USDA-NIFA: Multimodal Sensing for Early Detection and Real-Time Correction of Water Stress and Nutritional Needs in Plants

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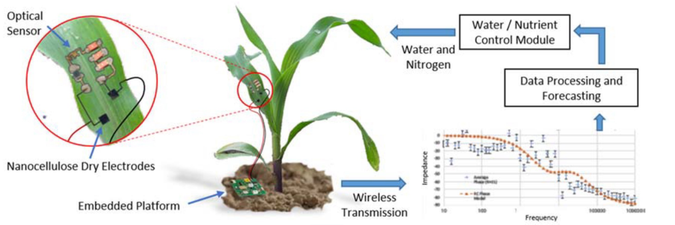
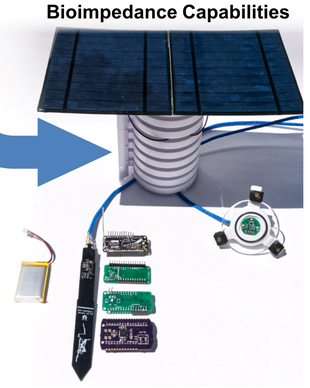
Challenge: Plant growth is influenced by many factors, including environmental factors such as soil humidity, ambient light conditions, and nutrient availability. In an agricultural context, monitoring the growth status of crops such as maize represents a source of valuable information for the grower, which could lead to optimization of growing strategies based on the performance of plants in particular regions of a field, or allow for targeted interventions for plants which are underperforming. However, accurately measuring the growth status of many thousands of plants in real time represents an enormous data collection challenge.

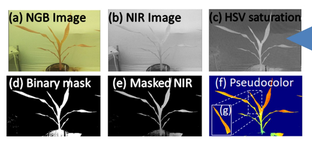


Simple Circuits for Remote Growth Monitoring

Environmental Station with Bioimpedance Capabilities



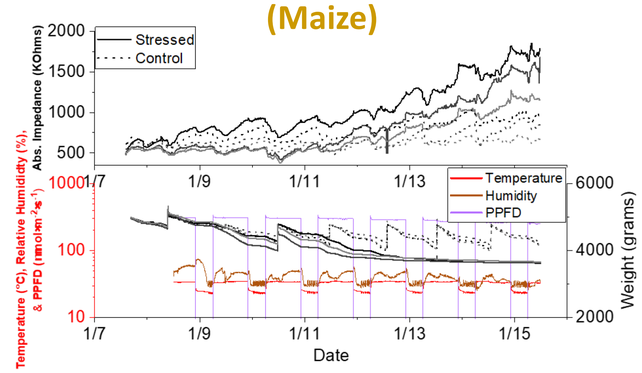
Non-Contact Detection of Water Stress



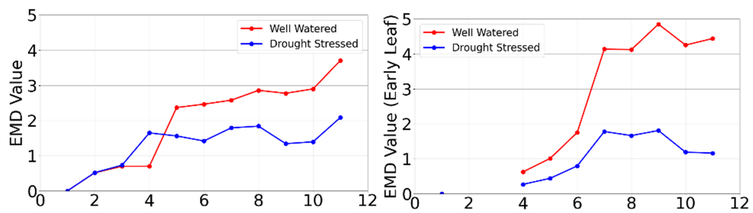
Broader Impacts (Education)

- Opportunity to bring in rural high school students to the interdisciplinary areas of flexible sensors, internet-of-things (IoT), data analytics, controls and plant sciences.
- Folded research efforts into REU, RET, and Senior Design projects.

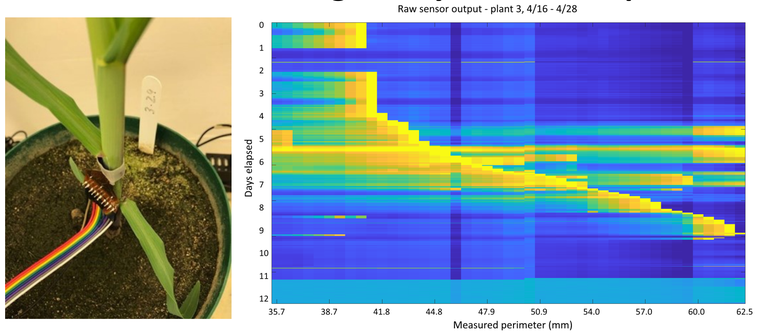
Bioimpedance Recording of Drought Stress (Maize)



Predictive Imaging of Drought Stress



Remote Monitoring of Physical Development



Scientific Impacts

- Introduced a low-cost system for precision agriculture and phenotyping.
- Developed On-Plant Sensors and Electrodes that limit deleterious affect or aberrations in data.
- Predictive models present a potential to aid automatic detection of early water stress, using the presented results.
- High-throughput data collection system and an image processing technique for visual phenotyping to identify water deficit.

Broader Impacts (Technology)

- Success of this research would have an eventual impact on the U.S. agriculture where more than 3 million farmers operate 2.2 million farms. Two percent of the population uses 900,000 million acreages of farmland to feed the US population.
- Optimize the amount of water and fertilizer applied to crops that is needed to achieve high yield (in quality and quantity) = ***$B***

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