CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)
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Project Number
S1018

Project Title
Less Water, More Food? A Novel Low-Cost System for Real-Time 3D Imaging of Soil Moisture for Intelligent Irrigation

Abstract

Objectives/Goals
Hunger, one of the most prominent problems in the world today, is primarily caused by a shortage of fresh water. Significant optimization of water use can be achieved by knowing the time and amount of watering, as well as the specific location of soil that requires irrigation. However, most existing techniques of soil moisture measurement can only provide results at one point in the soil, require frequent calibration, and remain very costly.

Methods/Materials
I created a novel system capable of real time assessment of soil moisture content, which consists of a self-sustained data acquisition device, three-dimensional data analysis algorithm, and a real time visualization program. The system is very low cost compared to analogous instruments (can be under 30 dollars), is capable of wireless data transmission, is solar-powered, features one-button calibration, provides accurate time and location from the GPS signal, and can store historical data over long periods of time. It is based on using simultaneous measurements of resistance between two arrays of electrodes (up to 48 electrodes). After the data is digitized, coupled with GPS information and stored on a local SD card, it is sent via a wireless connection. An algorithm uses resistance values to construct a three-dimensional image of relative soil moisture content, which is visualized in real-time.

Results
I found that After the application of water, there was a substantial change in soil resistivity across all measurements, which justifies that resistivity can be used for a relative assessment of water content. I observed a distinct difference in resistance near the top and bottom of the soil volume, showing the dynamics of water penetration downward. Even before the application of water, various electrodes exhibited different resistance measurements. In order to account for these irregularities, a ratio of the present resistance values to the resistance of dry soil is computed. This process separates the variation of resistance due to moisture from the variation of resistance due to instrumental factors.

Conclusions/Discussion
By significantly increasing the efficiency of agricultural irrigation, this unique system can help to preserve precious freshwater resources and potentially alleviate the problem of hunger all around the world.

Summary Statement
I created a novel low-cost system for real-time three-dimensional imaging of soil moisture content which can be used to save precious freshwater resources.

Help Received
My physics teacher helped me to explore present soil moisture measurement methods. My sister helped with transmitting the data from the data acquisition device to the computer via a Serial port.