Diagnostic Inspection Robot for Terrain (DIRT)

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Project Background

Modern agricultural soil testing is slow and labor-intensive, limiting farmers' ability to make timely decisions. An autonomous soil-diagnostic rover capable of collecting subsurface samples and performing on the spot spectral analysis will enable faster, denser, and more cost-effective soil quality assessments

Motives

Develop an autonomous soil diagnostic rover capable of collecting subsurface samples and generating spectroscopic soil quality measurements

Goals:

- Analyze soil at wavelengths between 900nm - 1700nm
- Reach soil depth of 10cm
- Shouuld be able to perform drilling and analysis in untilled soil
- Should perform soil analysis using a 16cm^3 container of soil which can later be expelled to perform soil analysis with new soil sample in a different location

Mechanical

Drill Bit Conceptual Design:

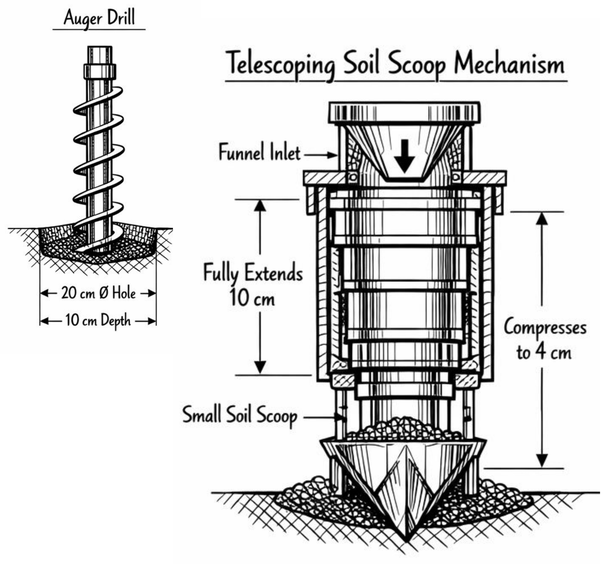

***Figure 1**: Soil Drill and Scoop*

- The drill uses a core-auger design that cuts into the soil and separate claw that transports loosened material upward toward the sampling chamber.
- The claw collects approximately 16 cm^3 of soil by allowed the scooped soil to go into a collapsible cylinder chamber.
- Once the chamber is fully collapsed, the soil is pushed into the spectrometer chamber
- The auger flight stabilizes the bit during penetration.
- The material selected is hardened 4140 alloy steel or 17-4PH stainless steel.

Mechanical Cont.

Spectrometer Chamber.

- The spectrometer chamber provides a fixed-volume cavity that holds a max of 16 cm^3 of soil.
- The illumination and collection windows create an optical path, allowing the halogen lamp and fiber probe to capture soil spectra.
- The chamber receives soil directly from the drill.
- The trap door allows for the soil to be dropped back into the scoop and allows the initial cylinder to bring the soil back down.
- The clear acrylic/glass body ensures optical transmission.

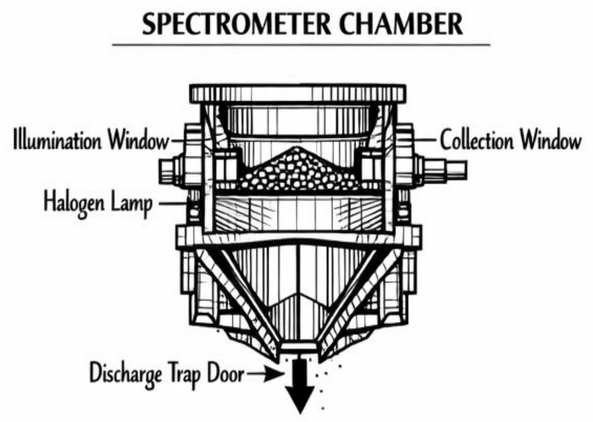

***Figure 2:** Spectrometer Chamber Side view*

Software

- Partial Least Squared ML Model
  - Takes spectrometer values and creates soil predictions based on values
  - Computes from wavelength range of 700nm - 1700nm (VIS-NIR)
  - Provides pH values, organic matter values, Nitrogen values, moisture values, and clay content
  - Computation will be done on Raspberry Pi that is placed on the Rover
- Claw and Drill Motion control
  - Drill and Claw motion control will be done on ESP32 (on the rover)
  - Commands will be sent from Raspberry nano on a separate controller

Next Steps

- Solidify CAD Design of Scoop, Drill, and Spectrometer chamber
- Devlop power budget-friendly schematic encompassing all electronic
- Develop custom PLS model suitable to the 700nm - 1700nm range