PhenoBee: Drone-based Robot for Field In Vivo Proximal Hyperspectral Imaging

Ziling Chen[1]

[1]Affiliation not available

January 14, 2023

Ziling Chen[1], *Jialei Wang[2], Xuan Li[1], Jian Jin[1]*

[1]*Agricultural & Biological Engineering, Purdue University, West Lafayette, USA*

[2]*Mechanical Engineering, Purdue University, West Lafayette, USA*

ORCiD: 0000-0003-4060-6499

In soybean phenotyping, hyperspectral imaging via proximal sensing has higher signal-over-noise and resolution than remote sensing. However, it has not been adopted for large-scale field applications due to its low throughput and high labor costs. Additionally, no automation solution has been developed to collect in vivo proximal hyperspectral images of dicot plants. In this study, a novel drone-based robotic system was developed to automate the collection of in vivo proximal hyperspectral images in the field. The system consists of a machine vision system to detect and estimate the pose of soybean leaflets, an articulated robotic arm with specialized control and path planning algorithms to operate proximal sensors and grasp the leaflets, and a heavy-duty customized drone to provide mobility in the field. For each sampling location, the system flies to the location, lands on top of the canopy, approaches the plant with the proximal sensor, and collects data. An experiment was conducted in October 2022 at the Agronomy Center of Research and Education at Purdue University. The designed system collected 90 samples with a centimeter-level landing accuracy, a detection accuracy of over 75%, and an operation success rate of over 85% (preliminary results). The system provides a novel approach to adopt in vivo proximal hyperspectral imaging on a large-scale. The results of this study demonstrate the potential to identify nutrient deficiencies, diseases, and chemical damage in the field earlier to prevent yield loss, improves food quality, and accelerate the development cycle of agricultural products.