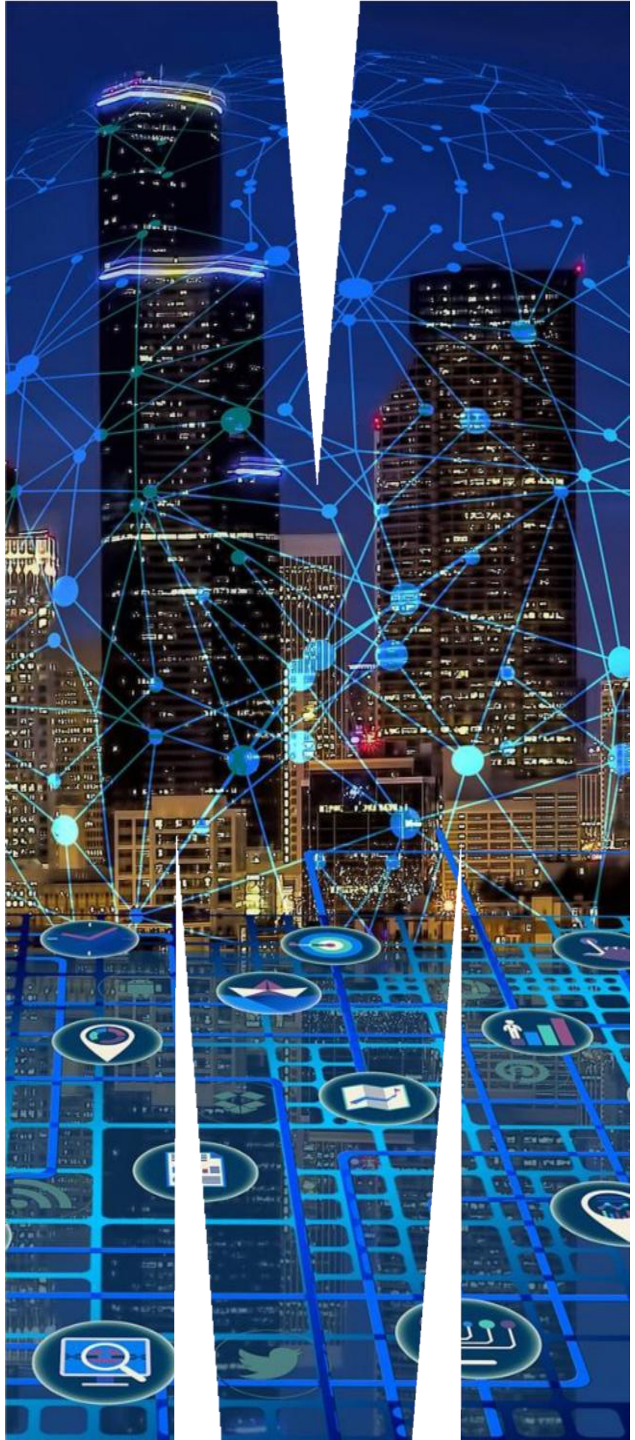
MONASH University

TRC3500: Sensors and Artifical Perception

Week 2 Lab

Project 1 - Soil Moisture Sensor



Deliverables

For this project there are the following deliverables:

1. Circuit schematics and clear photographs of the breadboards for your calibration and signal conditioning circuits
2. Report characterising your sensor's functionality (maximum two pages)
3. Link to your project repository on GitHub
4. Declaration of generative AI use

Materials

Student provides
- Tap water and cup
- Box, shallow bowl, or baking tray to use as a spill tray
- Spoon, chopstick, butter knife, etc. for stirring coir between measurements
- Paper towel or rag for any spills
- A way to stabilise the wires for measurement

Provided to each group
- Eleclab toolkit
- Bolts or wires
- 6 coir pellets (3 for calibration, 3 for measurement/characteristics)
- Gloves
- Transfer pipette
- Measuring cup
- 250ml plastic cup (red party cups/IKEA toddler cups?)
- Op amp

Safety Notes

1. **Be cautious using water near your breadboard and components**. We recommend using the transfer pipette to fill the measuring cup from a glass or cup instead of pouring, and adding the water to the coir on a different surface than the one you are using to make your measurements. Use a spill tray to contain the water and coir sample.
2. **Use provided PPE.** Wear gloves while handling coir, and break it apart in the sealed plastic bag to minimise dust before you transfer it to the cup.
3. **Do not keep damp coir.** Dispose of the coir after your testing is complete and wash your supplies. After some time it may become mouldy.

Part 1: Build it

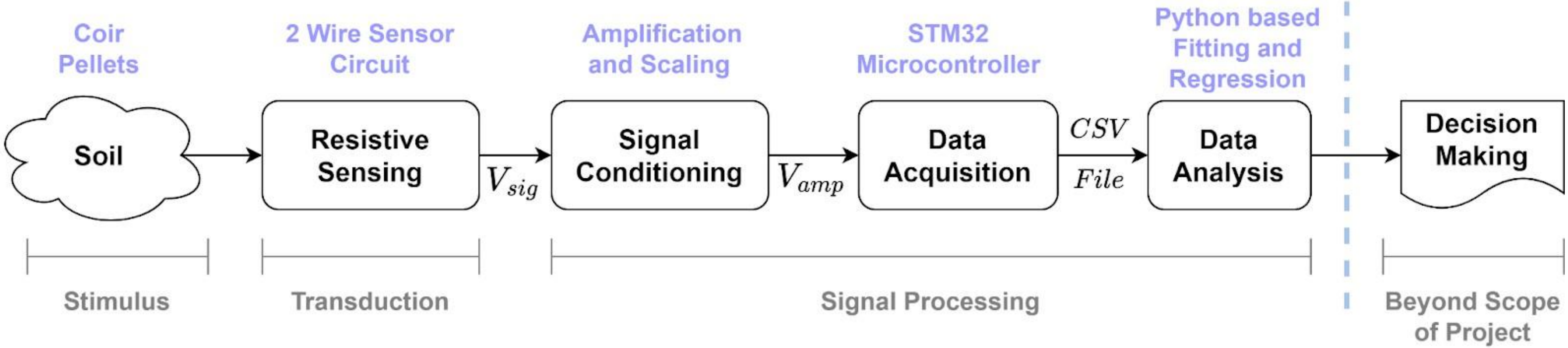
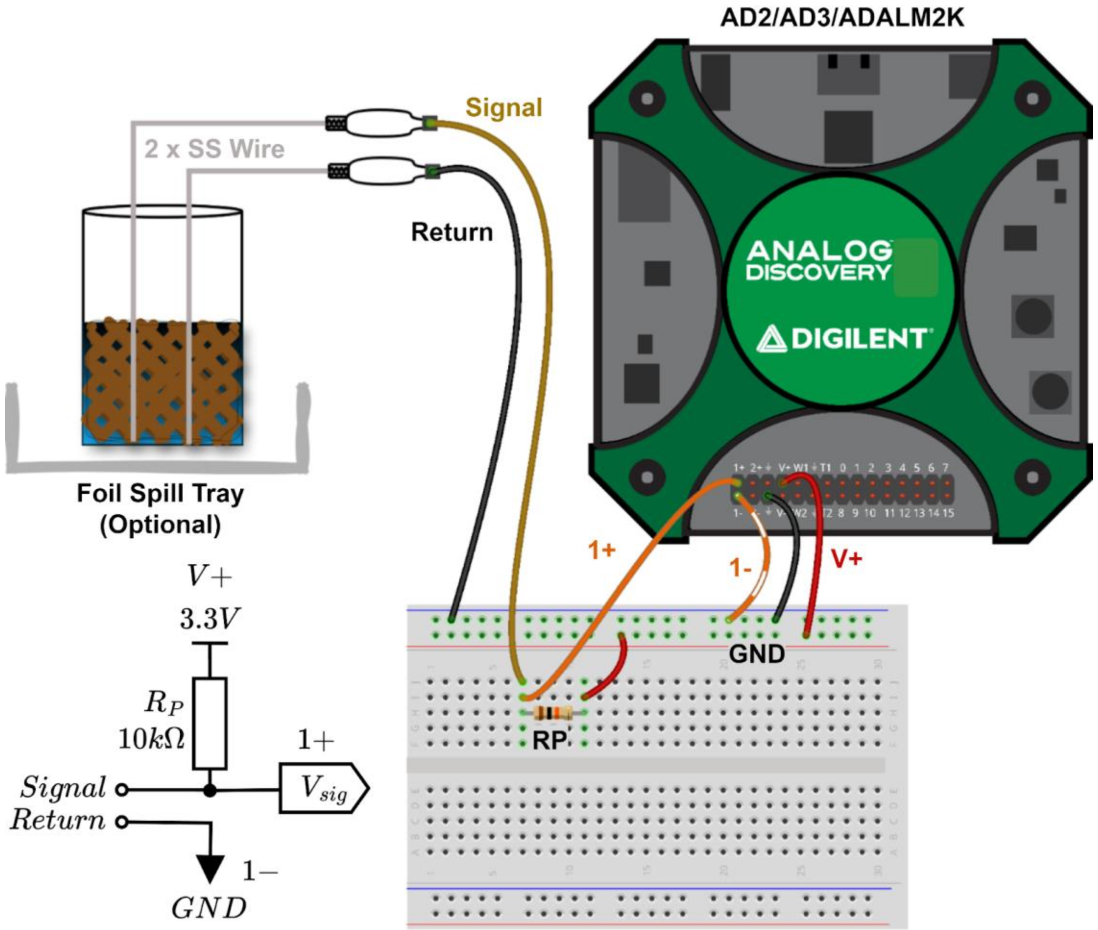


Figure 1. Block diagram for Project 1

Part 1: Build it



Representative diagram of the setup for calibration, including schematic.

Part 2: Signal Processing

Signal Conditioning

- Design a signal conditioning circuit that takes the output range of the sensor and expands its dynamic range for the STM32's onboard 12-bit ADC. Calculate the component values and verify that they function as expected with an LT-Spice simulation.
- The architecture of a suitable conditioning circuit and the process for solving for the resistor values may be found in the Week 2 Laboratory Activity.
- Assemble your conditioning circuit on a breadboard, and connect it to the microcontroller.

Data Acquisition

- Starting with the code supplied for basic ADC and Data Capture on the STM, you can take the output of the operational amplifier in your conditioning circuit, and connect it to the A0 pin of the STM.

Part 3: Transfer Function and Sensor Characteristics

- Measure the *transfer function* of your sensor

  In your report, include a plot of your transfer function that includes the raw data, an indication of the variability of each data point, and a fitted transfer function. Specify the function class, parameter values, and goodness-of-fit in terms of R^2.

- Measure the *repeatability* of your sensor

  What is the range of measurements in [X medium] as a percentage of the full span of the sensor?

- Measure the *span-end saturation* and *full span* of your sensor

  Taking the point of saturation as the end of the sensor's range, what is the full span of the sensor in stimulus units?

Part 3: Transfer Function and Sensor Characteristics

- Measure the *inaccuracy* of your sensor

  Report the sensor's inaccuracy as the highest deviation from the fitted transfer function, as a percentage of full scale (where the full scale is the resolution of the ADC).

- Measure the *nonlinearity* of your sensor

  Assuming a linear transfer function based on terminal points within the span-end saturation, what is the nonlinearity as a percentage of full scale?

- Quantify the *measurement resolution* of your sensor

  What is the minimum difference in water volume that is detectable a) in dry medium, ambient humidity (0 ml added), b) in damp medium (Xml added), c) in near-saturated medium (Xml added)?

  How does this difference relate to the repeatability you measured previously?

Thank You…