

Machine learning framework to identify and quantify multiple biotic and abiotic stresses in soybean

Project Summary:

Phenotyping is integral to crop scouting for farmers and specialists, and researchers who study traits relevant to crop production and breeding. However, phenotyping (process of collecting data on traits, such as, diseases, insect feeding, and yield) is time consuming and resource intensive especially on large farms and fields. This phenotyping bottleneck has motivated the scientific community towards intense efforts to update technologies and upgrade the tools and analytics in field phenotyping. For example, state-of-the-art High Throughput Phenotyping (HTP) through multiple sensors mounted on ground robots and drones have unlocked new prospects for non-destructive field-based phenotyping for a large number of traits including plant physiological, biotic and abiotic stress traits in a rapid, precise and accurate manner.

Multiple biotic stresses affect Iowa soybean production, and other seedling and adult plant diseases. In season farm monitoring and site-specific chemical applications to manage spatial stress expression of biotic and abiotic stresses will provide farmers with an attractive option to improve profitability. In order to obtain precise, reproducible and time-saving stress monitoring, we used digital images and then using machine learning methods extracted useful information (such as 'disease signatures') from the images in an automated manner. Specifically, we also used tri-band and hyperspectral cameras to identify 'disease signatures' which will allow identification, differentiation and prediction of diseases in real time. These disease signatures will distinguish common foliar soybean diseases, nutrient deficiency and herbicide injury symptoms. These diagnostic tools can be implemented using smartphone and drones meeting the requirement of farmers, scouts and researchers. We continue to expand this work on multiple stresses and also preparing it as a package for easy integration in current imaging tools.

Our research will fill a huge gap in on-going research and tool development for disease scouting and farmer's decision making. This work will enhance the applicability of customizable farming and will lead to huge savings as farmers can control site specific stress in a timely and strategic manner. The output of this research will assist farmers in disease scouting using drones (either on their own or through a contract), and will enable screening for different stresses in an accurate, precise and speedy manner. One of our long-term goals is to make smartphone apps for farmers to assist in scouting, enabling the farmer to use their smartphone to determine the presence, severity of specific diseases in order to make strategic decisions on disease/stress control. We aim to provide entrepreneurial opportunities for chemical companies, technology companies, equipment companies, prescription farming companies. Better health, safe and sustainable environment.