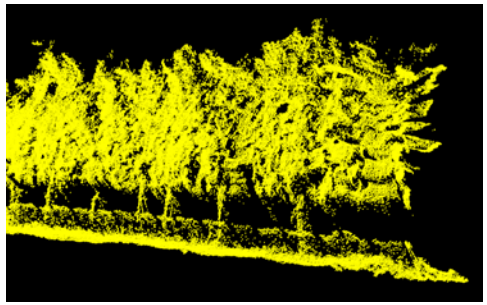
VINBOT – an unmanned ground vehicle for precision viticulture

INSTITUTO SUPERIOR DE AGRONOMIA
Universidade de Lisboa

LEAF
LINKING LANDSCAPE, ENVIRONMENT, AGRICULTURE AND FOOD

VINBOT



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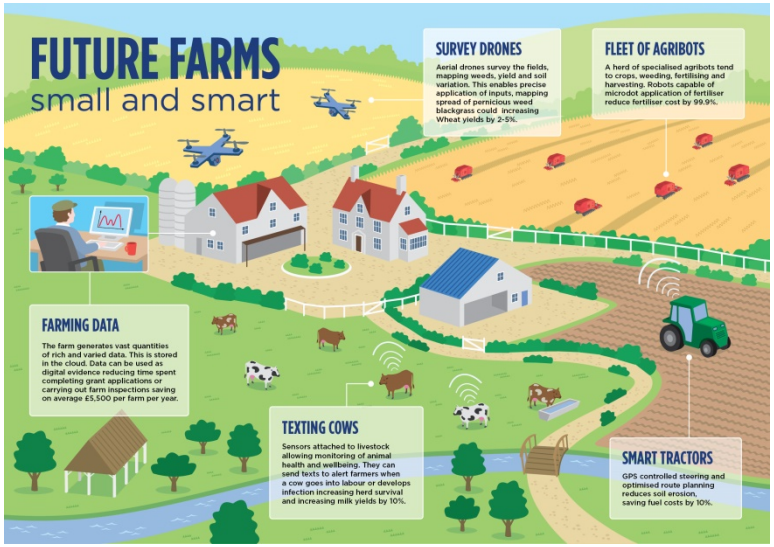
INTRODUCTION

- The increasing use of robots in agriculture;
- Several applications for terrestrial robots in agriculture;
- Market projections: strong growth of the agricultural robots market in the coming years;

  - EU is strongly encouraging R&D&I actions in this area: **Strategic Research Agenda for Robotics in Europe**



https://twitter.com/nesta_uk/status/653579634823467008

EXAMPLES TERRESTRIAL ROBOTS IN VITICULTURE

- Winter pruning;
- Spraying;
- Mechanical weeding;
- Transport
- Phenotyping;







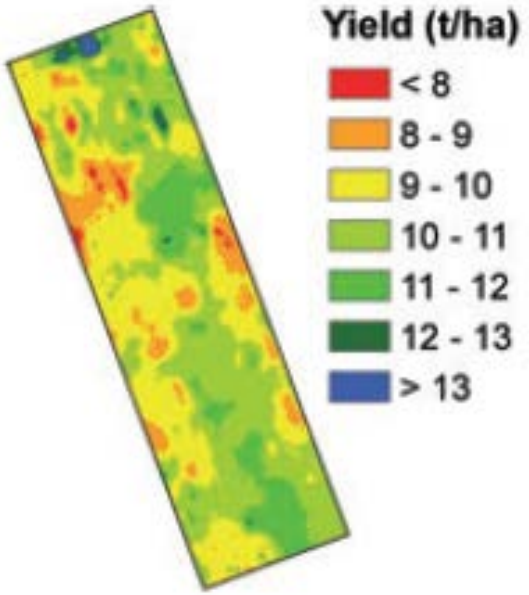

Yield estimation in Viticulture

Strong demand for improved systems

Advantages of yield forecast

- ✓ Planning crop thinning according to an optimal yield target;
- ✓ Planning and organization of harvest: labor, manpower, equipment, etc.;
- ✓ Planning cellar needs: fermenter space, tanks, barrels, oenological products, bottles and others;
- ✓ Planning purchases and/or grape sales;
- ✓ Grape prices establishment and wine stock management;
- ✓ Management wine & grapes market;
- ✓ Investment planning;
- ✓ Planning marketing strategies.
- ✓ others

Lopes, C.; ISA/ULisboa



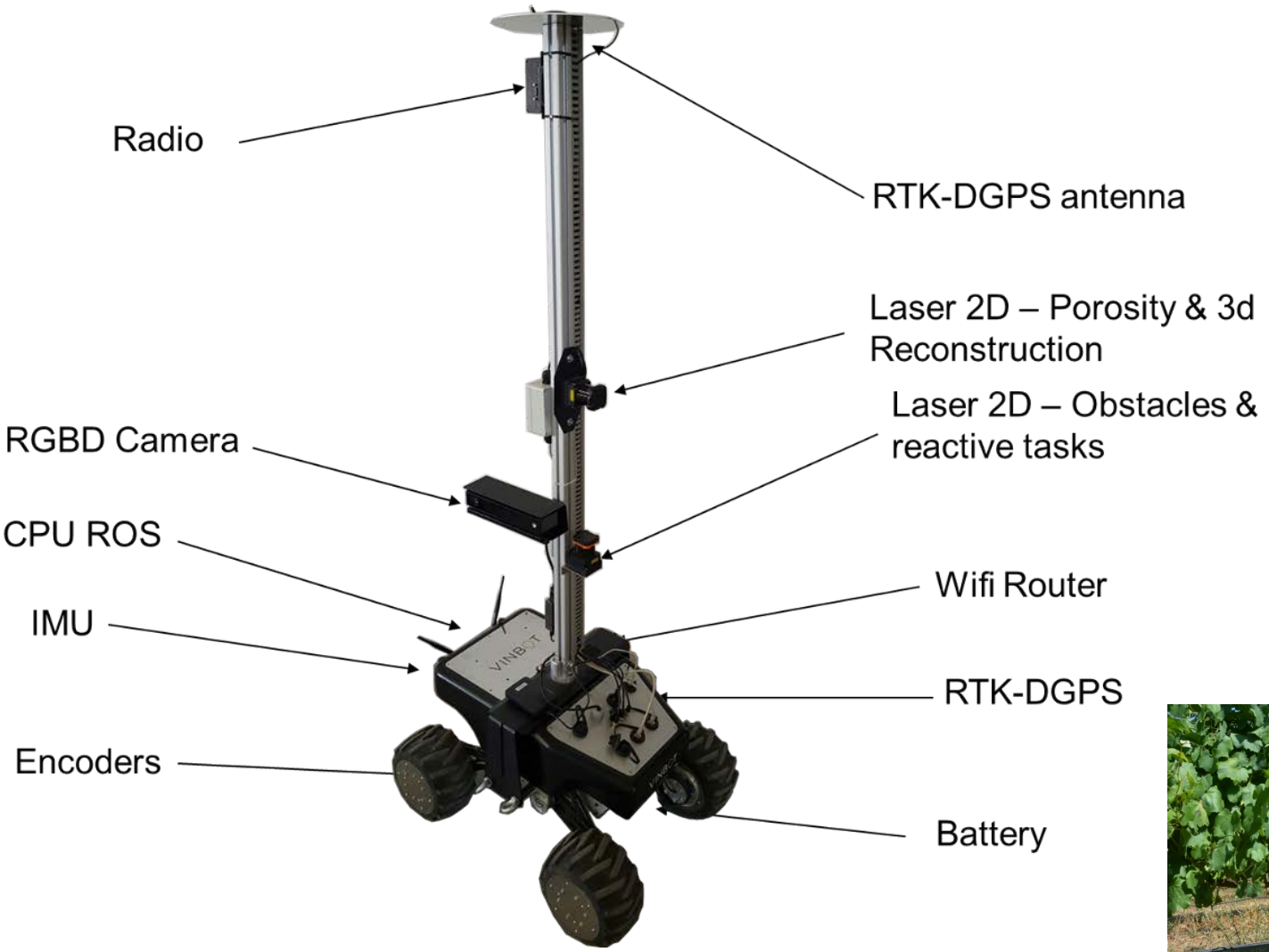
VINBOT

Autonomous cloud-computing vineyard robot to optimise yield management and wine quality (http://www.vinbot.eu)

EU, FP7 (Grant Agreement FP7- SME-2013-2, 605630; 2014-2016)

Objectives: provide an alternative to the manual sample-based yield estimation methods by developing an all-terrain autonomous mobile robot with a set of sensors capable of capturing and analyzing vineyard images and 3D data by means of cloud computing applications, in order to obtain yield maps representing the spatial variability of the vineyard plots.

CONFIGURATION



How does VINBOT works

(Source: Proj. Vinbot, FP7, GA nº 605630)

Ateknea Solutions

GPS

R G B

3D

Recognition cluster visible area

estimation total cluster area (modeling/calibration)

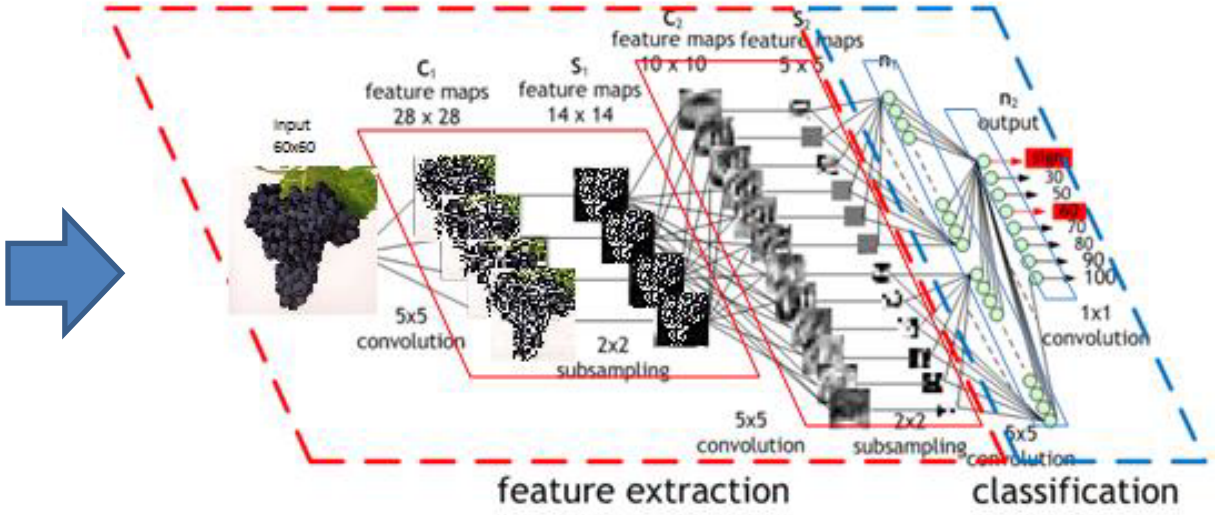
Transforming cluster area into kg grapes & building yield maps

Color	Range (kg/m)
	1.6 – 1.8
	1.8 – 2
	2 – 2.2
	2.2 – 2.46
	>2.4

YIELD ESTIMATION (1/4)

- **detection of visible clusters**/ fragments on the image (scanning both sides canopy)

grape detection using Convolutional Neural Networks inside of Deep Learning Field



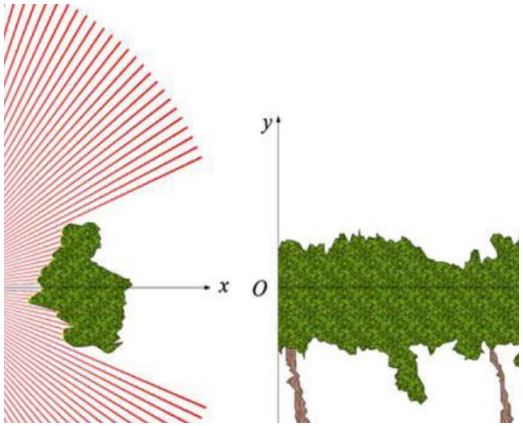
YIELD ESTIMATION (2/4)

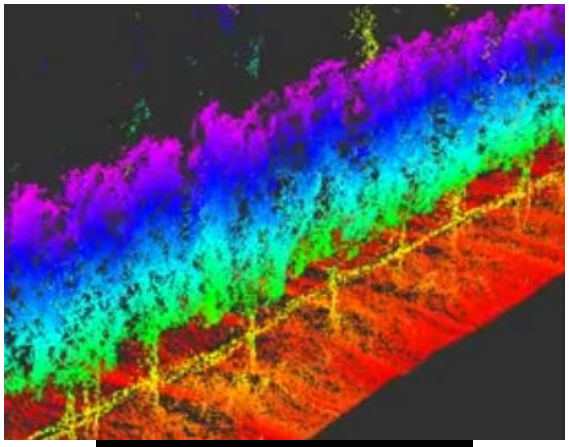
CANOPY FEATURES ESTIMATION

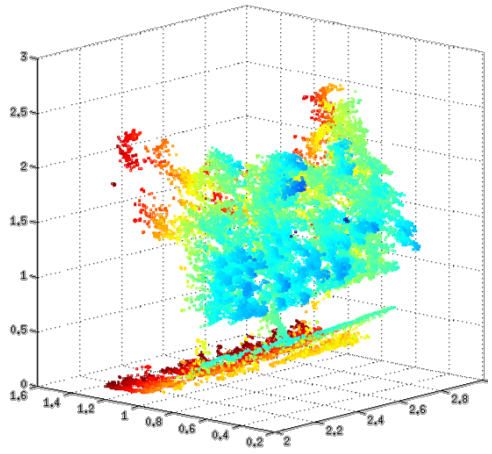
3D canopy reconstruction using Range Finder data

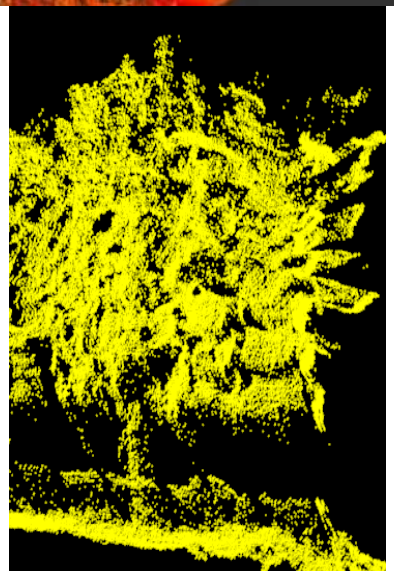
canopy features:

- canopy height;
- canopy volume;
- exposed leaf area;
- **canopy porosity**









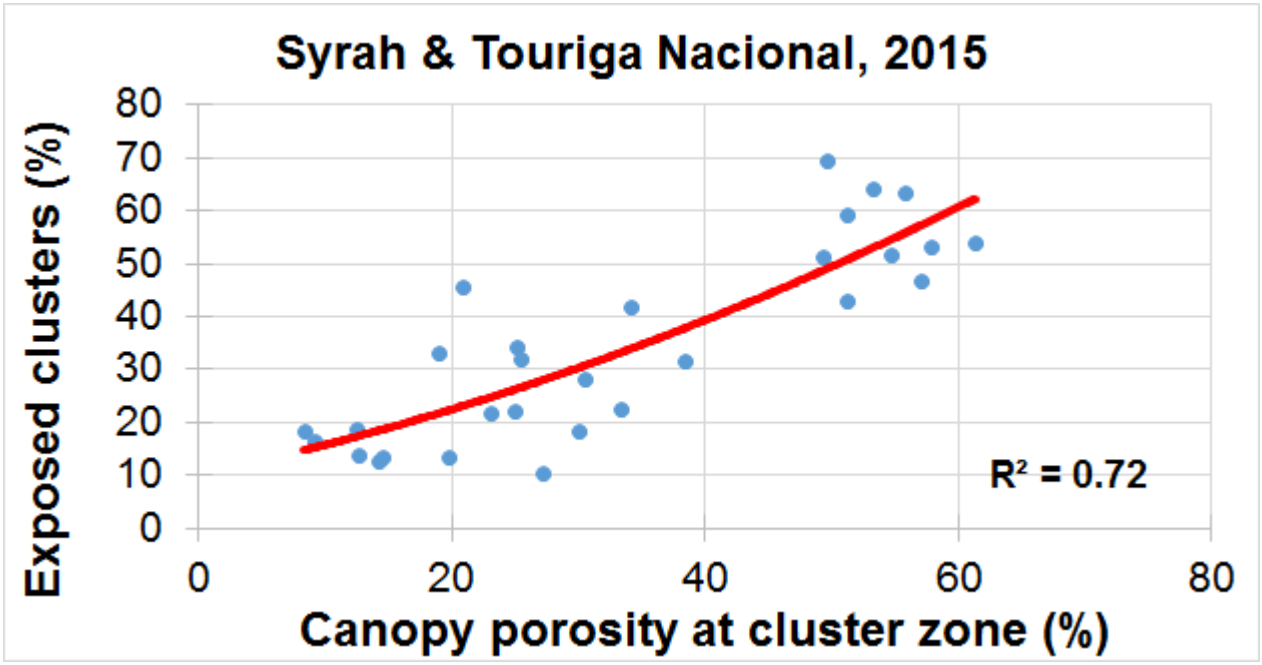
Source: Proj. Vinbot, FP7, GA nº 605630

YIELD ESTIMATION (2/4)

Estimation of total cluster projected area using canopy porosity as explanatory variable

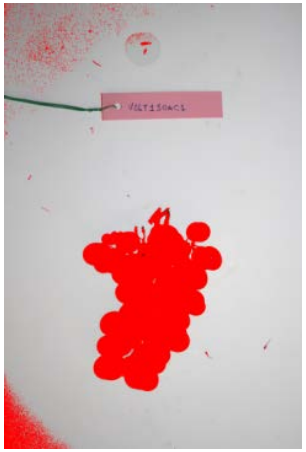


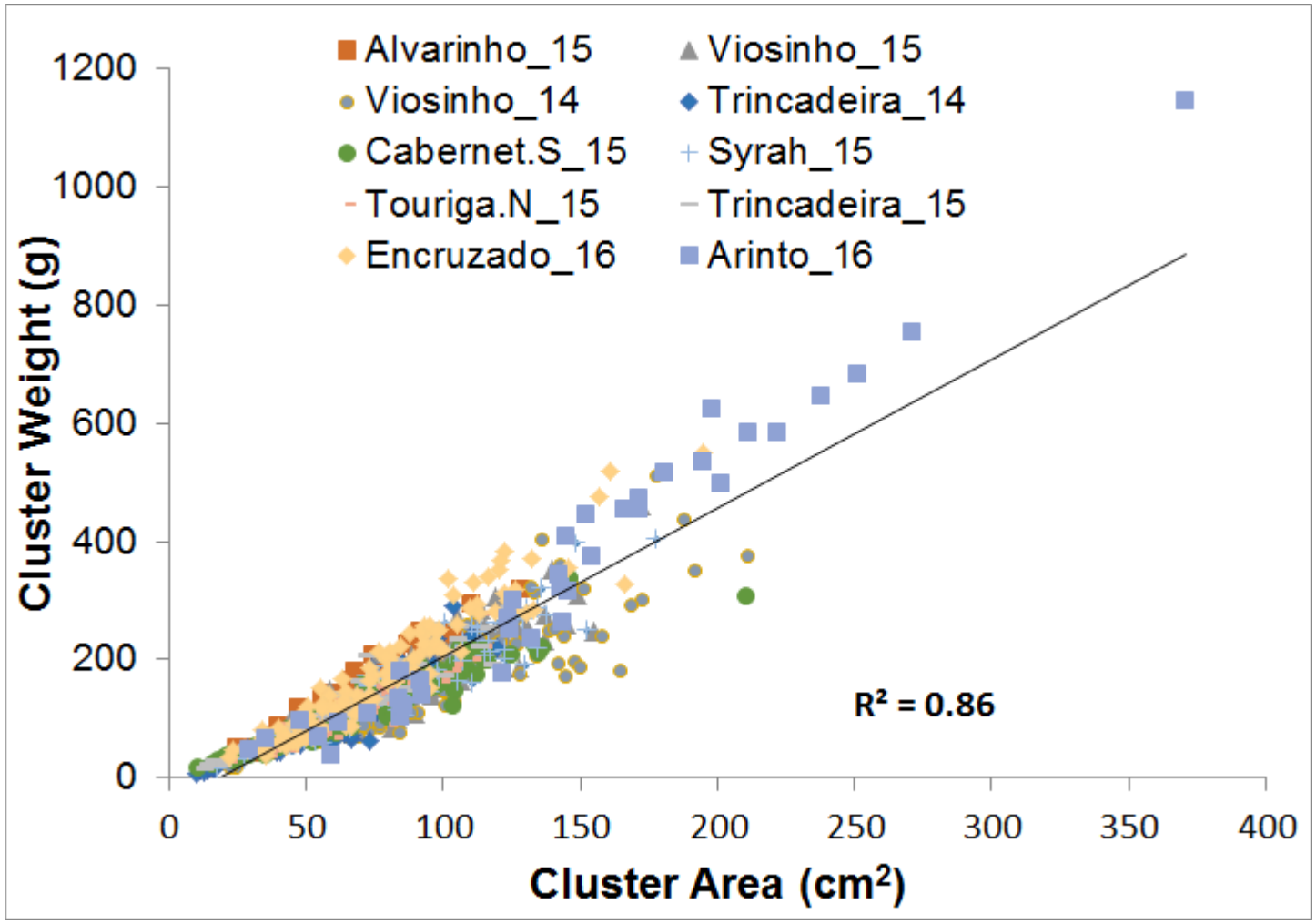
e.g. canopy manipulation at cluster zone to obtain a wider range of canopy porosity



YIELD ESTIMATION (3/4)

transforming cluster projected area into kg of grapes using relationships obtained per variety.





YIELD ESTIMATION (4/4)

Producing yield maps

Color	Range (kg/m)
	1.6 – 1.8
	1.8 – 2
	2 – 2.2
	2.2 – 2.4
	>2.4

Alvarinho

Color	Range (kg/m)
	4.5 – 5
	5 – 5.5
	5.5 – 6
	6 – 6.5
	>6.5

Viosinho

Color	Range (kg/m)
	3.5 – 4
	4 – 4.5
	4.5 – 5
	5 – 5.5
	>5.5

Encruzado

Color	Range (kg/m)
	1.6 – 1.8
	1.8 – 2
	2 – 2.2
	2.2 – 2.46
	>2.4

Arinto

LIEN
DE LA VIGNE

VINELINK INTERNATIONAL
www.liendelavigne.org

ASSEMBLEE GENERALE 2017
2017 General Assembly

NOUVEAUX OUTILS POUR LE SUIVI DE LA QUALITE DES RAISINS :

Capteurs, analyse des données, outils d'aide à la décision

New tools for monitoring grapes quality : sensors, data analysis, decision

VALIDATION

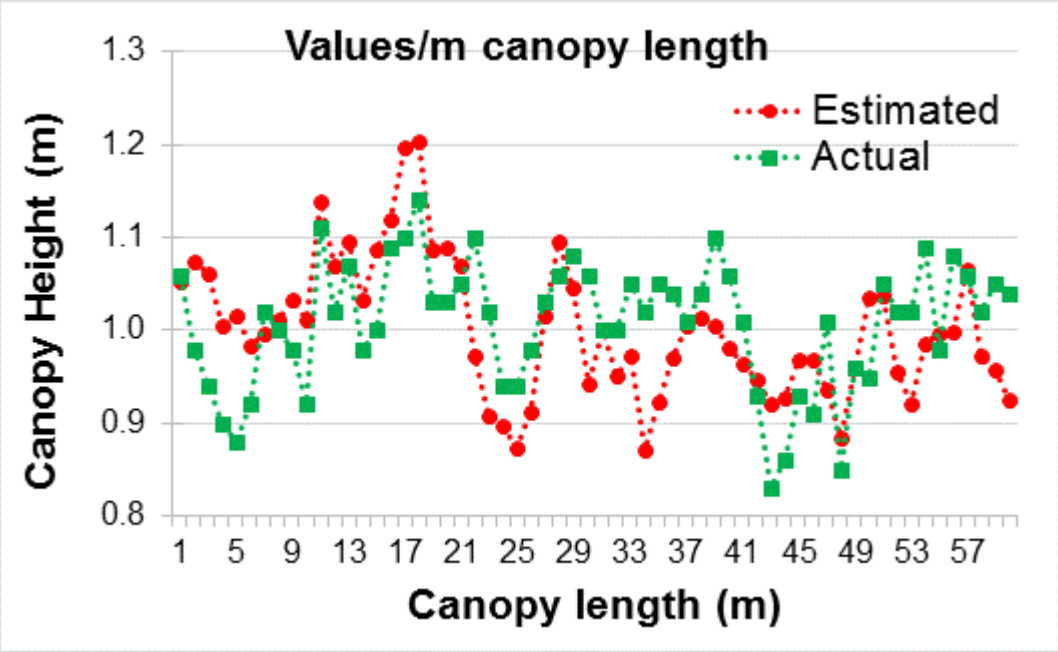
Functioning & performance of the platform in field conditions

- In general the robot **was able to deal with most field & canopy** challenges;
- skidding in some **steep slope vineyards with recently tilled soils**

VIDEO

VINBOT VALIDATION

Canopy features: e.g. Alvarinho vineyard plot

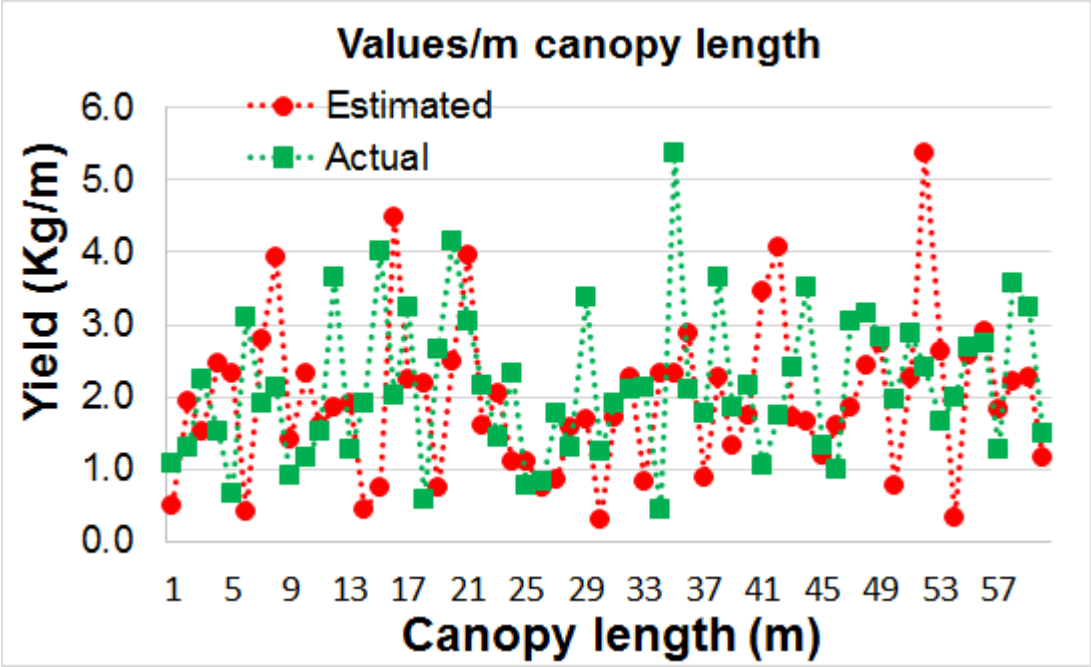


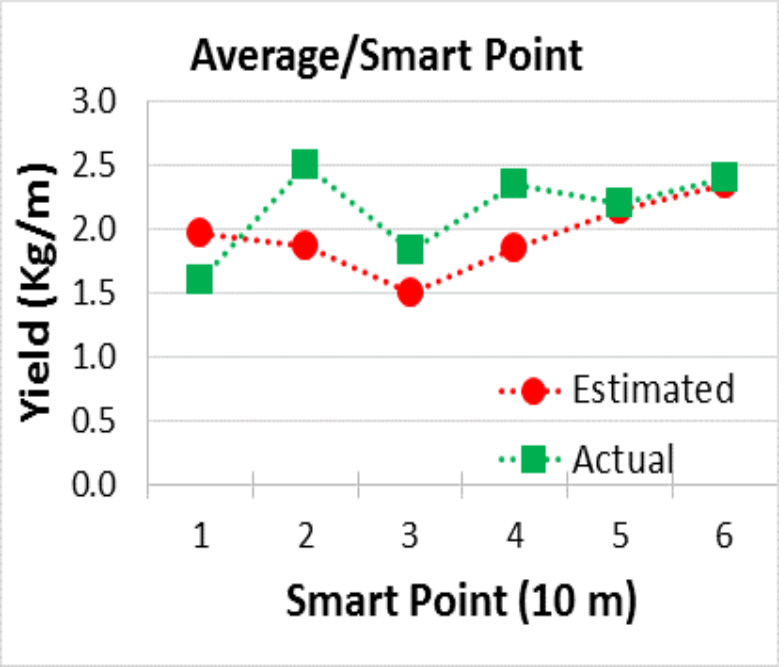
Canopy Feature	Actual (m)	Estimated (m)	MAE (m)	MA%E	RMSE (m)
Height (m)	1.01	1.00	0.06	6.20	0.07
Exposed leaf area (m^2/m)	2.43	2.45	0.13	5.40	0.15
Volume (m^3/m)	0.42	0.45	0.05	14.12	0.07

Source: Proj. Vinbot, FP7, GA nº 605630

VINBOT VALIDATION

Yield: e.g. Alvarinho vineyard plot





	Actual	Estimated	MAE	MA%E	RMSE
Yield (Kg/m)	2.15	1.95	1.1	64.0	1.4

VINBOT

CONCLUSIONS & FUTURE WORK

- **Functioning and performance of the autonomous platform**: in general the robot was able to deal with most field and canopy challenges; problems of locomotion in slope vineyards with recently tilled soils;

- **Accuracy of estimated values**:
  Canopy features - satisfactory agreement per m canopy length; better agreement when using pooled data averaged per 10 m canopy length;
  Yield - low fit between actual and estimated yield per m of canopy length but an acceptable error when averaged per smart point (10 m);

- Further research on **computer vision algorithms**, data processing, modeling and calibration is needed to improve VINBOT prediction ability;

- Research is ongoing in order to test the platform and machine vision algorithms in other varieties and vineyard plots and to overcome the bias related to the **clusters occlusion** .

Thank You for Your Attention

Robotnik VINBOT

ASSIST Innovative Minds

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Ateknea Solutions

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COOPERATIVA AGRÍCOLA DE GRANJA 1952

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Bodegas Familiares de Rioja

viticoltori dal 1860
D'ALFONSO DEL SORDO