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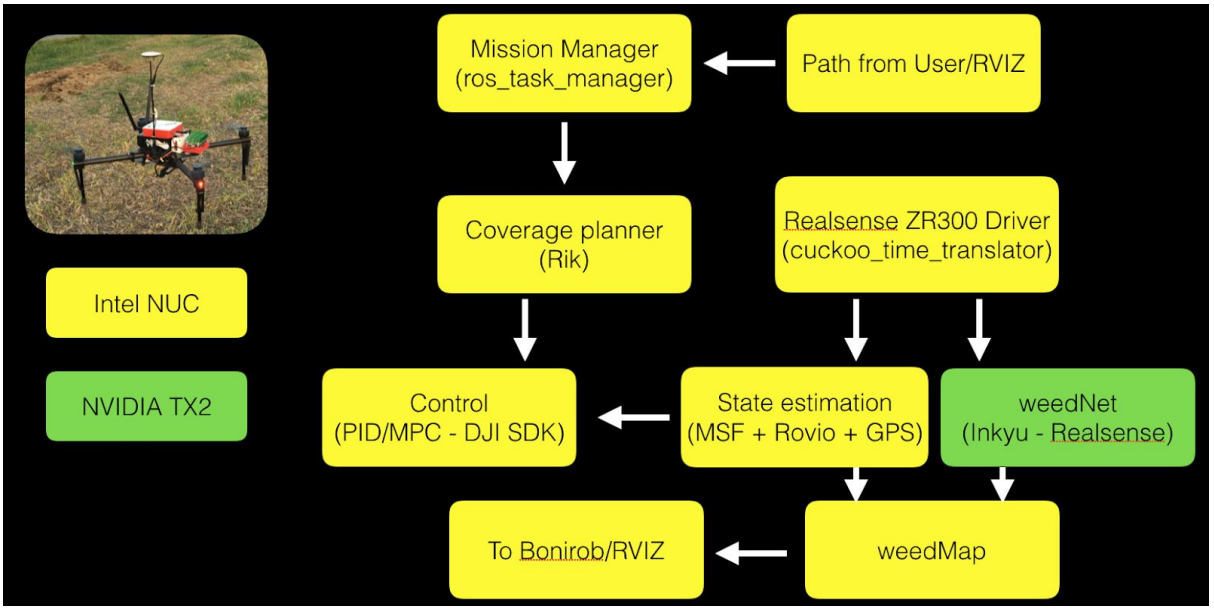
weedMap: Real-time weed mapping onboard Unmanned Aerial Vehicles

We present a framework and implementation for onboard crop-weed classification, localisation and mapping using unmanned aerial vehicles. The implementation allows crop - weed classification to be performed using an rgb or multispectral camera at 2-3 Hz using a state of the the art semantic classifier [1] on an NVIDIA TX-2. The semantic segmentation results from the images are mapped to the real world coordinates of the weeds using the UAV (IMU) pose, estimated by fusing visual, inertial and GPS measurements in an extended kalman filter framework [2] onboard an Intel NUC i7, the relative transformation between the camera and the UAV IMU and the correct (hardware) timestamps of the image and localisation information. We use a convex hull filter to estimate and keep track of the time offset between various sensors[3] to accurately reproject the classified image pixel positions to the ground plane. The mapped weed locations can then be forwarded to farmers via a mobile/PC ground station or an Unmanned Ground Vehicle (UGV) for selective intervention actions to be taken on demand.



[1] I. Sa *et al.*, "weedNet: Dense Semantic Weed Classification Using Multispectral Images and MAV for Smart Farming," *arXiv [cs.CV]*, 11-Sep-2017.
[2] M. Bloesch, S. Omari, M. Hutter, and R. Siegwart, "Robust visual inertial odometry using a direct EKF-based approach," in *2015 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2015, pp. 298–304.
[3] H. Sommer, R. Khanna, I. Gilitschenski, Z. Taylor, R. Siegwart, and J. Nieto, "A low-cost system for high-rate, high-accuracy temporal calibration for LIDARs and cameras," in *2017 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, 2017.