ANTONIO – Multimodal sensing for individual plANT phenotyping iN agriculture robOtics

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End-term Project Seminar
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Involved countries and partners

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AgriCircle

Leading provider of technologies for a more productive and sustainable agriculture (AC)
[Switzerland]

Principal Researcher
Dr. Peter Fröhlich

Duration: 24 months (March 2021 to February 2023)

Overall budget: 693.5K €

Objective

The overall goal of ANTONIO project was the development and implementation of multi-sensor systems and sensor processing algorithms to enable agri-robots to perform plant phenotyping and precision agriculture tasks, such as precise local application of pesticides/fertilizers and yield estimation.

The envisaged idea was based on an integrated sensor network, including mobile sensors mounted on board of ground robots and drones. Information coming from the fixed sensing devices was flagging “attention spots” in the crop for further local investigation by the robotic platforms.

Selected research approach, methodology

Sensor	Description
Differential GPS	Rover system w/base station, providing single precision accuracy of approximately 2.5 m and RTK accuracy of approximately 0.25m
9-DoF IMU	Inertial sensor w/gyroscope, accelerometer, and magnetometer
2D LIDAR Sick LMS 111	Set for outdoor environments
Rotary Encoders	Mounted on the sprocket of each track
Traction Motor Sensors	Measuring electric current absorbed by the traction motors
Intel RealSense D400	Camera providing multiple outputs including RGB, IR, and depth images
Onboard computer	Intel i7 CPU, 16GB RAM DDR, 256GB SSD, Wi-Fi and BT connectivity
Power Supply	24V DC 30A LiPo battery package (3 hrs autonomy)

Sensor	Description
Commercial Drone Model	Parrot Bluegrass Field
Onboard Cameras	Sequoia Multispectral Camera, 4 Separate Bands [Green: 550nm +/- 40nm, Red: 660 nm +/- 40nm, Red Edge: 735nm +/- 10nm, Near Infrared: 790nm +/- 40nm]

- UGV multisensory system tested in lab and field for effectiveness
- Sensors synchronized and spatially calibrated for data consistency
- Development of self-calibration method for merging “point-clouds” from stereo sensors
- Algorithm development and validation through numerical simulations and lab tests

Major results:Highlight key accomplishments and challenges faced

Field Tests and Data Acquisition

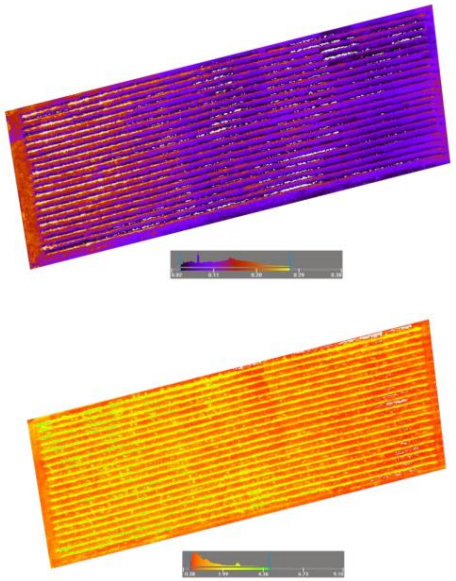
- Initial Field tests conducted in private and experimental vineyards
- Successfully verified of the proper functioning of all system components

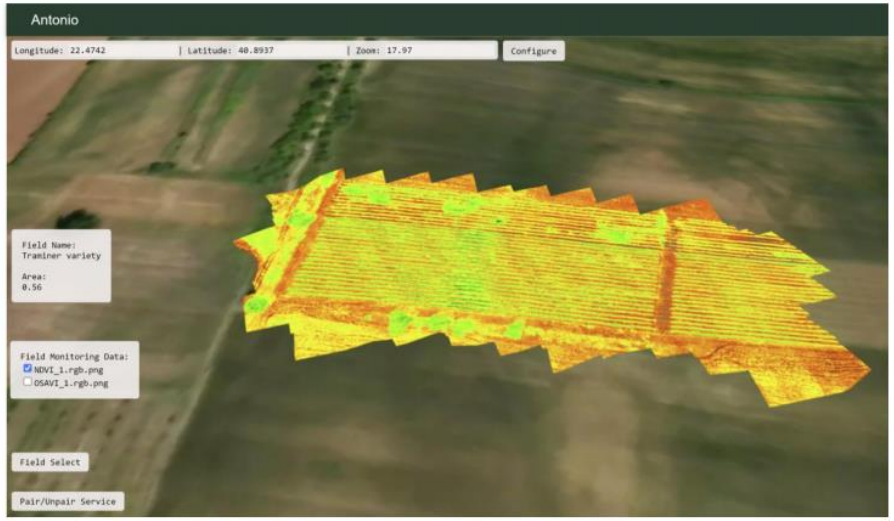
Spectral Image Processing and Feature Extraction

- Spectral conversion of RGB images to spectral bands
- Successful extraction of features from spectral images characterizing crop health and condition (NDVI, GNDVI, SAVI, CI, OSAVI, TCARI)

Decision Support System (DSS, ANTONIO Platform)

- Utilization of PIX4Dfield software for map processing and integration into the ANTONIO platform
- Access to live data for different fields





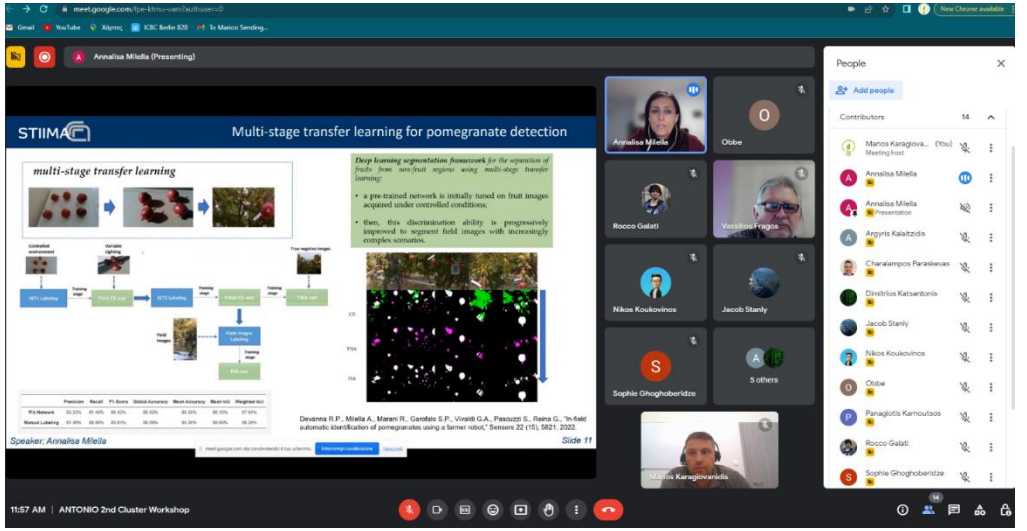
Cooperation with stakeholders, industry partners and/or public and private sector (if applicable)

1st Cluster Workshop

The primary objective of this workshop was to engage farmers, stakeholders, and key actors in the agricultural sector to provide them with a comprehensive understanding of the ANTONIO project, its objectives, and its wide range applications in precision agriculture.

2nd Cluster Workshop

The purpose of the workshop was to present an overview of the project's activities and summarize all work done by partners in one conclusive meeting. In this conclusive workshop all partners of the project had the chance to present their work to the rest of the participants and share their thoughts on the outcome, provide insights about future work, and discuss means of implementation of the project's outcomes.



Opportunities and next steps for innovation

Scalability and Cost Optimization

- Develop strategies for scalability and cost-effectiveness.
- Conduct a cost-benefit analysis, explore cost-saving technologies, and design scalable architectures.

Efficient Data Management

- Enhance data management capabilities.
- Develop advanced data management solutions, explore cloud-based storage, and implement encryption protocols.

Integration with Existing Farming Practices

- Ensure smooth integration with existing farming practices.
- Conduct user experience studies, gather farmer feedback, and provide training for seamless adoption.

Compliance with Regulations and Safety Standards

- Ensure compliance with regulations and safety standards.
- Stay informed about regulations, collaborate with regulatory bodies, and implement and audit safety features.

Summary and Conclusion takeaways and lessons learned

The ANTONIO project represents a transformative leap in precision agriculture, offering unprecedented capabilities in crop monitoring and disease detection.




To ensure its effectiveness and sustainability, addressing key challenges such as scalability, data management, integration, and regulatory compliance is imperative. By focusing on these areas, the project can not only unlock its full potential but also contribute significantly to advancing modern agriculture and fostering a more sustainable and resilient food system.

LET'S KEEP IN TOUCH!

Please feel always free to reach out to us.

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Thank you for your attention!