Unmanned Ground Vehicle for High-throughput Phenotyping to Quantify Field Crops Characteristics

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Abstract: Digital imaging technology has gained significant interest in recent decades, particularly in the field of high-throughput phenotyping (HTP) for plant breeding. Breeding programs generates thousands of new crop lines that require evaluation under multiple environments. Considerable efforts have been made in utilizing genome wide association studies (GWAS) and genomic selection (GS) to identify genetic markers and improve desirable crop characteristics. Selecting key phenotypes is an essential component of plant breeding, and traditional methods require considerable resources and are subjective. Therefore, breeders and geneticists are in an urge of a robust technology to identify desirable crop traits. HTP using advanced sensors is a promising approach to evaluate improved crop genotypes for traits of agronomic importance. In this project, six Research and development Centers (RDCs) of Agriculture and Agri-food Canada have been utilizing University of Saskatchewan built Field Phenotyping System ("*UFPS Cart*") to phenotype a heritage bread wheat panel. The UFPS cart is a proximal sensing mobile platform equipped with multiple payloads (RTK GPS, RGB, NIR, and LiDAR sensor). For diverse climatic data collection, the panel consisting of 30 Canadian western spring wheat varieties were grown under six environments. This study aims to develop large-scale data management and image analysis pipelines to quantify different crop growth characteristics representing agronomic and physiological traits. It support data-driven decision making under genotype × environment effect. The multi-location imagery and ground observation data from six environments are currently being processed using the internal General Public Science Cluster (GPSC) for deep learning training to develop prediction models and extract phenotypic traits of interest (canopy height, crop lodging, heading, maturity, grain yield and protein content). The developed tools and associated models will aid to accelerate advances in cereal breeding programs.

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