Ubiquitous Soil Sampling Robots For Confluent Soil Monitoring

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Introduction

- **Hydrological properties of the rhizosphere influence the hydraulic connection between the root and soil and modify soil organic carbon (SOC) pools** [1]
- **Rhizosphere the first critical component in the soil-plant-atmosphere water continuum** [2-3]
- **Low soil water content can limit plant growth and productivity** [4]
- **Temporal and special soil water distribution is critical for sustainable agricultural** [5]
- **A very few research aim, probing the interactions between water, chemistry and biology along the gradient from the root to the soil** [6]

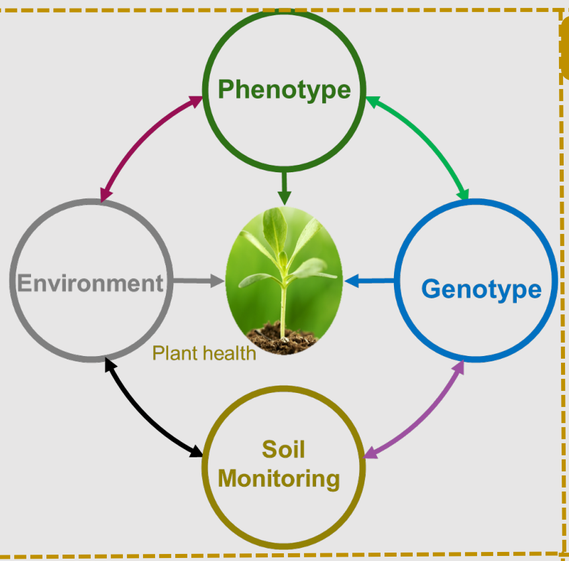
Proposal Aims

Our primary objective is to design and build a fleet of co-robots that can sense and report on plant root and soil properties at the scale of an agronomic production field.

- **AIM I. Design and develop soil swimming robots for soil sensing of the maize plant root and its rhizosphere with an above-ground carrier mobile robot to support large-scale field campaigns.**
- **Develop the use of the soil robot collective to identify interactions between maize roots and soil water relations at critical plant development time points.**
- **Aim II. Integrate phenotype (above- and below-ground) and environmental data for prediction of agronomic traits in maize hybrid field trials.**
- **AIM III. Share the impact and scientific findings of this project with the greater scientific community and public by implementing a coordinated set of activities that engage students, scientists, growers, and the public.**

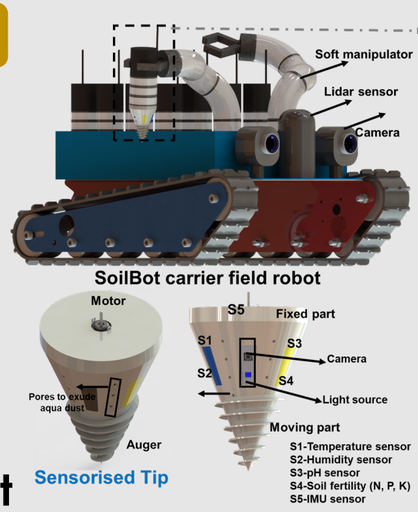
Our Approach

- Dynamic change
- Continuous feedback
- In situ
- Biochemical-based
- Dynamically moving robots
- Mapping the defined soil area



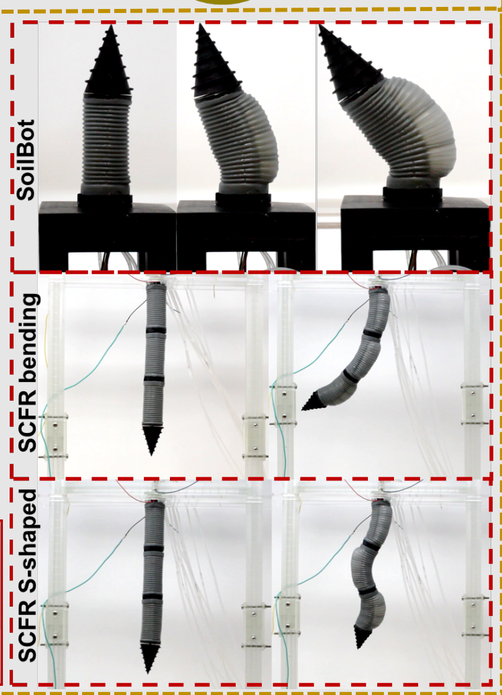
Proposed Robot

- Auger-like tip
- Sensorized probe
- Multi-mode soft actuator
- Carrier field robot
- Modular soft SoilBot



Current Development

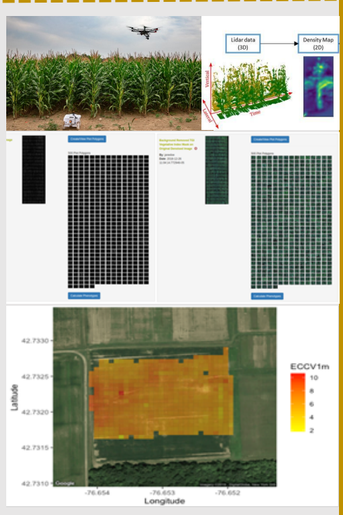
- 3D printed actuators
- Modular design
- Multi-chamber actuator design
- 3D print cyanate ester auger tip
- Each module bending >80°
- Silicone based printing



Work Plan

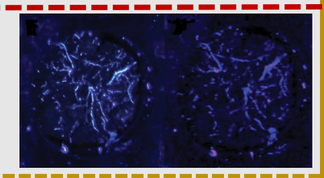
AIM I

- Develop functional modules of SoilBot (Yr-1-2)
- Integrate modules into robot (Yr-1-2)
- Develop control architecture (Yr 2-3)
- Below-ground phenotyping (Yr-1-3)
- Experimental design and data analysis (Yr 2-3)



AIM III

- Disseminate with popular media
- Disseminate in peer reviewed publication



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