**Service Robotics for Precision Agriculture Applications**

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### Motivation and Background

- World population is expected to reach about 9 billions in 2050, as a consequence food demand will increase and arable areas will decrease.
- Increase efficiency and production, while reducing inputs and costs in agricultural processes.
- Autonomous machines in the agricultural context exploit LiDARs, Global Navigation Satellite System (GNSS), Inertial Measurement Units (IMUs), cameras, and sensors fusion algorithms.

### Addressed Problem and Novelties

- Autonomous navigation in row-based crops (e.g. orchards and vineyards)
- Cooperation between Unmanned Aerial Vehicles (UAVs) and Unmanned Ground Vehicles (UGVs), computer vision, and novel deep learning based navigation algorithms.

### Adopted Methodologies and Results

**Global Path Generation**

- Georeferenced map generation of the designated crop and global path planning with novel approaches

**UAV Landing on Mobile Platform**

- Precise landing on the mobile platform of UGV is required for retrieval.
- Vision-based motion estimator and a robust tracking controller are used to achieve precise landing on the rover.
- The ApritiTag is detected in real-time for localization thanks to robust tag detection with limited computation resources.
- Data-driven approach to estimate unknown aerodynamic forces induced by the ground effect for control synthesis.

**Local Autonomous Navigation**

- Extended Kalman Filter (EKF) to loosely fuse IMU and GNSS receiver data.
- Vision-based local navigation technique to overcome localization issues inside inter-row space, due to thick canopies.
- GNSS-based navigation to switch between two different rows, thanks to a clear view of the sky.

### Submitted and Published Works