Friday, 23 December de 2022

Completion of the PAgFRUIT project

The **PAgFRUIT research project** on **Precision Fructiculture** has concluded on 30/09/2022. Here below you can find the summary of the main achieved advances and results, together with a list of **Open Access publications**.

Fruit production in Spain faces a key challenge contemplated in the 2017-2020 Science, Technology and Innovation Research Plan: "Improving the competitiveness and environmental, economic and social sustainability of agricultural production, through the introduction of processes and technologies that increase efficiency and sustainable intensification, including the prevention, protection and control of pests and diseases". This challenge is part of the main challenge 2 on "Bioeconomy: sustainability of primary production systems", with relevant implications in challenge 5 "Climate change and use of natural resources and raw materials", which is where this research project was located. In these challenges, **the PAgFRUIT project has contributed to advance in the applicability of Precision Agriculture technologies**, such as photonic sensors (LiDAR, RGB-D cameras, intensive photogrammetry, multispectral images from different is types of platforms), to various aspects of fruit growing systems, and particularly in intensive and super-intensive production systems. In summary, the main achievements have been: **i)** creation of a protocol and a code for the extraction of geometric and structural information from the foliar canopy of intensive and super-intensive fruit tree plantations from 3D point clouds generated by LiDAR sensors, and images acquired from UAV using Structure-from-Motion photogrammetry; **ii)** characterization of fruit tree canopy through a structural index that correlates with canopy development according to different management strategies (mainly, different nutritional treatments); **iii)** correlation between vegetation indices calculated from multispectral images from different platforms (Sentinel-2, PlanetScope and drone) with the geometric and structural parameters of the orchards, to serve as a "proxy" in monitoring vigor and development of the foliar architecture of the trees; **iv)** development of advanced methods based on photonic sensors for the detection, georeferencing and discrimination of fruits, as well as for the measurement of diameter, using artificial intelligence techniques; **v)** creation of maps of geometric and structural variables of fruit trees based on geostatistical methods, and zoning through cluster analysis, all compared with vigor indices derived from multispectral images; **vi)** review of the dose decision support system (DOSA3D) for the application of phytosanitary products by calculating zonal doses and validation in vineyard plots with different intra-plot variability (characterized by LiDAR), and comparison of zonal applications using conventional machinery and by dron; **vii)** proposal of an advanced sampling scheme that, making use of vegetative parameters of the leaf canopy supplied by LiDAR sensors, and in combination with electronic detection of fruits, allows estimating the harvest (fruit load) with greater efficiency than conventional methods. **The results obtained consolidate photon-based sensors as a key technology in canopy phenotyping and tree architecture, opening the possibility of implementing new services available to fruit growers for a more optimized management of plantations**.

MAIN RESULTS PUBLISHED IN OPEN ACCESS

“PEER-REVIEW” ARTILES IN INDEXED JOURNALS

1 Gené-Mola, J.; Gregorio, E., Guevara, J.; Auat, F.; Sanz-Cortiella, R.; Escolà, A.; Llorens, J.; Morros, J.R. J.; Vilaplana, V.; Rosell-Polo, J.R., 2019. Fruit detection in an apple orchard using a mobile terrestrial lase Biosystems Engineering 187, 171-184. POSTPRINT OPEN ACCESS **http://hdl.handle.net/10459.1/667** http://hdl.handle.net/10459.1/667

2. Gené-Mola, J.; Gregorio, E.; Auat, F.; Guevara, J.; Llorens, J.; Sanz-Cortiella, R.; Escolà, A.; Rosell-Polo, Fruit detection, yield prediction and canopy geometric characterization using LiDAR with forced air-flow. C Electronics in Agriculture 168, 105121. POSTPRINT OPEN ACCESS **http://hdl.handle.net/10459.1/6878** http://hdl.handle.net/10459.1/687

3 Gené-Mola, J.; Sanz-Cortiella, R., Rosell-Polo, J.R., Morros, J.R, Ruiz-Hidalgo, J., Vilaplana, V., Gregorio Fruit detection and 3D location using instance segmentation neural networks and structure-from-motion ph Computers and Electronics in Agriculture 169, 105165. POSTPRINT OPEN ACCESS **http://hdl.handle.net/10459.1/67802** http://hdl.handle.net/10459.1/678

4 Guevara, J., Auat, F., Gené-Mola, J., Rosell-Polo, J.R., Gregorio, E., 2020. Analyzing and overcoming the GNSS error on LiDAR based orchard parameters estimation. Computers and Electronics in Agriculture 17 PREPRINT OPEN ACCESS **http://hdl.handle.net/10459.1/68089** http://hdl.handle.net/10459.1/680

5 Gené-Mola, J., Llorens, J., Rosell-Polo, J.R., Gregorio, E., Arnó, J., Solanelles, F., Martínez-Casasnovas, 2020-1. Assessing the Performance of RGB-D Sensors for 3D Fruit Crop Canopy Characterization under I Operating and Lighting Conditions. *Sensors 20*(24), 7072; ARTÍCULO OPEN ACCESS **https://doi.org/10.3390/s20247072** https://doi.org/10.3390/s202470

6 Gené-Mola, J., Sanz-Cortiella, R., Rosell-Polo, J.R., Escolà, A., Gregorio, E., 2021-1. In-field apple size es photogrammetry-derived 3D point clouds: Comparison of 4 different methods considering fruit occlusions. Electronics in Agriculture 188, 106343. ARTÍCULO OPEN ACCESS **https://doi.org/10.1016/j.compag.20** https://doi.org/10.1016/j.compag

7 Lavaquiol, B., Sanz, R., Llorens, J. Arnó, J., Escolà, A., 2021. A photogrammetry-based methodology to o digital ground-truth of leafless fruit trees. Computers and Electronics in Agriculture 191, 06553. ARTÍCULO ACCESS **https://doi.org/10.1016/j.compag.2021.106553** https://doi.org/10.1016/j.compag

8 Guevara, D.J., Gené-Mola, J., Gregorio, E., Auat Cheein, F., 2022. 3D Spectral Graph Wavelet Point Sign Pre-Processing Stage for Mobile Laser Scanning Point Cloud Registration in Unstructured Orchard Enviro *Sensors Journal*. POSTPRINT OPEN ACCESS **http://hdl.handle.net/10459.1/72508** http://hdl.handle.net/10459.1/725

9 Guevara, D.J., Gené-Mola, J., Gregorio, E., Torres-Torriti, M., Reina, G., Auat Cheein, F., 2021-1. Compa matching techniques for autonomous robot navigation in urban and agricultural environments. *Journal of A Sensing 16(2), 024508. POSTPRINT* OPEN ACCESS **http://hdl.handle.net/10459.1/71527** http://hdl.handle.net/10459.1/715

10 Pérez, G., Escolà, A, Rosell-Polo, J.R., Coma, J., Arasanz, R., Marrero, B., Cabeza, L.F., Gregorio, E., 20 characterization of a Boston Ivy double-skin green building facade using a LiDAR system. *Building and En (2021), 108320.* ARTÍCULO OPEN ACCESS **https://doi.org/10.1016/j.buildenv.2021.108320** https://doi.org/10.1016/j.buildenv

11 Martínez-Casasnovas, J.A., Sandonís-Pozo, L., Escolà, A., Arnó, J., Llorens, J., 2022. Delineation of man in super-intensive almond orchards based on vegetation indices from UAV images validated by LiDAR-der canopy parameters. *Agronomy 12(1), 102*. ARTÍCULO OPEN ACCESS **https://doi.org/10.3390/agrono** https://www.mdpi.com/2073-439

12 Sandonís-Pozo, L., Llorens, J., Escolà, A., Arnó, J., Pascual, M., Martínez-Casasnovas, J.A., 2022-1. Sate multispectral indices to estimate canopy parameters and withinfield management zones in superintensive orchards. Precision Agriculture, 2022. ARTÍCULO OPEN ACCESS **https://doi.org/10.1007/s11119-022** https://doi.org/10.1007/s11119-0

13 Miranda, J.C., Gené-Mola, J., Arnó, J., Gregorio, E., 2022-1. AKFruitData: a dual software application for A cameras to acquire and extract informative data in yield tests performed in fruit orchard environments. So 101231. ARTÍCULO OPEN ACCESS **https://doi.org/10.1016/j.softx.2022.101231**
https://doi.org/10.1016/j.softx.20

DATA ARTICLES

14 Gené-Mola, J., Sanz-Cortiella, R., Rosell-Polo, J.R., Morros, J.R., Ruiz-Hidalgo, J., Vilaplana, V., Gregoric Fuji-SfM dataset: a collection of annotated images and point clouds for Fuji apple detection and location u structure-from-motion photogrammetry. Data in Brief 29 (2020), 105591. ARTÍCULO DE DATOS OPEN A **http://doi.org/10.1016/j.dib.2020.105591**
http://doi.org/10.1016/j.dib.2020.

15 Gené-Mola, J.; Gregorio, E.; Auat, F.; Guevara, J.; Llorens, J.; Sanz-Cortiella, R.; Escolà, A.; Rosell-Polo, LFuji-air dataset: Annotated 3D LiDAR point clouds of Fuji apple trees for fruit detection scanned under dif flow conditions. Data in Brief 29 (2020), 105248. ARTÍCULO DE DATOS OPEN ACCESS **https://doi.org/10.1016/j.dib.2020.105248**
https://doi.org/10.1016/j.dib.202

16 Gené-Mola, J., Sanz-Cortiella, R., Rosell-Polo, J.R., Escolà, A., Gregorio, E., 2021-2. PFuji-Size dataset: A images and photogrammetry-derived 3D point clouds with ground truth annotations for Fuji apple detectio estimation in field conditions. *Data in Brief* 39, 107629. ARTÍCULO DE DATOS OPEN ACCESS **https://doi.org/10.1016/j.dib.2021.107629**
https://doi.org/10.1016/j.dib.2021

ARTICLES IN DISSEMINATION JOURNALS

17 Gené-Mola, J., Gregorio, E., Rosell-Polo, J.R., 2020-0. Cómo la inteligencia artificial nos ayuda a contar m Conversation (Ciencia y Tecnología), 27/01/2020. ARTÍCULO DIVULGATIVO OPEN ACCESS **https://theconversation.com/como-la-inteligencia-artificial-nos-ayuda-a-contar-manzanas-130571**
https://theconversation.com/com

BOOK CHAPTERS

18 Martínez-Casasnovas, J.A., Arnó, J., Escolà, A., 2022. Sensores de conductividad eléctrica aparente para la variabilidad del suelo en Agricultura de Precisión. En: A. Namesny, C. Conesa, L.M. Olmos, P. Papass "Tecnología Hortícola Mediterránea. Evolución y futuro: viveros, frutales, hortalizas y ornamentales". Bibli Horticultura, SPE3 S.L., Valencia, España. 1075 pp. ISBN: 978-84-16909-46-9. CAPÍTULO LIBRO OPEN **https://issuu.com/horticulturaposcosecha/docs/tecnologia_horticola_mediterranea**
https://issuu.com/horticulturapos
, pag 765-786.

PROTOCOLS AND CODES FOR DATA PROCESSING AND WEB APPLICATIONS

19 Protocolo de Clasificación de la nube de puntos generada por el equipo Viametris disponible en el apartad trabajo: **http://hdl.handle.net/10459.1/70512**
http://hdl.handle.net/10459.1/70
. Y código R-RStudio para la extracción de parámetros vegetativos disponible en el apartado de anejos de **http://hdl.handle.net/10459.1/70369**
http://hdl.handle.net/10459.1/703

20 Revisión de la aplicación DOSA3D – Dosis Zonal: **http://www.dosa3d.cat/es/introduction**
http://www.dosa3d.cat/es/introdu

21 Miranda JC, Gené-Mola J, Arnó J, Gregorio E, 2022-2. Herramienta GUI basada en Python para extraer i archivos de video producidos con cámaras Kinect Azure. AK_FRAEX - Azure Kinect Frame Extractor. **https://pypi.org/project/ak-frame-extractor/**
https://pypi.org/project/ak-frame-

22 Miranda JC, Gené-Mola J, Arnó J, Gregorio E, 2022-3. A simple GUI recorder based on Python to manag camera divices in a standalone mode. **https://pypi.org/project/ak-sm-recorder/**
https://pypi.org/project/ak-sm-rec

Aplicación informática AKFruitData: A dual software application for Azure Kinect cameras to acquire and e
23 informative data in yield tests performed in fruit orchard environments.
https://github.com/GRAP-UdL-AT/SOFTX_SOFTX-D-22-00152
https://github.com/GRAP-UdL-A

Gené-Mola J, Sanz-Cortiella R, Rosell-Polo JR, Morros JR, Ruiz-Hidalgo J, Vilaplana V, Gregorio E., 202
24 Matlab para proyectar detecciones de imágenes en nubes de puntos 3D generadas mediante estructura a
movimiento **https://github.com/GRAP-UdL-AT/SfM_3D_fruit_detection**
https://github.com/GRAP-UdL-A

Gené-Mola J, Sanz-Cortiella R, Rosell-Polo JR, Escolà A, Gregorio E., 2021. Proyecto Matlab para la esti
25 tamaño de manzanas en nubes de puntos 3D
https://github.com/GRAP-UdL-AT/apple_size_estimation_in_3D_point_clouds
https://github.com/GRAP-UdL-A

Felip Pomés M, Net Barnes F, Gené Mola J, 2022. Proyecto Python para la detección y seguimiento de fr
YOLOv5 y ByteTrack. El proyecto fue construido para ser probado en conjunto con el robot AMIGA para f
26 de frutas en el campo. Implementado en el Farm@thon organizado por Lleida Drone y Farm-ng, que obtu
premio del concurso Farm@thon 2022 **https://github.com/GRAP-UdL-AT/AMIGA_fruit_counting**
https://github.com/GRAP-UdL-A

Gené-Mola J, Llorens J, Rosell-Polo JR, Gregorio E, Arnó J, Solanelles F, Martínez-Casasnovas JA, Esco
Proyecto Matlab para evaluar el rendimiento del sensor RGB-D mediante el análisis de los datos RGB-D a
27 diferentes condiciones de plantaciones frutales
https://github.com/GRAP-UdL-AT/RGBD_sensors_evaluation_in_Orchards
https://github.com/GRAP-UdL-A

Gené-Mola J, Gregorio E, Auat F, Guevara J, Llorens J, Sanz-Cortiella R, Escolà A, Rosell-Polo JR, 2020
28 Matlab para la detección de frutas en nubes de puntos 3D adquiridas con el sensor LiDAR Velodyne VLP-
https://github.com/GRAP-UdL-AT/fruit_detection_in_LiDAR_pointClouds
https://github.com/GRAP-UdL-A

Gené-Mola J, Gregorio E, Sanz-Cortiella R, Escolà A, Llorens J, Rosell-Polo JR., 2019. Proyecto Matlab p
29 nubes de puntos 3D a partir de datos adquiridos con un escáner láser terrestre móvil (MTLS) compuesto
LiDAR Velodyne VLP-16 y GNSS GPS1200+ **https://github.com/GRAP-UdL-AT/MTLS_point_cloud_g**
https://github.com/GRAP-UdL-A

DATA

Gené-Mola, J., Llorens, J., Rosell-Polo, J.R., Gregorio, E., Arnó, J., Solanelles, F., Martínez-Casasnovas,
30 2020-2. KEvOr dataset. Zenodo, 4286460. DATOS OPEN ACCESS **https://doi.org/10.5281/zenodo.428**
https://doi.org/10.5281/zenodo.4

Guevara, D.J., Gené-Mola, J., Gregorio, E., Torres-Torriti, M., Reina, G., Auat Cheein, F. 2021-2. AgLiMat
31 [Data set]. Zenodo. DATOS OPEN ACCESS **https://doi.org/10.5281/zenodo.4415385**
https://doi.org/10.5281/zenodo.4

ARTICLES IN CONGRESSES

Llorens, J.; Cabrera Pérez; C., Escolà, A.; Arnó, J., 2019. R software code to process and extract informat
Lidar point clouds. En: Poster Proceedings of the 12th European Conference on Precision Agriculture, Jul
32 Montpellier, France. pp. 114-115. e-book publication. SupAgro Montpellier. ISBN 978-2-900792-49-0.
http://hdl.handle.net/10459.1/84290
http://hdl.handle.net/10459.1/84

Gené-Mola, J.; Sanz-Cortiella, R.; Rosell-Polo, J.R.; Morros, J.R.; Ruiz-Hidalgo, J.; Vilaplana, V.; Gregoric
Fruit detection and 3D location using instance segmentation neural networks and structure-from-motion ph
33 7th Annual Catalan Meeting on Computer Vision. September 22, 2020, Universitat Autònoma de Barcelon
(http://acmcv.cat/). **http://hdl.handle.net/10459.1/84029**
http://hdl.handle.net/10459.1/84

34 Llorens, J., Alsina, A., Arnó, J., Martínez-Casasnovas, J.A., Escolà, A., 2021-1. Multi-beam LiDAR-derivec for optimal canopy 3D monitoring in super-intensive almond (Prunus dulcis) orchards. In: Stafford, J.V. (ec Agriculture'21. Wageningen Academic Publishers, Amsterdam (The Netherlands), pp 395-401. DOI: 10.3920/978-90-8686-916-9. PREPRINT OPEN ACCESS: **http://hdl.handle.net/10459.1/84065** http://hdl.handle.net/10459.1/84(

35 Llorens, J., Escolà, A., Casañas, E., Rosell-Polo, J.R., Arnó, J., Martínez-Casasnovas, J.A., 2021-2. Estim geometric and structural parameters in a super-intensive almond (Prunus dulcis) orchard from multispectra indices derived from a UAV image. In: Stafford, J.V. (ed.), Precision Agriculture'21. Wageningen Academi Amsterdam (The Netherlands), pp 129-135. DOI: 10.3920/978-90-8686-916-9. PREPRINT OPEN ACCE **http://hdl.handle.net/10459.1/84060** http://hdl.handle.net/10459.1/84(

36 Martínez-Casasnovas, J.A., Llorens, J., Sandonís-Pozo, L., Escolà, A., Arnó, J., 2021. NDVI from satellite estimate LiDAR-derived geometric and structural parameters in super-intensive almond orchards. In: Staff Precision Agriculture'21. Wageningen Academic Publishers, Amsterdam (The Netherlands), pp 567-572. I 10.3920/978-90-8686-916-9. PREPRINT OPEN ACCESS **http://hdl.handle.net/10459.1/84063** http://hdl.handle.net/10459.1/84(

37 Lavaquiol, B.; Llorens, J.; Sanz, R.; Gené, J., Arnó, J.; Gregorio, E.; Escolà, A., 2021. Metodología para e errores y validación de nubes de puntos 3D obtenidas en campo para la caracterización de la arquitectura frutales. XI Congreso Ibérico de Agroingeniería (virtual). **http://hdl.handle.net/10459.1/84291** http://hdl.handle.net/10459.1/84:

38 Sandonís-Pozo, L., Plata-Moreno, J.M., Llorens, J., Escolà, A., Pascual, M. Martínez-Casasnovas, J.A., 2(PlanetScope Vegetation Indices to Estimate UAV and LiDAR-derived Canopy Parameters in a Super-Inter Orchard. 14th International Symposium FRUTIC 2022, June 29 – July 1, 2022, Valencia. **http://hdl.handle.net/10459.1/84009** http://hdl.handle.net/10459.1/84(

39 Gené-Mola, J., Sanz-Cortiella, R., Rosell-Polo, J.R., Escolà, A., Gregorio, E., 2022-1. Apple size estimatio photogrammetry-derived 3D point clouds. Anual Catalan Meeting on Computer Vision 2022, Universitat Au Barcelona, (http://acmcv.cat/). **http://hdl.handle.net/10459.1/84013** http://hdl.handle.net/10459.1/84(

40 Gené Mola, J.; Gregorio, E.; Sanz Cortiella, R.; Escolà, A.; Rosell Polo, J.R., 2022-2. Fruit detection and s photonic sensors and artificial intelligence. International Conference on AI Applications in Agriculture. Inter for Biosaline Agriculture (ICBA) and Universitat de Barcelona (UB). July 19-20, 2022. Barcelona. **http://hdl.handle.net/10459.1/84030** http://hdl.handle.net/10459.1/84(

41 Martínez-Casasnovas, J.A., 2021. Aplicaciones de la teledetección en la caracterización de frutales y en l cultivos extensivos. III Jornadas Científico-Técnicas de Teledetección y Agricultura de Precisión (Lleida, E CONFERENCIA/WORKSHOP. **http://hdl.handle.net/10459.1/84138** http://hdl.handle.net/10459.1/84:

42 Sandonís-Pozo, L., Llorens, J., Escolà, A., Arnó, J., Pascual, M., Martínez-Casasnovas, J.A., 2022-3. Ass different N treatments in Hedgerow Almond Orchards by means of LiDAR point clouds. XXI International N Workshop 2022. Madrid 24-28 Octubre 2022. **http://hdl.handle.net/10459.1/84121** http://hdl.handle.net/10459.1/84:

43 Sandonís-Pozo, L., Arnó, J., Rufat, J., Villar, J.M., Martínez-Casasnovas, J.A., Pascual, M., 2022-4. Análi foliar de setos de olivo mediante LiDAR y su relación con la productividad y atributos de calidad del aceite Nacionales del Grupo de Olivicultura de la Sociedad Española de Ciencias Hortícolas (SECH). Logroño 1 2022. **http://hdl.handle.net/10459.1/84118** http://hdl.handle.net/10459.1/84:

44 Cabrera-Pérez, C., Llorens, J., Escolà, A., Royo-Esnal, A., Recasens, J., 2022. Manejo de malas hierbas viñedo mediante acolchados orgánicos y su efecto sobre el vigor del cultivo. En: G. Santesteban y N. Tori de Horticultura 91, 390-394. **http://hdl.handle.net/10459.1/84189**
http://hdl.handle.net/10459.1/841

DOCTORAL THESIS, FINAL DEGREE AND MASTER THESIS DISSERTATIONS

45 Gené Mola, J., 2020. Fruit detection and 3D location using optical sensors and computer vision. Directores J.R. Rosell Polo. Tesis Doctoral OPEN ACCESS: **http://hdl.handle.net/10803/669110**
http://hdl.handle.net/10803/6691
(Premio Extraordinario de doctorado)

46 Alsina Theas, A., 2020. Determinación de los parámetros óptimos de escaneo del sensor LiDAR Velodyne plantaciones de almendros súper-intensivos. Máster en Ing. Agronómica, UdL. Tutores: J. Llorens, A. Esc OPEN ACCESS: **http://hdl.handle.net/10459.1/70512**
http://hdl.handle.net/10459.1/705

47 Maestro Balaguer, S., 2020. Puesta en marcha y evaluación experimental de una cámara RGB-D: Micros Máster en Ing. Industrial, UdL. Tutor: E. Gregorio. TFM OPEN ACCESS: **http://hdl.handle.net/10459.1/6**
http://hdl.handle.net/10459.1/696

48 Rosell Tarragó, M., 2020. Design of a 3D photogrammetry acquisition system and data processing workflo TFG Grado Ing. Mecánica, UdL.Tutores: A. Escolà, R. Sanz. TFG OPEN ACCESS: **http://hdl.handle.net**
http://hdl.handle.net/10459.1/703

49 Raduà Castellví, P., 2020. Detección y caracterización geométrica de frutos utilizando técnicas de fotogra Grado Ing. Agraria y Alimentaria, UdL Tutor: R. Sanz. TFG OPEN ACCESS: **http://hdl.handle.net/10459**
http://hdl.handle.net/10459.1/703

50 Rotés Biosca, A., 2021. Prestaciones de una cámara monofocal para la caracterización de árboles frutale plataformas aéreas y terrestres. Medida del NDVI y comparación con sensores de relfectancia. Grado de Alimentaria. UdL. Tutores A. Escolà, J. Arnó. TFG OPEN ACCESS: **http://hdl.handle.net/10459.1/72242**
http://hdl.handle.net/10459.1/722

51 Camats, H., 2020. Fenotipado mediante un sensor LiDAR terrestre de una plantación de almendros bajo u experimental de fertirrigación. Grado de Ing. Agraria y Alimentaria, UdL. Tutores: J. Arnó, J. Llorens. TFG ACCESS: **http://hdl.handle.net/10459.1/70369**
http://hdl.handle.net/10459.1/703

52 Casañas, E., 2020. Anàlisi de paràmetres vegetatius en plantacions intensives d'ametllers mitjançant difer de teledetecció. Grado de Ing. Agraria y Alimentaria, UdL Tutor: J.A. Martínez, J. Llorens. TFG OPEN AC **http://hdl.handle.net/10459.1/84140**
http://hdl.handle.net/10459.1/841

53 Ferrer Ferrer, M., 2021. Fruit size estimation using Multitask Deep Neural Networks. Master Thesis in Con Universitat Politècnica de Catalunya. Supervisors: J. Ruiz Hidalgo (UPC) & J. Gené Mola (UdL). TFM: **https://unidisc.csuc.cat/oc-shib/index.php/s/8ryaSG2MFClhCll**
https://unidisc.csuc.cat/oc-shib/ir

54 Simón, P., 2022. Detecció i seguiment visual de fruites. Trabajo final de grado en Ingeniería de Telecomu Universitat Politècnica de Catalunya. Supervisores: R. Morros (UPC) & J. Gené Mola (UdL). TFG: **https://unidisc.csuc.cat/index.php/s/sA1InDfxITsxi54**
https://unidisc.csuc.cat/index.php

55 Net Barnés, F., 2022. Fruit detection and tracking in RGB-D videos. Master Thesis in Computer Vision. Ur
Autònoma de Barcelona (UAB). Supervisors: J. Gené Mola (UdL) & R. Morros (UPC). TFM:
https://unidisc.csuc.cat/index.php/s/sQ2Xdv8OO3DO6lN
https://unidisc.csuc.cat/index.phı

56 Galve, I., 2022. 3D apple segmentation and measurement in large unstructured point clouds. Master Thes
Vision. Universitat Autònoma de Barcelona (UAB). Supervisors: J. Ruiz-Hidalgo (UPC), J. Gené Mola (Ud
Vilaplana (UPC). TFM: **https://unidisc.csuc.cat/index.php/s/43cWuyyTe6KMa8gN**
https://unidisc.csuc.cat/index.phı