Section Sciences et Ingénierie de l'environnement
Design Project 2015 (semestre de printemps)

Proposition n°4

Exploring materials for low cost soil pressure sensors

Encadrant externe

Prénom, Nom Davis Daidié
Adresse courriel davis.daidie@sensorscope.ch *Téléphone 021 691 70 01
Nom entreprise Sensorscope Sàrl
Adresse entreprise EPFL Innovation Park, Bât. D
Site Web www.sensorscope.ch

Encadrant EPFL

EPFL STI IMX LMC
Prof. Karen Scrivener
MXG 232 – Station 12
1015 Lausanne

Email: karen.scrivener@epfl.ch

Teé: 021/ 693 58 43

Descriptif du projet

Precision irrigation of cultures aims at optimizing the water consumption by providing plants with the exact amount of water they need, when they need it. To achieve this, it is necessary to measure the soil water tension around the plant roots, which indicates the effort required by root systems to extract water from the soil. Currently available reference soil water tension sensors (Watermark®) are complex and expensive, and therefore not adapted for deployment in many areas where water scarcity is a major issue, such as the Sahel region. Alternative, gypsum-based sensors are inexpensive, but their accuracy, reproducibility and durability do not match those of the Watermark® sensor.

This kind of sensor is based on the measurement of the electrical resistivity of a porous material. The principle is as follows: The amount of water in the pores of the material, in equilibrium with the surrounding soil, affects the measured resistivity and gives information on the amount of water in the soil. When a lot of water is available in the soil, more pores of the probed material (and larger ones) will be filled with water, which will decrease its electrical resistance. On the other hand, when the soil dries, only the smaller pores remain filled with water, while air fills the other ones, thereby increasing the electrical resistance of the material.

Resistivity could depend also of other parameters as water salinity or subtract temperature for instance. Care must be taken to avoid such dependency or to have a mean of compensation (physically or by calculation).

Objectif

The aim of the project is to design a reference material making use of cheap and widely available components that would match (or exceed) the performance of currently available materials. Cement-based materials are cheap and have the capability to provide appropriate pore sizes in order to cover a useful range of sizes to match soil pore sizes.

This cementations material must have pore sizes covering a range of 0.1 um to 100 um, with a high reproducibility and/or homogeneity per production batch. Ideally it may be made in a material which intrinsically cancel or limit the dependency of the resistivity to electrical conductivity of water and or temperature (at least).

It will be important to document the design process as well as the manufacturing process, in order to transfer these processes to a different setting. In particular, cost and industrialization aspects should be appropriate for the local context of Burkina Faso as well as more industrial and/or equiped context.

Descriptif tâches

- Background documentation and research :
    - Importance of water pressure measurement in agriculture, principle, methods, current usage and recommendation.
    - Physics of soil, water and sensor material: Understanding and describing the physical and chemical properties of the material of the sensor to get a well-known or at least reproducible function of resistivity relatively to soil water pressure in different soil types and conditions.

- Sensor design
    - Material composition and design process
    - Dimensional definition
    - Tests and comparison with available commercial sensors in different types of soil.
    - Cost analyse in industrial or mid-size production

Divers

All of this is explorative and tasks could be modified and or added during the course of the project.