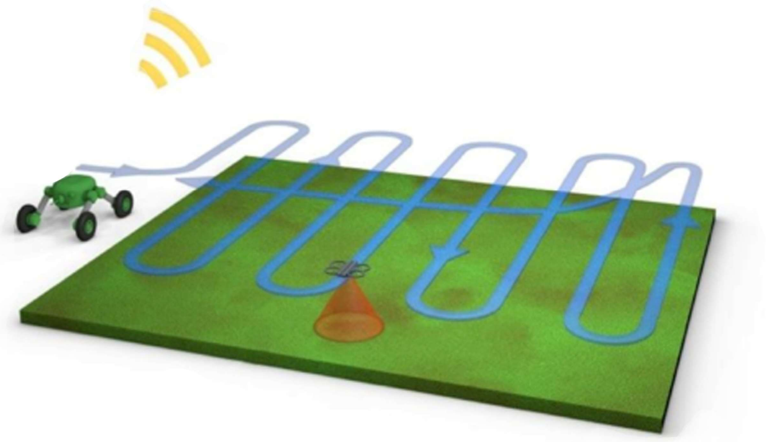
http://flourish-project.eu/

Flourish

A Collaborative Robotic Approach to Precision Agriculture

(2015 - 2019)



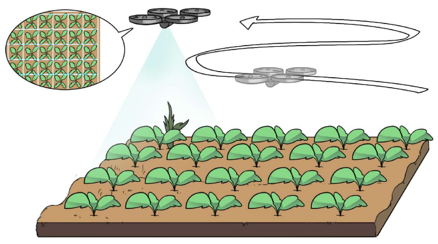
OBJECTIVES

- Improve/maintain crop yields
- Minimize/eliminate chemical inputs
- Maximize farmer comfort - minimize intervention

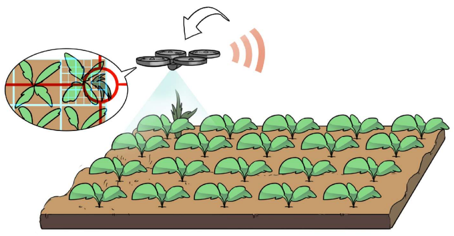
AIMS

- Field surveillance using an unmanned aerial vehicle (UAV)
- Intervention using an unmanned ground vehicle (UGV)
- High-level objectives decided by farmer
- UAV-UGV-farmer collaboration

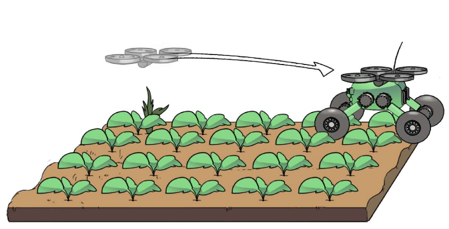
CONCEPT



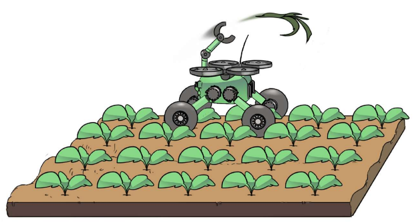
1. A UAV continuously collects rich sets of sensor data over a field.



2. Detected problem areas are communicated to the UGV and farm operator.



3. The UGV also serves as a mobile docking and charging station for the UAV.



4. The UGV, equipped with a suitable end-effector, collaborates with the UAV to enter the field and apply precision treatment.

HARDWARE

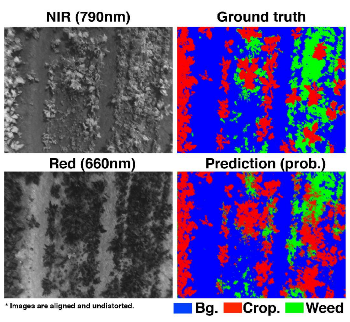
UAV: *DJI Matrice 100*

- On-board visual-inertial localization and spatio-temporal-spectral mapping
- Online crop and weed detection
- Adaptive mission planning and local collision avoidance

UGV: *BoniRob*

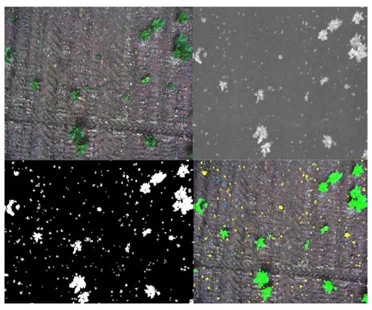
- Multi-sensor environment modelling and localization
- Online crop and weed detection
- Quasi-omidirectional navigation
- Field intervention (spraying, removal) using mechanical actuators

RESULTS



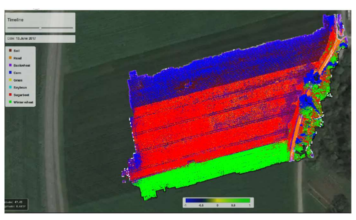
weedNet: Weed classification using aerial multispectral images

- On-board pixel-wise crop/weed classification using a convolutional neural network
- Collection of labelled datasets from controlled field experiments with a 4-channel Sequoia camera
- Analysis of varying multispectral input channels
- 0.8 F1- and 0.78 AUC classification scores



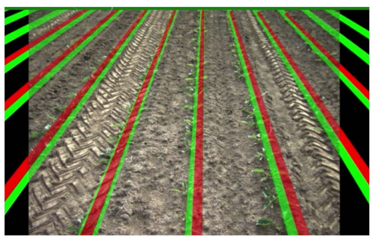
Vision-based crop-weed classification

- Vegetation detection, plant-tailored feature extraction, and classification to estimate crop-weed distributions
- Experiments on sugar beet fields in Germany and Switzerland with a DJI Phantom 4
- Optimization for real-time usage
- >95% classification accuracy



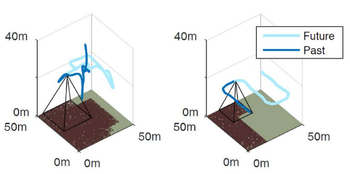
Spatio-temporal-spectral field mapping

- Input: raw RGB images, multispectral images, UAV poses; Output: 3D spectral point clouds
- UAV localization from vision+GPS+IMU
- Radiometric camera calibration
- Visualization through layered orthomosaics



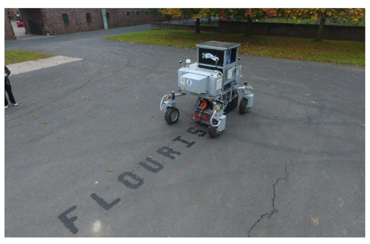
UGV localization

- Crop row-based localization
- Transversability analysis based on geometric and semantic information
- >90% accuracy in finding untransversable terrain
- Smooth, efficient global trajectory planning



Adaptive mission planning

- Informative path planning for efficient infestation detection given UAV battery life constraints
- Multiresolution mapping approach for planning using Gaussian Process models
- Mean error reductions of up to 45% compared to traditional “lawnmower” coverage



Ground intervention on the field

- Integrated computer-controlled sprayers
- Full ROS integration
- Robust weed and plant target tracking using non-overlapping cameras
- Experimental trials
- Probabilistic model update after treatment

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