

# ANTONIO – Multimodal Sensing for Individual Plant Phenotyping in Agriculture Robotics

ICT-AGRI-FOOD | 30 Jan – 01 Feb 2024 ERA-Net Cofund on ICT-enabled agri-food systems End-term seminar of funded projects – Warsaw, Poland

## **1.0 Introduction**

The ANTONIO project focuses on automating farming through robotics to enhance crop assessment and enable precision farming. The project's **decision support system**, a web-based platform, empowers farmers with real-time insights for optimized crop management. ANTONIO utilizes various sensors like **LIDAR, cameras, and accelerometers** to gather essential data, aiming to make agriculture more efficient and sustainable.



## 2.0 Methodology

#### 2.1 Multisensory System Development:

The multisensory system integrated into the ANTONIO project underwent **rigorous testing**, **calibration**, and **verification**. Extensive testing took place in both controlled laboratory and real-world field conditions. The goal was to ensure the system's **effectiveness** and **accuracy** in collecting and processing data for precision agriculture.

**2.2 Experimental Design and Data Acquisition** The ANTONIO project conducted initial field test in vineyards in **Italy** and **Greece**. These tests involved the deployment of the developed **UGV** and **UAV** to gather data essential for precision agriculture applications.



Figure 1. The UGV of the project under deployment in a vineyard

### **2.3 Data Processing and Decision Support**

Collected data, including **spectral images** and other sensor readings, underwent a **spectral conversion process** to extract essential features. These features included the widely used Normalized Difference Vegetation Index (**NDVI**), Green Normalized Difference Vegetation Index (**GNDVI**), Soil-Adjusted Vegetation Index (**SAVI**), Chlorophyl Index (**CI**), Optimized Soil-Adjusted Vegetation Index (**OSAVI**), and Transformed Chlorophyll Absorption in Reflectance Index (**TCARI**). Each of these features offered unique insights into vegetation health, chlorophyll content, and plant stress levels.



Figure 4. Data Flow Diagram of the multi-sensor system

## **3.0 Decision Support System: the ANTONIO Platform**

The true power of the ANTONIO project's Decision Support System (DSS) lies in its ability to drive the **ANTONIO platform**, a web-based solution designed to make the insights derived from **precision agriculture** accessible and actionable.

The ANTONIO platform serves as the user interface for the rich data and insights generated. This **userfriendly** platform provides farmers and researches with a comprehensive toolkit for precision agriculture. Here's how it enhances the **decision-making process**:

- Live Data Access: The ANTONIO platform offers real-time access to data collected from various fields, providing a live view of crop conditions and environmental parameters. Farmers can monitor their fields remotely, allowing them to respond to any changes.
- Historical Data Comparison: Users can access historical data stored in the platform, enabling them to track changes and trends over time. This valuable information aids in long-term decision-making, crop planning, and resource allocation.
- **Crop Protection Product Application:** The platform offers a unique feature allowing users to optimize crop protection product application. By identifying areas with specific needs, such as potential





Figure 2. Vineyard Map after image processing in NIR spectrum

Figure 3. Vineyard Map after image processing - NDVI Index

The processed data was utilized for generating maps and reports. These resources served as a basis for decision-making, enabling farmers to optimize crop protection product application, remotely monitor crop health, and compare historical data for informed crop management.

disease outbreaks or nutrient deficiencies, farmers can targe their interventions more effectively.

Crop Health Assessment: Utilizing the spectral analysis data, the ANTONIO platform provides an
overview of crop health. It includes essential insights into vegetation health, chlorophyll content,
and stress levels. This comprehensive analysis guides farmers in implementing precise and timely
care for their crops.



Figure 5. The ANTONIO Decision Support System

## **Acknowledgments:**

Authors acknowledge the funding received for





ANTONIO Project (Grant No. 862665) under the ERA-NET, ICTAGRI-FOOD 2019 Joint Call for proposal.

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