Autonomous ground system for 3D LiDAR based field phenotyping

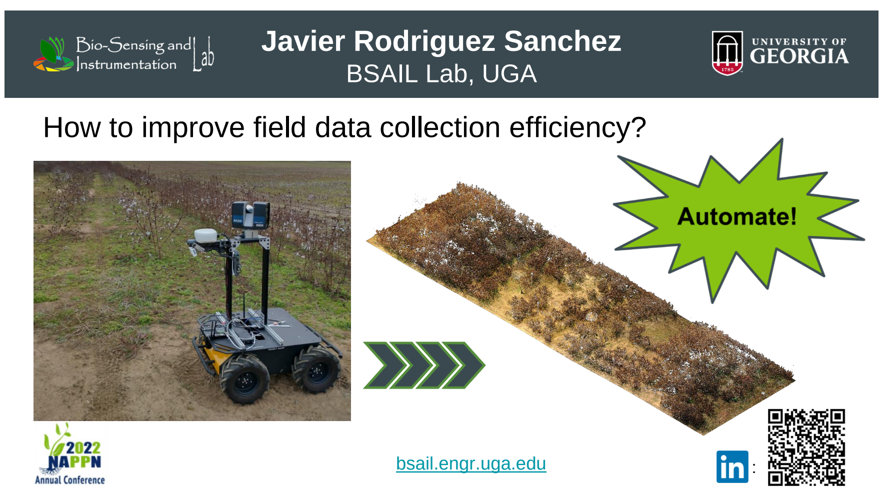
Javier Rodriguez-Sanchez[1,1] and Changying Li[1,1]

[1]University of Georgia

November 30, 2022

Abstract

To assist plant scientists, geneticists, and growers to understand crop-environment interactions, plant phenotyping is a powerful tool for improving crop cultivars and developing decision support systems in farm management. Recent trends use LiDAR to capture three-dimensional (3D) information from plants to analyze traits vital to plant growth and development. However, current terrestrial-based 3D analysis methodologies are time and labor intensive and can be a bottleneck when large agricultural fields need to be analyzed. Robotic technologies can be used to accelerate the field-based measurements of relevant plant features and optimize the high-throughput phenotyping process. In this paper, we present a robotic system with a 3D LiDAR and a data processing pipeline for efficient, high-throughput field phenotyping of cotton crops. The robotic system consists of a Husky robotic platform equipped with a FARO Focus 3D laser scanner. The components of the system are integrated under the ROS framework to ensure interoperability and data integrity and availability at any given time. The data processing pipeline involves the data collection, registration, and analysis tasks for measuring crop traits at the plot level—canopy height, volume, and light interception—and estimating yield. This work demonstrates a crop phenotyping platform that leverages two off-the-shelf equipment for the quantitative assessment of cotton plant traits in the field. This methodology can be extended to other agricultural crops contributing to the advancement of plant phenomics.



Title: Autonomous ground system for 3D LiDAR based field phenotyping
Co-authors: Javier Rodriguez-Sanchez, Changying Li

Abstract (max 250 words)

To assist plant scientists, geneticists, and growers to understand crop-environment interactions, plant phenotyping is a powerful tool for improving crop cultivars and developing decision support systems in farm management. Recent trends use LiDAR to capture three-dimensional (3D) information from plants to analyze traits vital to plant growth and development. However, current terrestrial-based 3D analysis methodologies are time and labor intensive and can be a bottleneck when large agricultural fields need to be analyzed. Robotic technologies can be used to accelerate the field-based measurements of relevant plant features and optimize the high-throughput phenotyping process. In this paper, we present a robotic system with a 3D LiDAR and a data processing pipeline for efficient, high-throughput field phenotyping of cotton crops. The robotic system consists of a Husky robotic platform equipped with a FARO Focus 3D laser scanner. The components of the system are integrated under the ROS framework to ensure interoperability and data integrity and availability at any given time. The data processing pipeline involves the data collection, registration, and analysis tasks for measuring crop traits at the plot level—canopy height, volume, and light interception—and estimating yield. This work demonstrates a crop phenotyping platform that leverages two off-the-shelf equipment for the quantitative assessment of cotton plant traits in the field. This methodology can be extended to other agricultural crops contributing to the advancement of plant phenomics.

Keywords: Autonomous field phenotyping, UGV, 3D LiDAR, TLS.