Effects of Moisture Heterogeneity on Analytical Performance of PPy Based Sensors Used for Assessing Nitrate in South Florida Sandy Soils

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Introduction

Nitrogen is the main macronutrient for plant growth and is often exploited in agriculture to increase crop production. Consequently, the excess nutrients are leached into surface and ground waters where they cause detrimental effects to aquatic life, biodiversity, and human health. We have developed a real-time IoT apparatus capable of determining concentrations in soil leachate, however challenges remain. One fundamental challenge with in situ soil nutrient measurements is due to the dynamic moisture heterogeneity of soils, even over short distances. This presents various changes in soil resistivities thereby influencing the sensor-to-soil interface and sensor output when measuring in situ.

Goals

This study aims to (*i*) understand the effect of θ_m, considering soil particle size, on polymer based nitrate sensor analytical performance and, (*ii*) derive a correction-factor function which accounts for θ_m on nitrate measurements.

Research Methodology

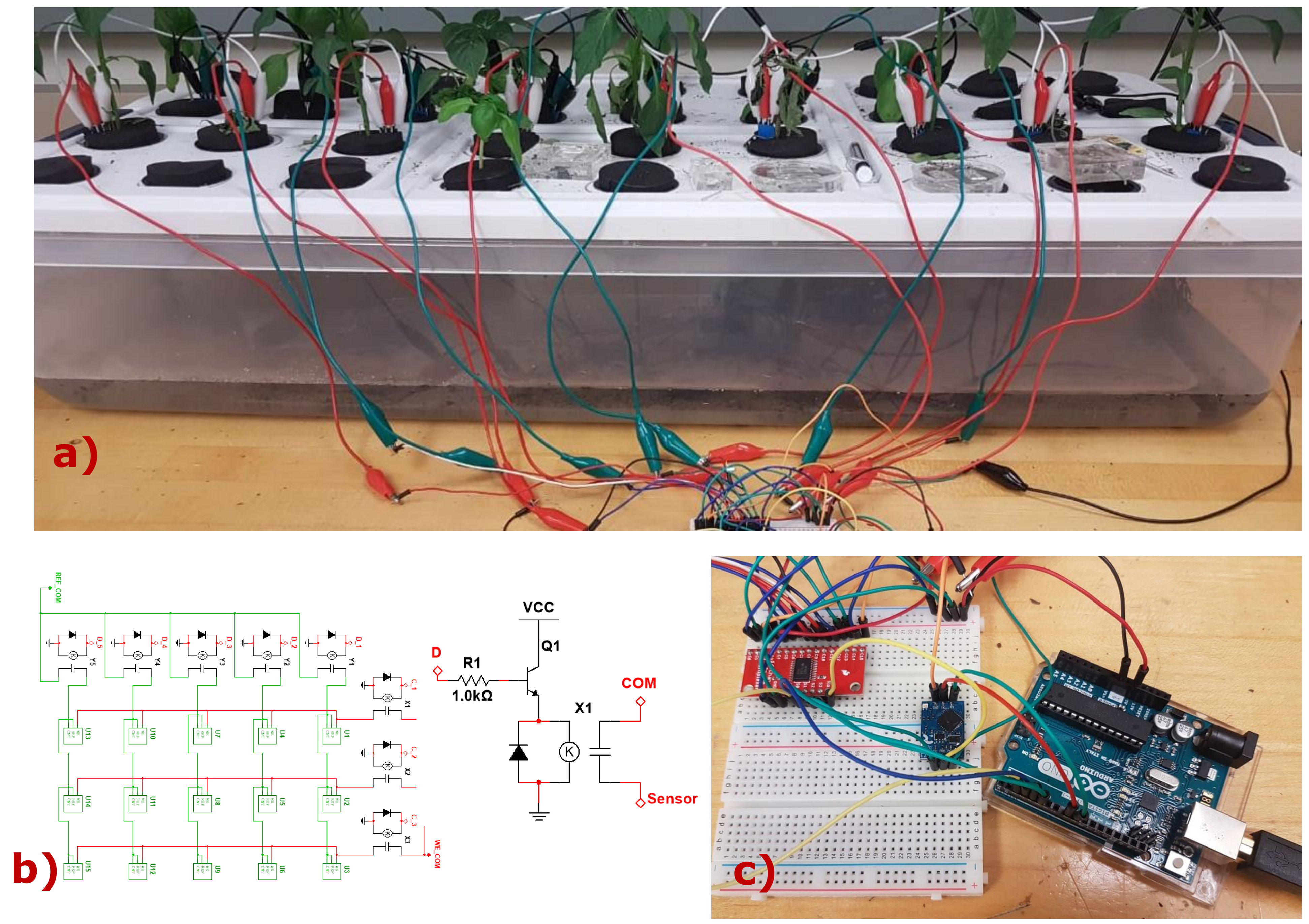


Figure 1. a) experimental set-up containing sand trays and multiplexed sensors in aquaponics chamber b) schematic drawing of reed relays and multiplexed system, and c) arduino multiplexed ORP circuit.

The N-doped PPy soil nitrate sensing platform employs a multiplexed sensor array to an oxidation/reduction potential (ORP) circuit and can communicate via LoRa technologies. The multiplexed sensor array allows us to easily select between soil sensors from each treatment group (A,B,& C). Sandy soil trays with six water content levels (0%, 4.54%, 9.09%, 13.63%, 18.18%, 22.72%, and 27.27%), will be manipulated by adding the corresponding volumes of deionized water in addition to the oven-dried soils.

Results

Preliminary data shows a linear relationship between the current variations at working electrode and the percent soil moisture content. Also, sensor accuracy increases as soil moisture approaches field capacity and flooded conditions.

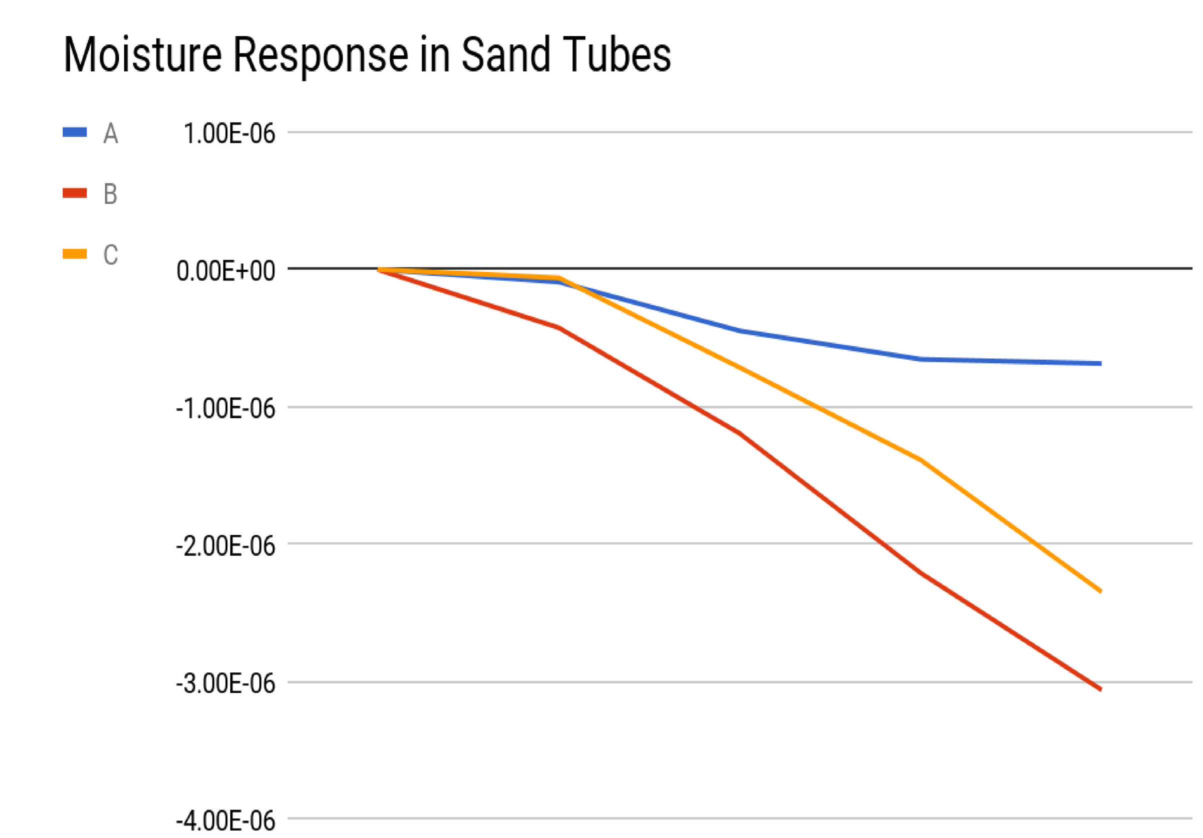
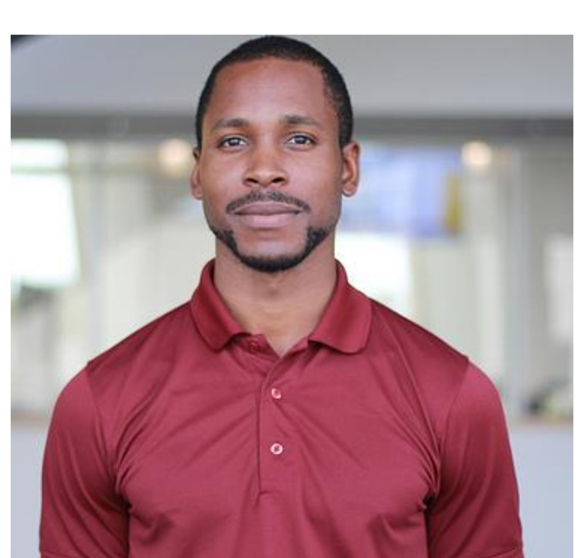


Figure 2. Nitrate sensor response to varying moisture in LOW, MED, and HI (A,C,B) treatment groups. Graph represents experiments done in 1mm particle size sand.

Future Work

Explore the effects by varying particle size and soil textures and to derive a correction factor equation which accounts for $\theta_{m.}$ Employ the sensing framework in field setting.



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This material is based upon work supported by the National Science Foundation under Grant No. HRD-1547798. This NSF Grant was awarded to Florida International University as part of the Centers of Research Excellence in Science and Technology (CREST) Program. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.