Cooperative Robotic Systems for Precision Agriculture and Plant Health Management

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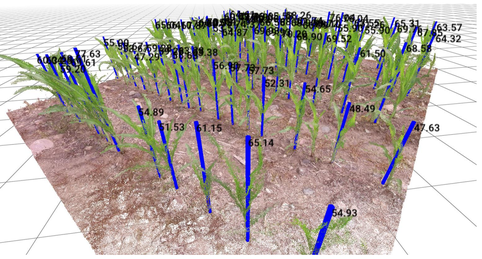
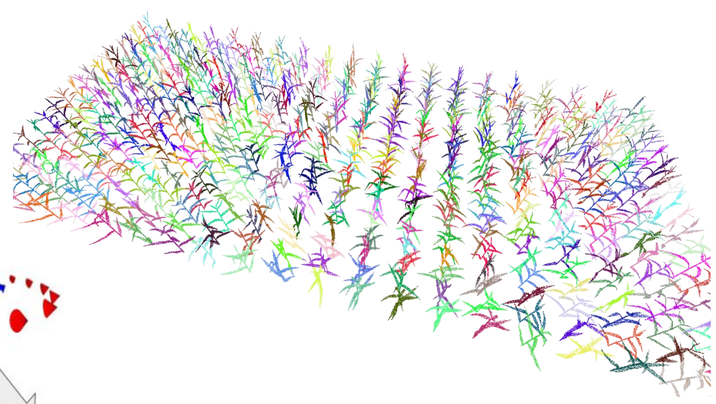
Introduction & Motivation

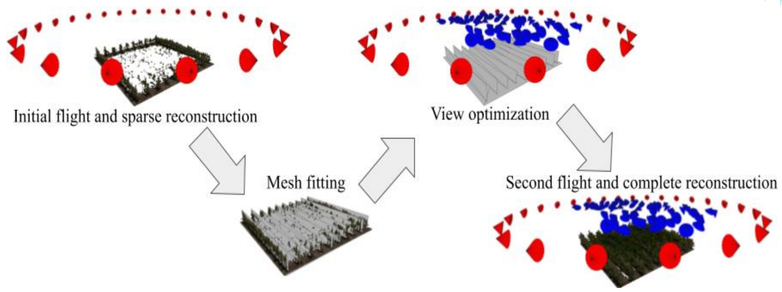
- Aerial and ground robotics for plant-centric crop management.
- Multi-modal and multi-resolution, 2D/3D approach on Nitrogen (N), Potassium (K), and Sulfur (S) deficiency detection and biomass assessment.
- Automated and optimized fertilizer recommendation reflecting spatio-temporal crop needs and enabling reduced environmental impact.
- Extensive field testing in multiple corn test sites especially in Minnesota.
- Major impact in improved yield, superior product quality, and environmental protection. Generalizability across crops.z

Multi-modal 3D Reconstruction

- Aerial and ground robot sensor fusion for single map representation for N/K/S deficiency detection.
- 3D model-based assessment of crop phenological characteristics.
- Current reconstruction and separation pipeline achieves mIoU of over 90%
- Proposed pipeline for optimizing images taken by aerial robot for plant reconstruction.

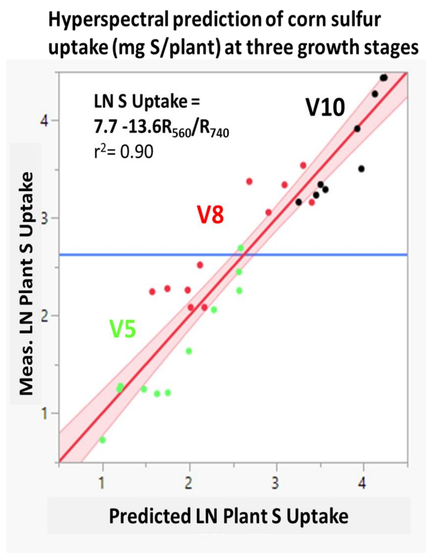






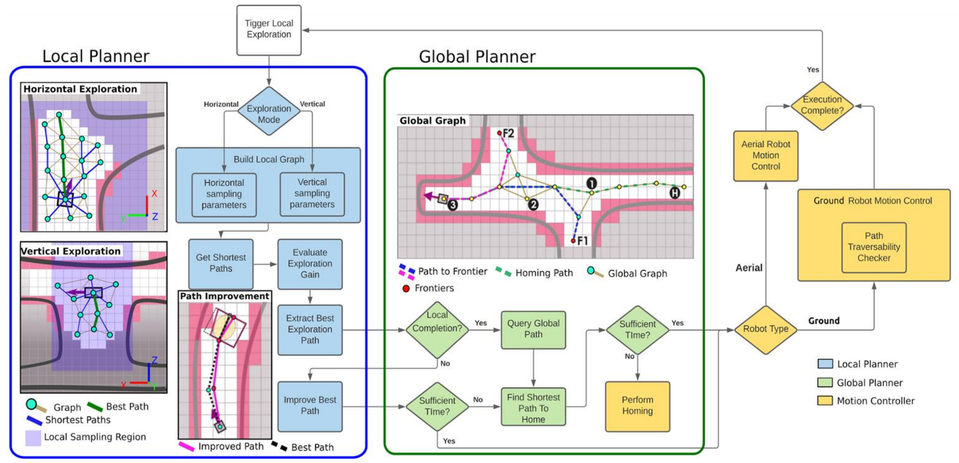
Plant Characterization and Nutrient Deficiency Detection

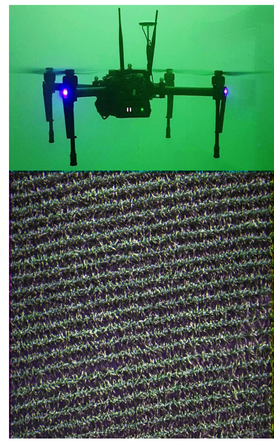
- N/K/S deficiency assessment on RGB through automated classification with custom features.
- Hyperspectral imaging for N/K/S deficiency identification.
- Multi-modal sensor fusion for enhanced and unified N/K/S deficiency detection.
- Multi-resolution approach working across spatio-temporal scales.



Robotized Precision Agriculture

- Autonomous path planning to locally cover the crop area and globally ensure auto-homing and full area coverage over 3D morphologies.
- Multi-spectra image alignment and map projection.
- Multi-modal sensor fusion for onboard localization and mapping.
  - Visual/NIR/LiDAR & GPU/IMU fusion for dense map reconstruction
- Autonomous plant localization and phenotyping from dense 3D point clouds.





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