Seed Imbibition Monitoring Using Miniature Systems

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Motivation

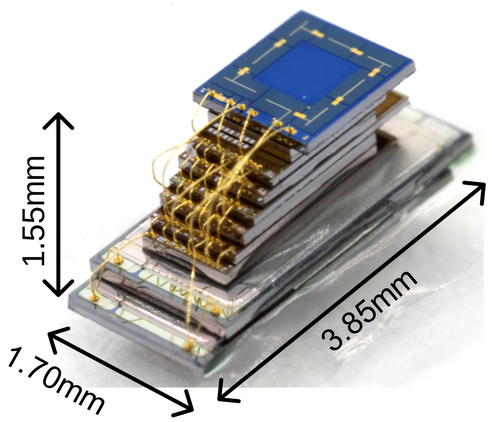
- Develop a tool to measure imbibition in soil in situ
- Minimize the system size to not disturb original imbibition significantly

Project Description

- Develop a wireless sensing system with a seed holding structure using low-power semiconductor chips
- Design a low-power CMOS chip that converts resistance to a digital code to realize a sensing system in a millimeter scale.

Context

- Typical imaging-based approach cannot monitor a seed in soil [1]
- We will record size of a seed using a force-sensing resistor and a resistance-to-digital converter in soil
- We will minimize the system size by reducing battery size based on low-power circuit design technique



Example of millimeter-scale system including a processor, memory, a radio, and batteries [2]

University of Pittsburgh

Develop a **millimeter-scale** wireless sensing system that measures the **growth rate** of a swelling maize **seed in soil**

Project Deliverables

- A seed holding structure that interface a seed and a force-sensing resistor
- A miniature sensing system with low-power custom and commercial chips that measure seed imbibition in soil
- A low-power CMOS custom chip that converts resistance to a digital code

Potential Impact

- This research studies low-power circuit design to reduce the over system size to a millimeter scale
- The research outcome enables to monitor imbibition of a seed in soil
- The miniaturized volume of electronics minimizes its impact on original interaction between a seed and soil and thus monitors imbibition more accurately
- It can transform the way to assess different recipes of soil and species in a biological manner using a seed

References and/or Acknowledgements

1. N. D. Miller, S. C. Stelpflug, S. M. Kaeppler, and E. P. Spalding, "A machine vision platform for measuring imbibition of maize kernels quantifies maternal effects, combining ability, and correlations with germination," *Plant Methods*, vol. 14, no. 115, 2018.
2. I. Lee, E. Moon, Y. Kim, J. Phillips, and D. Blaauw, "A 10mm^3 Light-Dose Sensing IoT^2 System with 35-to-339nW 10-to-300klx Light-Dose-to-Digital Converter," *IEEE Symposium on VLSI Circuits (SOVC)*, Jun. 2019.

- Collaboration with Dr. Edgar Spalding (Botany) and Dr. Jingy Huang (Soil Science) in the University of Wisconsin-Madison