (operator) costs					
Costs per working hour operator	€ 25		35		
hours per day on target site	20				
Total working hours	4200				
Number of operators on target site	0.25			(concerning Harvesting robots)	
Total labour costs	€ 26,250	per year			
Labour costs per m ²	€ 0.38	/m ² /year			
Labour costs per kg	€ 0.0117	/kg			
8.0 Investments					
Interest rate	5%				
	Costs	Number needed	Economic life cycle	Costs	
	(€/piece)	(per target production site)	(year)	(per m ² /year)	(per kg)
1 Pipe rail trolleys	€ 2,500	17	5	€ 0.14	€ 0.004
2 Containers	€ 1,000	60	5	€ 0.19	€ 0.006
3 Knives	€ 3	68	1	€ 0.00	€ 0.000
4 Workplace registration system	€ 35,000	1	5	€ 0.11	€ 0.004
5 Maintenance	€ 6,833	1	1	€ 0.10	€ 0.003
Total				€ 0.545	€ 0.017
Equipment costs per m²	€ 0.545				
Equipment costs per kg	€ 0.017				



Team



- **Jos Balendonck**, Co-ordination.



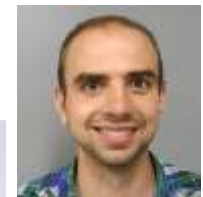
- **Jochen Hemming**, Computer Vision & Robotics, Lead of Applied testing.



- **Ruud Barth**, Computer Vision, Deep Learning, Applied Testing.



- **Bart van Tuijl**, Mechatronics, End-effector, Applied Testing.



- **Toon Tielen**, Mechatronics, Applied Testing.



- **Marcel Raaphorst**, Economics and Exploitation.

- **Jan Bontsema**, Co-ordination until Oct. 2015.

