ANTONIO - MULTIMODAL SENSING FOR INDIVIDUAL PLANT PHENOTYPING IN AGRICULTURE ROBOTICS

INTRODUCTION

ANTONIO has set itself the goal of simplifying and optimizing the use of crop protection products and other input products thanks to precision agriculture and automation. This is achieved using sensors as well as their fusion and implementation in a novel interoperability network in combination with artificial intelligence. The data should then be presented in conclusive maps via web service and mobile for farmers in an easily accessible and understandable way. It will thus be possible for farmers to further optimize the application of plant protection products and other input products in indoor crops.

The overall goal of ANTONIO project is 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 is based on an integrated sensor network, including mobile sensors mounted on board of ground robots and drones. Information coming from the fixed sensing devices will flag "attention spots" in the crop for further local investigation by the robotic platforms.

MAIN OBJECTIVES

This approach will lead to in-field high - throughput crop assessment, and this narrow temporal and spatial scale of detect ion ability can enable precision farming applications that rely on accurate high- resolution local maps, i.e. :

► Variable-rate applications, apply pesticides or fertilizers where it can be seen to be needed, that is treat the specific site instead of the entire crop or field

► Crop monitoring and yield estimation. Sensing technologies will be applied to monitor qualitative and morphometric parameters related to crop composition and development

► Using a flying vehicle (UAV) to inspect more remote parts of the field enables closer monitoring of plant health while minimising track use

► Control led traffic farming. Automated online estimation of key parameters of the terrain that affect its ability to support vehicular traffic
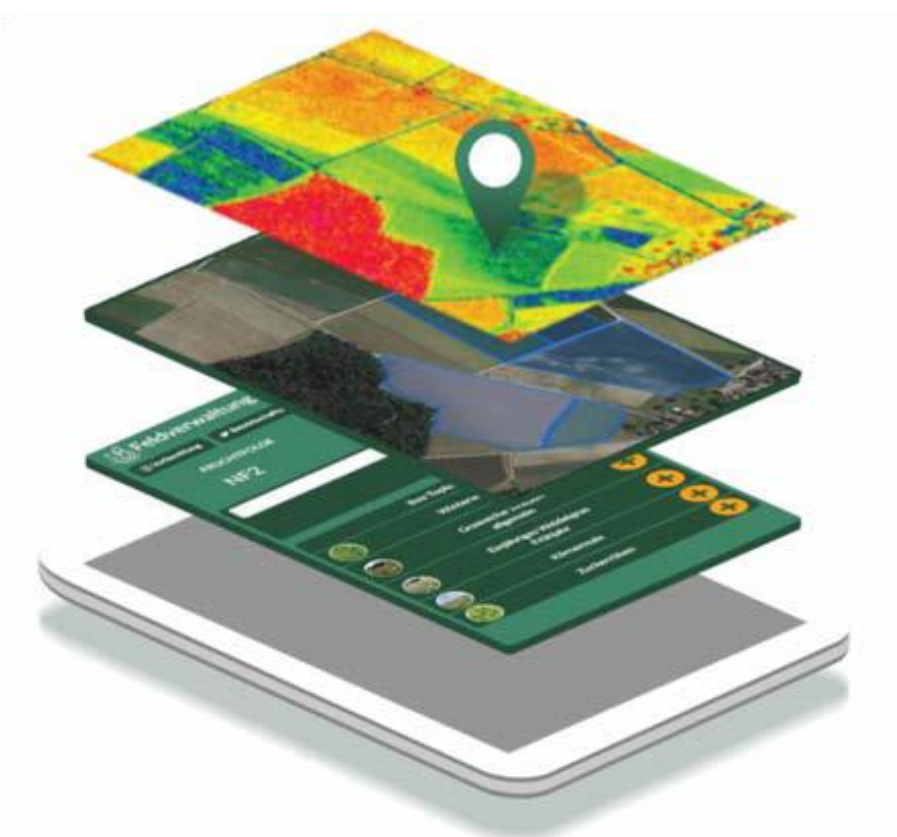
ANTONIO - Residues of pesticides and herbicides are considered to have significant impact on food and feed safety. Securing clean of pesticides and herbicides will reduce the risk to human health, and lead to improving food safety.

RESULTS

► A first prototype of a farmer robot was demonstrated for in-field multisensory data gathering

► The integrated robotic system comprises the POLIBA' farmer robot named Polibot and the CNR' multi-sensor suite.

► The perception system is composed of: a sub decimetre GPS system, proprioceptive stream (encoders + electric currents), and exteroceptive stream (RGB-D cameras)

► Multisensory data were processed through high-level layers for

  ▪ Estimating the characteristics of the terrain and how they affect the vehicle's motion capabilities
  ▪ estimating the degree of unevenness of the traversed surface

► Results obtained from the ongoing research were included in several publications in leading conferences and scientific journals in the field of agricultural robotics

► A basic framework for the front- and backend application has been developed

► A first prototype of the multimodal georeferenced 3-D map has been developed

Figure 1: Drone system

Figures 2 and 3: Sensorbox tests in Güttingen CH

The ANTONIO project will contribute to reach the United Nations Sustainable Development Goals SDG 3: Good Health and Well Being, SDG 8: Decent Work and Economic Growth, SDG 13: Climate Action.

CONCLUSIONS

► Economic aspects: The application of fertilizers, pesticides and herbicides where and when needed will result in optimal amounts of inputs, applied, without losses

► Environmental aspects: The precise application of pesticides and herbicides during the cropping season is expected to reduce the amount of agrochemicals applied into the soil and ground and surface water resources, EU framework directive for "A thematic strategy on the sustainable use of pesticides" (COM(2006)372, COM(2006)778)

► Societal aspects: Securing clean of pesticides and herbicides will reduce the risk to human health, and lead to improving food safety

► Relation to COVID-19: Promoting remote monitoring and operations (e.g., automatic in-field phenotyping), the ANTONIO framework may help to keep safe interpersonal distances and provide effective solutions to overcome the economic and social disruption that the pandemic has brought to the agricultural domain

FUTURE RESEARCH ACTIVITIES

► The farmer robot will gain autonomous ability to follow safely a vineyard row without any human supervision

► Multisensory data will be processed to extract relevant agronomic information from the crop

► Decision support system for the generation of application maps for plant protection products

► AI module for the decision support system