

Title: EAGER: SitS: Collaborative: Terahertz Sensors for In-Situ Soil Characterization and Imaging

Summary:

There is a need in agriculture to produce greater and greater yields to feed a growing population. Meanwhile, resource intensive agriculture puts a strain on limited supplies of water and energy. This has motivated the field of precision agriculture, which aims to precisely apply inputs to farming systems where they are needed most. Methods for sensing key drivers of plant health, soil moisture and nutrients, are limited to the surface or are labor-intensive. Our proposed work is to use a combination of two types of sensors, near-infrared spectroscopy, and surface plasmon resonance, to obtain underground measurements of soil water, carbon, and nitrogen, and possible other variables

The objective of this proposal is to: design, build, and test a modular NIRS-SPR sensor capable of measuring soil properties along a soil profile.

Intellectual Merit:

The proposed work is a novel, high-risk combination of two sensing modalities, in an entirely new application. This makes it suitable for the EAGER program. It is high risk because SPR has not been shown in soil; because of the limitations of off the shelf components; because of the rigors of the installation in the soil environment; because of the fabrication challenges with the sensor form factor; and because of the tight budget and time restrictions.

Broader Impacts:

A sensor which can be easily installed and provide real-time measurements of soil water, carbon, and nitrogen could be used in precision agriculture applications. Measurements of soil status can be used with crop modeling to provide optimal targets for agricultural inputs, like water and fertilizer. Such precise resource management can maximize yield while minimizing resource usage. Further, such measurements are needed for monitoring the nitrogen and carbon cycles, and affect the accuracy of pollution and climate modeling. The developed technologies will be disseminated through in-class and lab courses to undergraduate and graduate students, seminars in the professional societies and the NSF centers, and K-12 outreach. Women, Latinx, and African American students will be involved via multiple programs. Active interaction with industrial partners will be exercised.