FLEXIGROBOTS

Flexible robots for intelligent automation of precision agriculture operations

Introduction

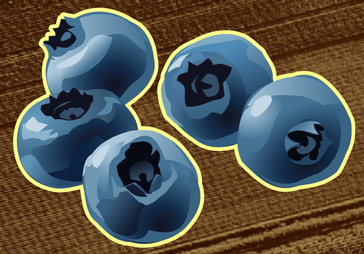
FlexiGroBots has a mission to unlock the full potential of Artificial Intelligence and Robotics in creating adaptable and diverse multi-robot systems. These systems work collaboratively to tackle intricate tasks seamlessly across different fields. As an EU-funded initiative, this project drives intelligent automation in precision agriculture operations, ultimately bringing significant advantages to farmers worldwide.

FlexiGroBots provides a platform for the creation of a European Common Agricultural Data Space, drawing upon the principles and established components put forth by the International Data Spaces Association (IDSA).

This project has dedicated components to support building, sharing and deploying AI services in the context of the Agriculture Data Space and to process geospatial information relying on Open Geospatial Consortium (OGC) standards.

Project Information

Funding programme	H2020-EU.2.1.1.
Grant agreement	No 101017111
Duration	36 months
Start date	January 1st 2021
Overall budget	8,154,443.75 €
Coordinator	Atos IT



Pilot 1 - GRAPEVINES (Spain)

Demonstrate the high capacity and versatility of robots to carry out different tasks in vineyards, contributing to the economic profitability and quality of grapes for the production of wine.

From pilot 1, the **soil**, **plants** and **weather** conditions of the bunches were investigated and inspected, considering the environmental factors that favour the appearance of Botrytis on grapes. Images were obtained with the position of the affected bunches to **train the detection models**.

In 2022, the fungus was inoculated to ensure the disease appearance. In 2023, the pilot demonstration was carried out by inspecting the test area and **treating the affected bunches.** The **harvest assistance demonstration** was also carried out, in which robots followed the grape pickers, transporting the boxes with the harvested grapes.

It is important to mention the difficulty of the **Botrytis detection** tests, caused by the non-appearance of the fungus; the probability and detection algorithms will improve their accuracy over time, as the models are trained with the images taken by the robots. Regarding harvesting, we can say that picking time is reduced, which improves grape quality and ease of harvesting.

Pilot 2 – RAPESEEDS (Finland)

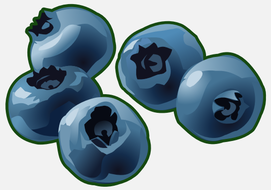
Demonstrate time-critical pest management and robotization of heavy machinery fleets in grassland management, while being environmentally and economically sustainable.

FlexiGroBots pilot 2 (Rapeseed) has focused on demonstrating a scenario with multiple drones and robots. The demonstration includes the **developments of various robots**, **mission workflow management**, **heterogeneous fleet management**, **connection to AI services** from the FlexiGroBots platform, and **data sharing with IDSA** agriculture data space.

We created a **grassland renovation scenario**, where weeding robots removed Rumex weeds, ground robots with ISOBUS tasks and controllers handled additional fertilisation and weed transportation tasks, and autonomous drones did the seeding and supervision tasks.

All tasks have been based on **drone surveys** and **AI analyses** of taken images, and all the devices have been supervised and controlled with **FlexiGroBots Mission Control Centre's (MCC)** Fleet Manager software. The multi-vendor and multi-party features have been based on the MCC Mission workflow management approach and data sharing between the parties via FlexiGroBots agriculture data space. The scenario was validated at our Ruukki pilot site in northern Finland.

Angel 4:	Running	64.68511	25.08801	1.0	3.0	103.9
Angel 3:	Running	64.68517	25.08659	1.0	1.0	22.0
Fertilizer 2:	Running	64.68511	25.08804	1.0	3.0	103.9
Fertilizer 1:	Idle	64.68480	25.08827	44.0	0.0	-113.8
Seeding Drone:	Running	64.68551	25.08691	1.0	2.0	22.0
Angel 2:	Idle	0.00000	0.00000	0.0	0.0	0.0



Pilot 3 - BLUEBERRIES (Serbia and Lithuania)

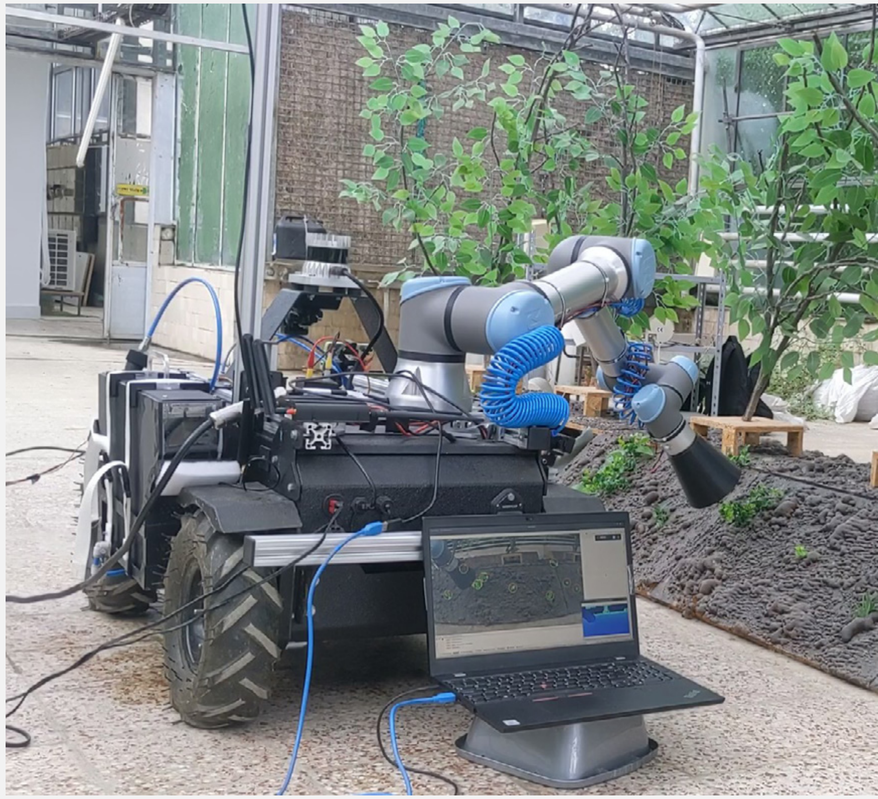
Demonstrate the potential of novel robotic solutions for blueberry farming in real farm operational environments, supported by advanced remote sensing, deep learning and decision-support techniques.

Growing high-quality blueberries is not an easy task. It demands a lot of devotion and manual labour. Within FlexiGroBots, we employed ground **robots** and **drones** to get a number of crucial layers of data. **Yield prediction**, **assessment of plant health** and **estimation of nutrient content** provide actionable insights for the farmer, who can use them to **optimise fertiliser application**, **irrigation** and **post-harvest activities**, such as sales and logistics.

On the other hand, our UGV - agRobot Gari is capable of substituting field workers by performing **automatic soil sampling** and analysis, as well as **target-spraying the weeds** according to the principles of precision agriculture.

This has been achieved through interdisciplinary development of UGV components, navigation and computer vision systems, and state-of-the-art deep learning algorithms, which process UAV images.

High efficiency and impressive performance make **Gari** an excellent companion of the farmer, the one that **saves inputs**, **increases the yield** and **ensures the highest quality of blueberries.**



FlexiGroBots platform v3

One of the primary objectives of FlexiGroBots is the development of an AI platform tailored for the management of diverse robot types. Over the past half-year, substantial effort has been dedicated to expanding and enhancing the platform.

The AI platform focused on two key areas in the project:

Integrating it with the project's architectures,

Enhancing hardware resources, including GPUs, for improved cluster performance and robustness in unexpected situations.

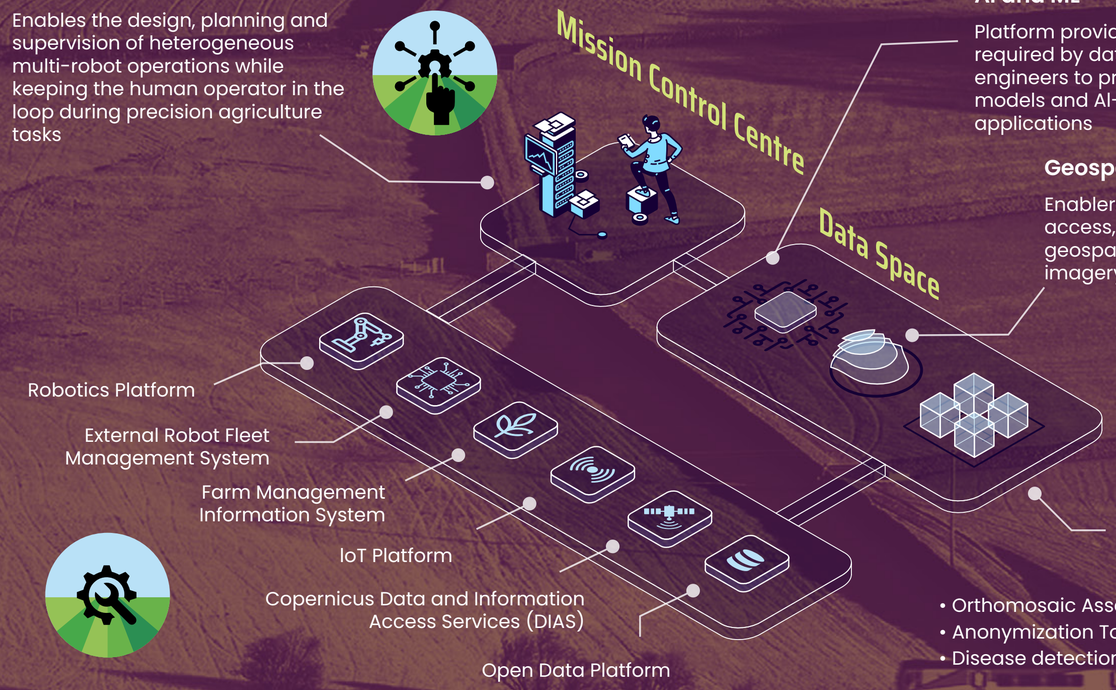
The Data Space, compliant with IDSA rules, is securely integrated with the AI platform. To facilitate data exchange with the AI platform, a REST API is established for smooth online interactions via a Jupyter notebook.

A novel feature within the FlexiGroBots data space is a user interface integrated with data space members, including pilot partners' systems. Also, the focus were on integrating the Open Data Cube (ODC) with the MinIO service in FlexiGroBots.

An innovative model for insect detection is also being introduced to enable more precise pest monitoring.

The Mission Control Centre (MCC) is the command hub for FlexiGroBots, overseeing all robot operations and task assignments. The user-friendly Fleet Manager app simplifies task management, facilitating communication with robots via MCC messages and MQTT broker, with successful testing in summer campaigns.

MCC also plays a vital role in data exchange with the Data Space.



AI and ML

Platform providing the technology required by data scientists and ML engineers to produce innovative models and AI-powered applications

Geospatial

Enablers and services facilitating the access, visualization and processing of geospatial datasets collected from satellite imagery and/or UAV's

Common Application Services

AI-driven components and services that can be reused in a wide range of precision agriculture scenarios. They include:

- SLAM and 3D scene reconstruction.
- People detection, location and tracking.
- People behaviour estimation
- Moving objects detection, location and tracking
- Orthomosaic Assessment Tool
- Anonymization Tool
- Disease detection in fruit
- Insect infestation detection
- Weed detection in row planting fields

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