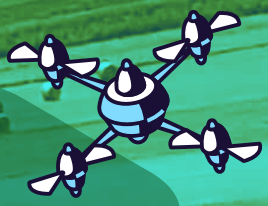
FLEXIGROBOTS



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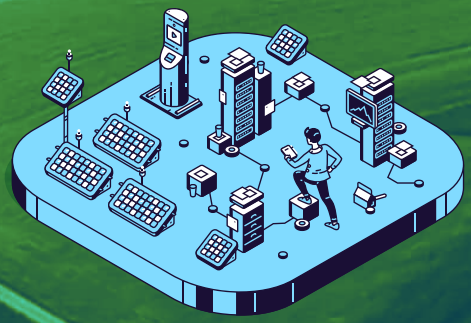
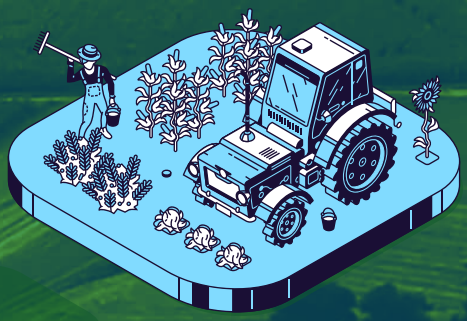


- Flexigrobots-h2020.eu
- FlexiGroBots
- Flexigrobots
- YouTube



This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101017111.

Project Updates

WP2 – Requirements, architecture and standardisation

WP2 focuses on analysing various aspects related to the design of the FlexiGroBots platform **such as its requirements, architecture and standardisation.**

During the period M25 - M30 in WP2 tasks T2.3 and T2.5 have been active. The activities developed in task **T2.3** can be divided into two different types, **interoperability at data level** and **synergies with Artificial Intelligence platforms.** Thus, the current **Data Management Plan** has been reviewed, identifying certain limitations that could be improved. In particular, it would be desirable to detail and list the specific data products developed by the pilots. Also, given the importance of open data in the European context, we consider that it is necessary to identify which datasets are suitable for publication in open repositories, while trying to identify which data services are suitable.

The importance of the FAIR principles should be reinforced in the context of the project, not only through publication, but also in the use of correctly identified and adapted metadata formats. For example, the use of semantic technologies, persistent identifiers or the use of appropriate standards can be explored. For all these actions, the Research Data Alliance forum can be of great help. For the second part of the activities, related to Artificial Intelligence platforms, the **AI4Europe platform** and **AI-on-Demand** have been contacted during this period.

The **AIoD platform**, in its current form, does not support the inclusion of new assets, although a new API is being developed to facilitate this. In addition, we are in contact with the AI4EOSC project co-ordination, in order to make our models available as far as possible in their market, reaching a wider audience through the EOSC.

For task **T2.5** the objective in this period has been to ensure the alignment of the three pilots taking into account that there are important differences between them, due to the fact that they are developed in different locations, for different crops and in different tasks. Thus the work has been aimed at **ensuring alignment between the three pilots, overseeing the creation of the super scenarios and initiating discussions on how to validate them**.

WP3 – Platform development

The main objective of this work package is to develop the FlexiGroBots platform and the necessary building blocks for its implementation. This platform is being designed to meet the requirements of all stakeholders and enable the establishment of a reference architecture for mission control systems in heterogeneous robot fleets.

Over the last 6 months, we have undertaken an **expansion**, **improvement**, and **stabilization** of the platform. To achieve this, we have

securely and reliably interconnected the AI-platform with the building blocks coming from other project partners in various ways, and we have also updated the components to the latest versions.

The improvements made during these 6 months have been focused on achieving two main objectives. The **first objective was to integrate and communicate the AI platform** with the rest of the project's components, allowing all three pilots to interact with every element of the architecture in a simple and feasible manner, and thus enabling the viable management of heterogeneous robot fleets in the field of precision agriculture.

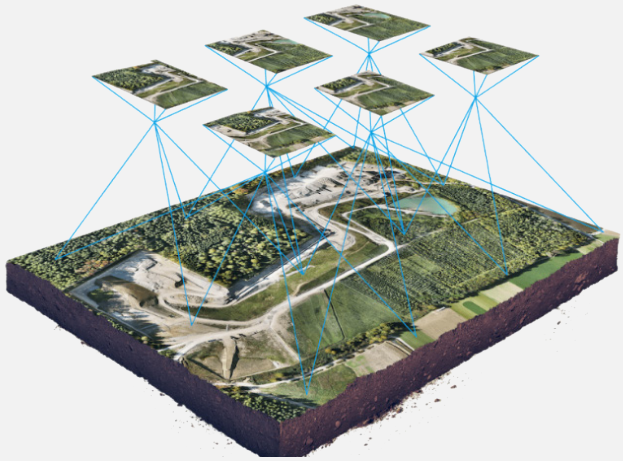
The second goal was to maintain and update the current platform to prevent unexpected downtime and enhance its performance by increasing GPU power for more efficient data processing.

The progress of the **AI platform** can be tracked in the project's GitHub repository.

As for the Kubeflow platform, it has been updated and improved by incorporating a model repository like MlFlow. Additionally, work pipelines have been updated and enhanced, particularly in pilot 3, where experiments were conducted using all Kubeflow functionalities. Furthermore, an MQTT broker has been installed to facilitate communication among all pilot components. To achieve this, adjustments and modifications were made to the platform to ensure seamless communication and avoid isolations in the project.

Read about FlexiGroBots platform v2

Regarding the **Data Space**, components have been updated to comply with IDSA regulations, certifying the project's data space as a secure and reliable system. Additionally, integration processes with the AI platform have been finalized using API-REST technology. The Data Space connectors have been delivered and configured for the rest of the project members to be integrated into the



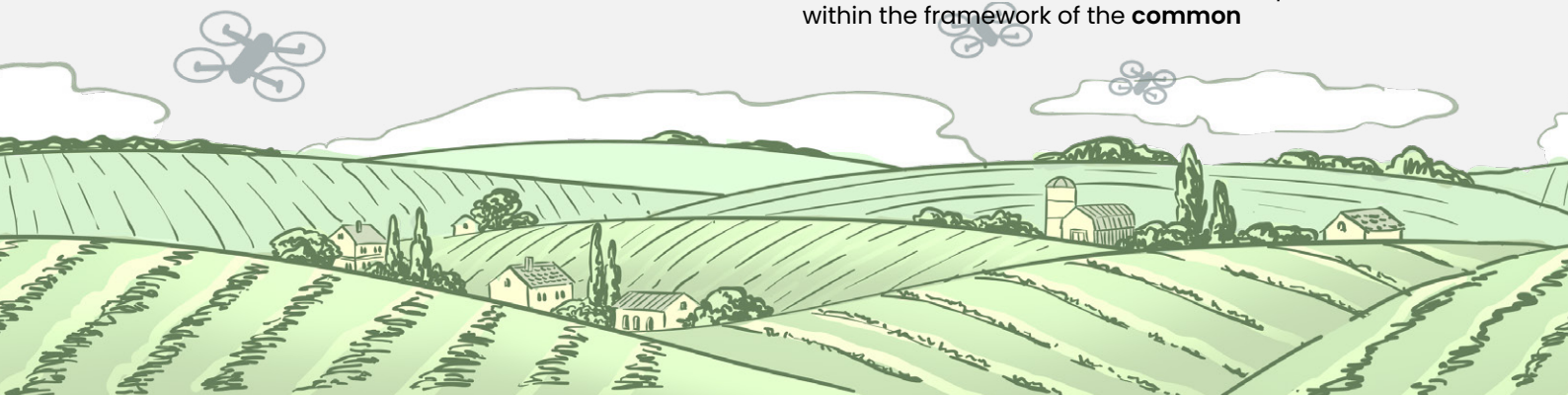
super-scenarios.

Moreover, the wrappers used for Data Space communication with MinIO have been updated, fixing bugs and adding functionalities. Finally, the integration of FlexiGroBots' Data Space has been officially added to the radar of IDSA, alongside other Data Spaces from across the European Union. This recognition highlights the project's successful efforts in complying with IDSA standards and further establishes FlexiGroBots' Data Space as a trusted and certified system within the EU's data ecosystem.

Concerning FlexiGroBots geospatial enablers and services, the project has redeployed them into the common infrastructure provided by Atos for accommodating all services that are transversal to all pilots.

All existing data collected in Pilot 1 (i.e., derived orthomosaics from UAV flights and Botrytis datasets) was transferred to it as well. In addition, the new Open Data Cube instance has been repopulated with all previously existing STAC metadata about the Sentinel 2 mission datasets that match the three pilot areas, offering currently access to more than 2.000 indexed Sentinel 2 scenes. All geospatial services are now accessible (and password protected) via https://geo.flexigrobots-h2020.eu.

Moreover, new assets have been developed within the framework of the **common**



application services.

The common applications deployed at this stage of the project successfully address the needs defined during the project's initial phase. These include 3D virtualization of crops, fields, and agricultural scenarios; real-time detection, localization, tracking, and action recognition of people to enhance the ground situational awareness of the Unmanned Ground Vehicles (UGVs) used in the project; detection, localization, and tracking of moving vehicles/people from Unmanned Aerial Vehicle (UAV) footage to improve aerial situational awareness and thus prevent collisions and hazardous situations in the field; facial anonymization to avoid GDPR issues; dataset generation to fill existing gaps in the necessary datasets; fruit disease detection; insect pest detection in crops; weed detection; and, generation of orthomosaics and heat maps indicating disease probability.

All the above-mentioned applications are available to consortium members, having been thoroughly tested with real pilot data and are either complete or in the final stages of fine-tuning. Some of them are deployed as inference services on Kserve, while the rest are accompanied by their corresponding Docker image in the project's repository for straightforward and direct usage.

This suite of tools and services reflects our commitment to providing comprehensive, practical, and cutting-edge solutions to the challenges faced in modern agriculture.

Finally, to facilitate the work for stakeholders and project users, the most commonly used common apps have been incorporated into a web platform that interacts in real-time with the AI-platform and performs inference on the previously described artificial intelligence models. This integration aims to enhance user experience and provide seamless access to the AI functionalities, facilitating efficient decision-making and utilization of the developed models.

The Mission Control Centre, as the final and pivotal element of the platform, has undergone significant enhancements. The continuous development of its key components, such as the Farm Mission Workflow Manager, the Robot Fleet Mission Controller and Supervisor, and the Robot Task Planner, has contributed to its improved performance.

Notably, an intuitive graphical user interface has been successfully incorporated, enhancing the user experience and facilitating seamless interaction with the system. In parallel, efforts are underway to update the communications with the Data Space, ensuring efficient data exchange and integration with the AI subsystem.

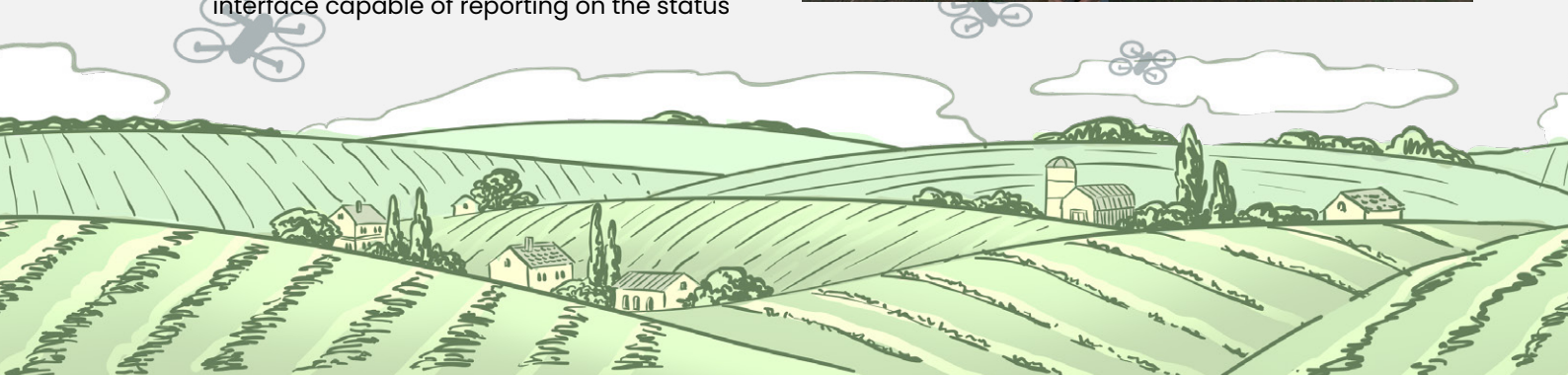
Looking ahead, our focus in the upcoming months will be on finalizing the pending components and seamlessly integrating them into the centralized platform infrastructure. This iterative approach aims to optimize the Mission Control Centre's functionality and reliability, solidifying its role as an effective solution for managing heterogeneous robot fleets in the domain of precision agriculture.

WP4 – Pilot 1: Grapevines

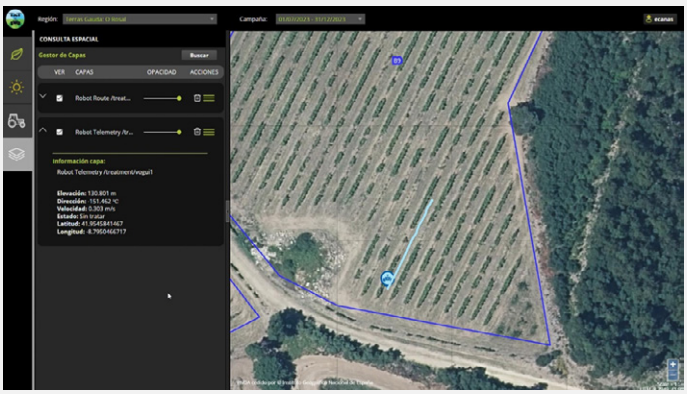
Pilot 1 aims to improve the work carried out in a vineyard during the campaign by automating certain tasks. The objectives of the pilot are:

- Early Botrytis detection
- Phytosanitary treatments
- Transport of the grapes
- Integration with WP3 components

During this period, SER progressed in the development of the Decision Support Systems (DSS) platform to provide farmers with an interface capable of reporting on the status



of their crops. It allows the farmer to visualize, through a satellite view, data obtained from UAV flights, from which WU has generated heat maps, ortho mosaics, NDVI maps and



Botrytis prediction point maps. To display this information, SER integrated the platform with the OGC services offered by the FlexiGroBots Open Data Cube, where WU shares the raster and vector data resulting from its aerial inspections.

SER and CSIC worked on the communication between the DSS platform and the UGV, using the FlexiGroBots MQTT Broker, which allows sending and receiving messages with the telemetry of the robots.

In this way, the platform displays where the robots are located and the route they take during the inspection, treatment or transport of the grapes.

"The field tests have been a success and, after an intense week of work, we face the end of the year with great strength and enthusiasm",

Sergio Álvarez **said,** Head of Innovation at Seresco and Pilot 1 leader.

CSIC worked during the last months on the autonomous navigation of the UGVs and on the communication with the UAVs, in collaboration with WU. This communication consists of sharing information through a Botrytis prediction map generated by the drones. CSIC is developing a Cartesian robotic arm that allows them to get near the bunches of grapes to apply treatments precisely.

Hard work for the partners of pilot 1 (SERESCO, TERRAS, WU and CSIC) is coming. We will soon address the third annual field tests, where multirobot scenarios will be deployed in the summer period, the success of the project will depend on it!

WP5 – Pilot 2: Rapeseeds

The Rapeseed pilot focuses on piloting solutions in pest management, weeding and harvesting of silage.

The last spring of the rapeseed pilot was active preparation for field demonstrations of all three pilot use cases and for robot demonstrations in the project General Assembly in Oulu and Ruukki pilot site in northern Finland. In addition, the pilot system including the server backends with data sharing and mission workflow and field robot mission manager was developed further and already partly integrated to use cases.

In the silage harvesting use case the autonomous tractor with the windrower tool, the silage harvesting timing service, and the autonomous drone-based situation awareness service were developed to the

point where real environment testing could be done. The autonomous tractor was able to run mission without human intervention. The harvesting timing service was able to analyze the digestibility of the silage. The drone was able to automatically follow the tractor and monitor its environment and transfer the data to the developed fleet mission manager application.

In the Rumex weeding use case the development of both the robot arm and weeding tool, and the field robot platform continued. Both parts were tested separately. The Rumex posture detection functionality was able to find the location of the Rumex root which is essential for successful weeding. The integration of the arm into the field robot was started.

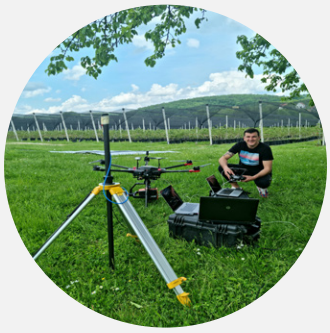
In the pest management use case, the focus was on integrating the commercial systems with developed data sharing and mission control solutions, and in moving the yellow trap-based pest detection AI solution.

WP6 – Pilot 3: Blueberries

The goal is to demonstrate novel robotic solutions for blueberry farming in real (farm) operational environments, supported by **advanced remote sensing, deep learning and decision-support techniques**.

Within the blueberry pilot, we will present 3 use-cases. Our robot Gari can do a lot of things, just by changing his “backpacks”. The first “backpack” is the **soil sampling module** which he uses to collect the soil samples and analyse the chemical and electrical properties of the soil. The second one is for scanning the blueberries, where he uses the BioSense’s **Plant-o-Meter** device to calculate a suite of vegetation indices and learn more about the plants

Last but not least, he will use the cameras to recognise weeds and target-spray them with a super-precise robotic arm. In these activities he will have the support from the sky, where drones will scan the fields and prepare the missions.



The support will also come from the FlexiGroBots platform, which will analyse the images, locate blueberry rows, plan the missions and help the robot navigate through the field. the otherwise tediouAll these activities will help farmers understand their crops, combat weeds and conducts job of soil analysis, and ultimately achieve a higher quality of fruit and better yields.

D6.1 – Pilot 3 objectives, requirements and design

WP7 – Dissemination and Exploitation

Within the past six months of the project (M25-M30), WP7 continued with the implementation of its tasks according to the timeline and the work plan foreseen in the proposal. **T7.1** and **T7.2** continued their work on the **project's promotion** activities resulting in the continuation of the preparation and submission of scientific publications, the organization and participation in workshops, and the continuation of the synergies with relevant projects such as the ICAERUS and VIRAL projects. Additionally, three blog posts on various topics written by partners as well as the 4th newsletter were published.

The business modelling and ecosystem building aspect and **technology transfer** part of the project were also further developed. The **T7.3** leader has successfully prepared detailed **Guidelines and Templates for PESTEL and SWOT analyses**, providing a structured framework for assessing the external macro-environmental factors and internal strengths, weaknesses, opportunities, and threats. Secondly, the project has also developed **Guidelines and Templates for the Business Canvas**, a powerful tool to visualize and define the business model.

Additionally, further development is taking place also for **T7.4** Technology transfer and demonstration roll-out.

The project consortium partners are actively engaged in the tech transfer process, aiming to transfer the developed technology to various exploitation collaborates, including industry, tech developers, and regional agricultural/robotics Digital Innovation Hubs (DIHs). In order to reach a broader audience and engage stakeholders, a **methodology for a virtual farm day is being designed and implemented.**

T7.5 on Sustainability and long term operations was initiated as well within this reporting period. This task has started in the 25th month of the project, putting in contact and initiating discussions between the members of the different organisations involved in the task. The aim of the task is to **draw up a plan to ensure the long-term sustainability of the project**. Within the scope of these contacts, a short presentation and a series of forms are being developed to serve as a mechanism for obtaining feedback from the digital innovation hubs.

Finally, **T7.6** "Ethical assessment of AI and Agrifood" task is partly a continuation of CEPS' evaluation of the ELSE factors, which ought to be expanded towards the final version of trustworthy AI model for precision agriculture. The most complex work stream aims to explore optimal agri-food data spaces for trustworthy AI applications to precision agriculture.

News & Events

EVENTS

Sarka Messut

27 - 28/01/2023 | SEINÄJOKI, FINLAND

FlexiGroBots partners **Mtech Digital Solutions** and Natural Resources Institute Finland **(LUKE)** participated in the Sarka Messut presenting „Drone-projects for supporting crop research and farming".

Startup Village Networking Event

07/02/2023 | VILNIUS, LITHUANIA

FlexiGroBots partnet The Spanish National Research Council **CSIC** attended the "Startup Village Networking EVENT„ where they were invited to present CSIC developments in the FlexiGroBots project.

FinDrones 2023

15 -16/02/2023 | SALO, FINLAND

FlexiGroBots partners from Natural Resources Institute Finland **(LUKE)** and Technical Research Centre of Finland Ltd **(VTT)** took part in the organization of FinDrones 2023 - Drones in Bioeconomy and Rural Logistics conference.

Exchange meetings in Agro-Food Robotics Computer Vision & Robotics

20/02/2023 | WAGENINGEN, NETHERLANDS

WU partners participated in the workshop introducing the potential of FlexiGroBotsto the robotics community by explaining the extraction of grape phenotypic traits with UAV RGB videos.

How drones connect technology, people and domains?

0*9/03/2023 | WAGENINGEN, NETHERLANDS*

WU and **BIO** partners participated in the symposium. The symposium was organised on the occasion of the 10-year celebration of the Unmanned Aerial Remote Sensing Facility (UARSF) of WUR.

Second conference of the berry fruit agrobusiness sector

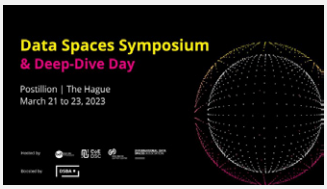
09/03/2023 | REKOVAC, SERBIA

The conference was organized by the **BIO** and **ZEL** partners from Serbia. The FlexiGroBots project was presented to an audience of more than 200 blueberry producers, agronomy students, and agricultural advisors.

European Robotics Forum ERF2023

14/03/2023 | ODENSE, DENMARK

FlexiGroBots partners from the **CEPS**, **BIO**, **ART21**, and **CSIC** had an opportunity to join robotics companies and organizations from around Europe introducing smart solutions for agriculture and exchanging knowledge about the state-of-the-art in the field.



Data Spaces Symposium

21/03/2023 | THE HAGUE, NETHERLANDS

Liisa Pesonen from **LUKE** presented the **FlexiGroBots** project during the Agriculture & Green Deal Domain Lounge Session within the Data Spaces Symposium

Unlocking the Power of Robotics in Agri-Food

11/05/2023 | ATHENS, GREECE

This event brought together experts from across Europe to discuss the latest trends, challenges, and opportunities in the field of robotics in the agri-food sector. **FlexiGroBots** project took participation in the event as co-organizers of the session titled “Mapping Innovations Across the EU.”

The IEEE/CVF Conference on Computer Vision and Pattern Recognition 2023

18 - 22/06/2023 | VANCOUVER, CANADA

BIO partners had opportunity to participate at the conference presenting some of the results from FlexiGroBots project.

NEWS

FlexiGroBots-developed innovation recognised by EU Innovation Radar

05/*06/2023*

BIO and **IDSA** were recognised as **'Key Innovators'** in the development of innovation titled "Embedded and flexible perception system able to work integrated in the different robotics platforms" developed in EU-funded Research & Innovation project FLEXIGROBOTS.

Second Review Meeting

16/05/2023 | ONLINE

On **May 16, 2023**, **FlexiGroBots** had its **second review meeting**. The project coordinator together with leaders and participants of seven work packages (WP1-WP7), presented significant results achieved by the project's to the European Commission (EC).

Blogs

FlexiGroBots platform v2

Interview with Advisory Committee Member

Interview with end-users

Publications

Research article: Dataset on UAV RGB videos acquired over a vineyard including bunch labels for object detection and tracking

Mar Ariza-Sentís, Sergio Vélez, João Valente

New research article entitled "Dataset on UAV RGB videos acquired over a vineyard including bunch labels for object detection and tracking " is published in the Data in Brief journal by Wageningen University (WU), one of the FlexiGroBots partners.

Meet FlexiGroBots Partners

Zeleni hit

Zeleni hit is a family owned, SME-sized agri-food company which provides service and consultancy in all areas of horticultural and agricultural production. Since its establishment in 2000, the activities of Zeleni hit have been focused on providing the know-how and innovative technology solutions in cultivar selection, fertilizer management and biological control in IPM and organic systems.

The professional skills of the team contribute to the R&D&I in domain of fruits, vegetables, flowers and ornamentals, as well as field crops.

The company assists growers in optimizing the plant growth, yield, crop resilience and sustainability. Moreover, one of the main missions of the company is providing healthier and more balanced agroecosystems, as well as more sustainable future.

In the FlexiGroBots project, Zeleni hit is engaged within Pilot 3 on blueberries use case and with its large scale experience in blueberry crop, contributes to developing FlexiGroBots platform, together with BIO.

Nebojša Momirović

Smiljana Momirović

Nevena Momirović

Luke

LUKE, Natural Resources Institute Finland is Finland's second largest governmental research institute, performing non-profit research and providing expert services, in order to advance the bioeconomy and the sustainable use of natural resources. Its research is divided into four multidisciplinary research programmes which aim to create new bio-based products and business opportunities, increase productivity by digitalization, support regional vitality by circular economy, create well-being from immaterial values, and support the profitability of healthy food production.

Within FlexiGroBots:

The main contributer from LUKE in FlexiGroBots is the Production Systems unit, Digital technologies in agriculture team. The team is focused especially on data management and robotics in agriculture. LUKE acts as main facilitator for the Finnish pilot tests integrating robotics for the agriculture within Pilot 2. In addition, LUKE participates to the platform architecture design and development. LUKE incorporates a robotic ISOBUS tractor, different sizes of Unmanned Ground Vehicles, spraying and spreading drone, and other types of drones.

Jere Kaivosoja

D.Sc. (Tech.) is expertized in drone technologies in precision agriculture and more generally in GIS applications. He coordinates LUKE's project efforts in FlexiGroBots.

Juha Backman

D.Sc. (Tech.) Backman has his background in machine automation and robotics, especially the embedded control systems and industrial internet.

Jere Kaivosoja

M.Sc.(tech.), his Projects and duties involve: Safety of machinery, functional safety, automation of crop production, information management.

Liisa Pesonen

Is a senior scientist. Her projects and duties involve: Precision agriculture, smart farming, data acquisition and information management in farms, automation in plant production, site-specific nitrogen fertilization.

mtech

Mtech Digital Solutions Ltd is a digital solutions provider specialised in the bio economy. Our operation is marked by our long-term experience as a partner of agricultural breeding and advisor organisations and as a provider of online services and ICT solutions for farm enterprises, food companies, advisor, and breeding organisations as well as authorities. Mtech is providing a MyFarm platform that offers for farmers and advisors' access to modern farm management tool for cattle management, crop production and accounting.

Mikko Hakojärvi
Director, Farm management software

Johanna Häggman
Development director

Within FlexiGroBots project Mtech is working with next level precision farming tasks files. In pilot 2, task files are needed in silage harvest related operations as well as in crop protection operations in rape seed production.

ISOBUS compatible task files are a common basis for a prescription map that can be addressed with existing machinery and in future with more autonomous machinery developed during the project. Increasing the automation in farming machinery is likely to progress gradually, at some point reaching FlexiGroBots level. Therefore, in the first scenario Mtech is searching for essential steps in gradually increasing autonomy of tractors and implements.

Current farm machinery is capable of providing real-time technical information of used machinery by means of location, loading, fuel consumption, RPM, etc. that is often called telemetry information. Currently, information is not necessarily important as machines are operated by human workers. Despite the current status with autonomous machinery this information is estimated to turn essential from the fleet management point of view which is also one aspect in pilot 2.

Overall, the efforts of Mtech in the FlexiGroBots project aim to clarify the transition towards more autonomous farming machinery from the farm and management point of view. Further Mtech is especially working to clarify the changes required for farm management systems to support the future need of farms with more and more autonomous farm machinery.

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