Arduino Soil Moisture Probe

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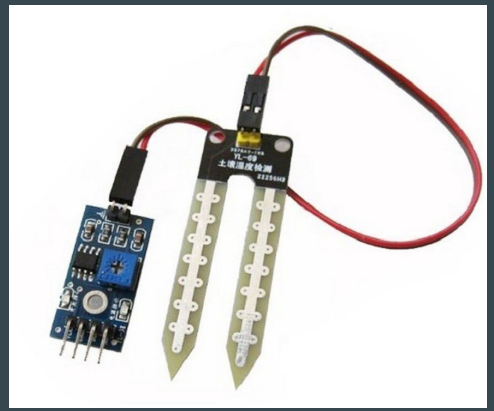
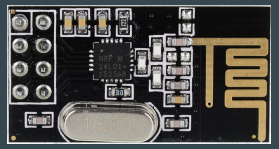
Goals

- Remotely monitor soil moisture in Engineer's Way bioretention system
  - Relate soil moisture data to rainfall events and optimize water flow
- Create a soil moisture probe using cheap and readily available equipment
- Make a product that is easily reproduced and can be used in a variety of applications
  - Homes, gardens, irrigation systems, etc.

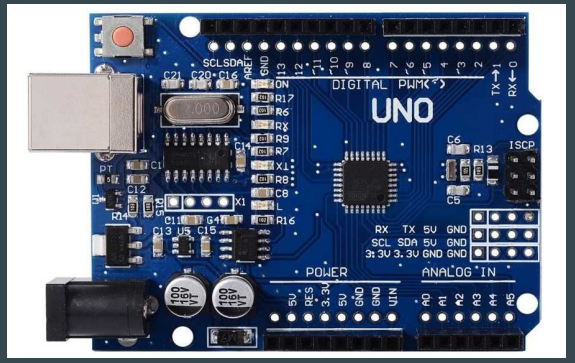
Equipment



WINGONEER YL-69 Sensor and HC-38 Module

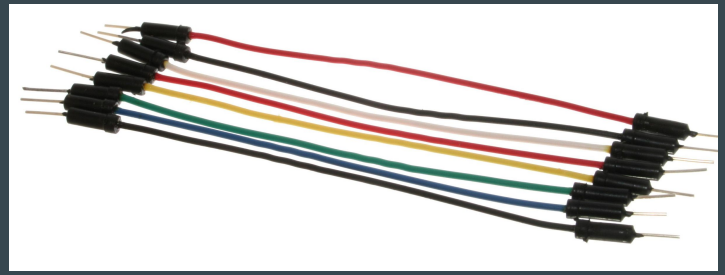


NRF24L01 Radio Transmitter (2x)

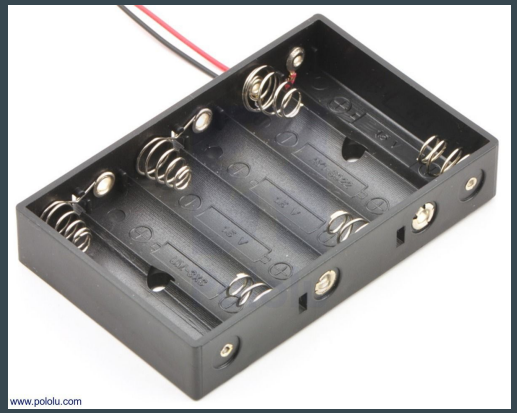


Arduino Uno Board (2x)

Total Cost: $20



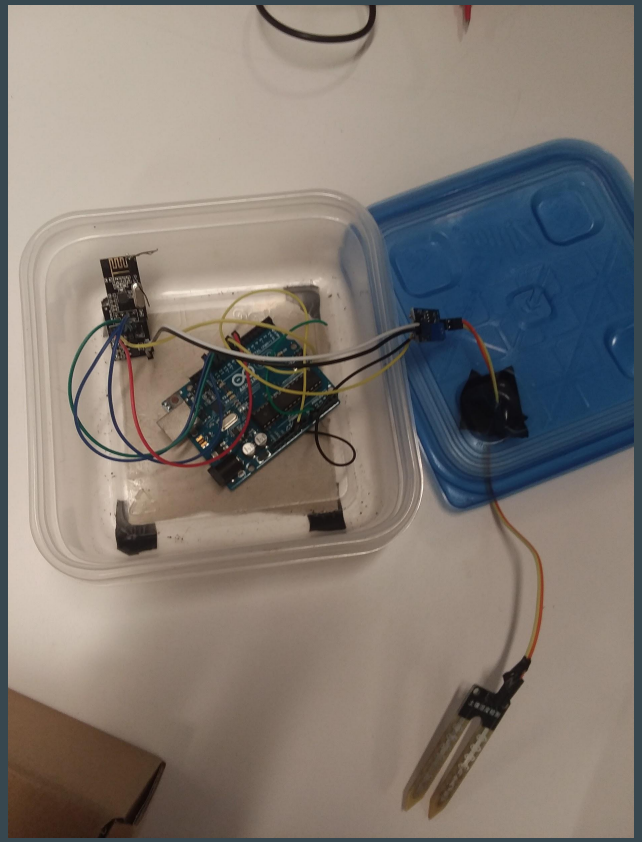
Colored Wire with pins for Arduino (18x)

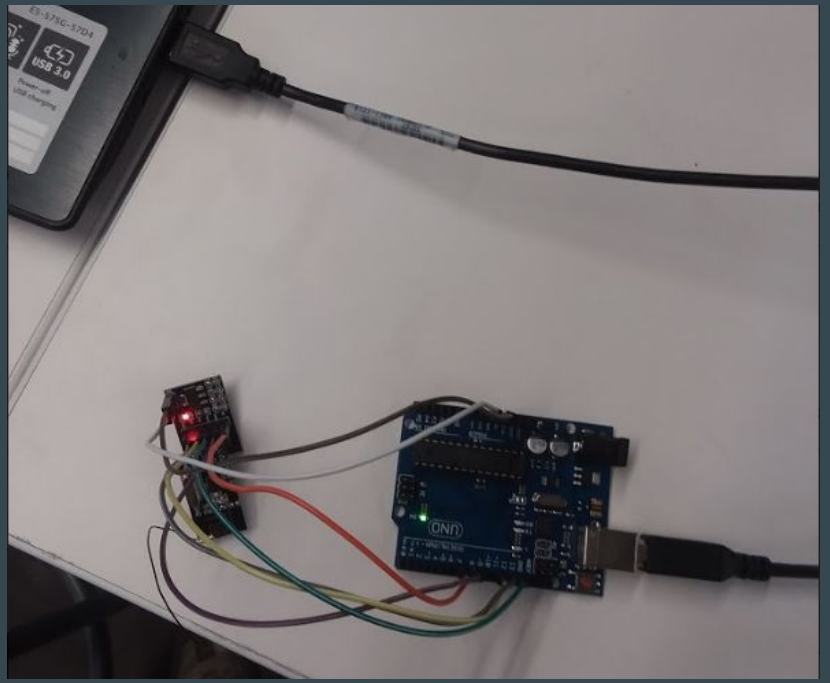


AA Battery Pack (connects 6 in series)

Setup

- Moisture Probe, Arduino, Radio Transmitter, and battery pack deployed in bioretention system
  - Waterproof plastic container with slot for probe
- Radio receiver and Arduino connected to PC in Thornton B-Wing
- Probe gathers moisture data, transmits to receiver, and uploads to PC
  - All data sent to Blynk server, which can be viewed via Blynk mobile app

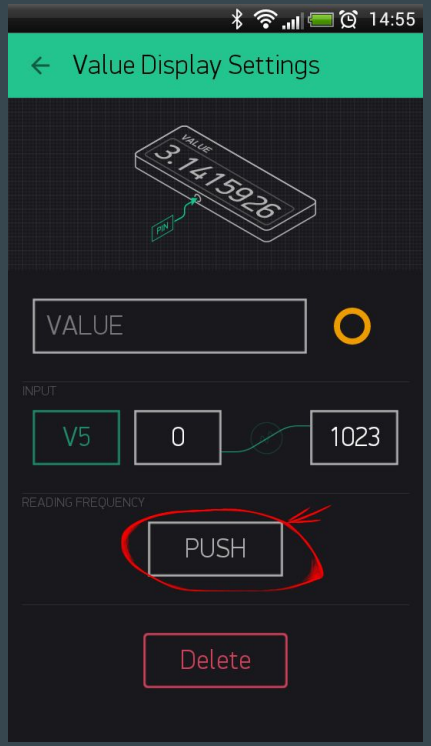



USB 3.0

Program

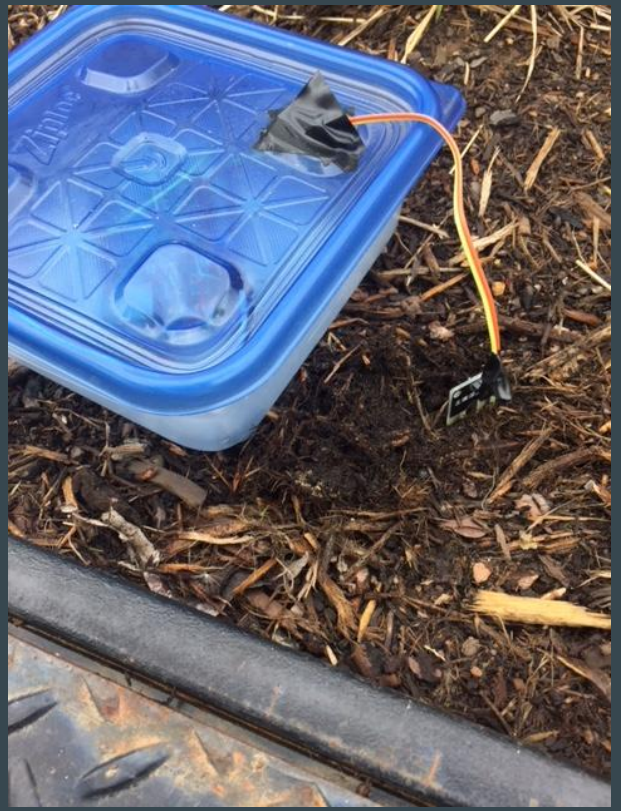
- All coding in the Arduino IDE, required importing different libraries all shown in the Git repository:
  - RF24 for radio communication
  - Blynk for posting data to server
- Only two scripts required
  - Transmitter records and sends data (RadioTransmit)
  - Receiver records and uploads data (RadioBlynkReceive)

https://github.com/uva-hydroinformatics/Soil_moisture_and_Rainfall_sensing



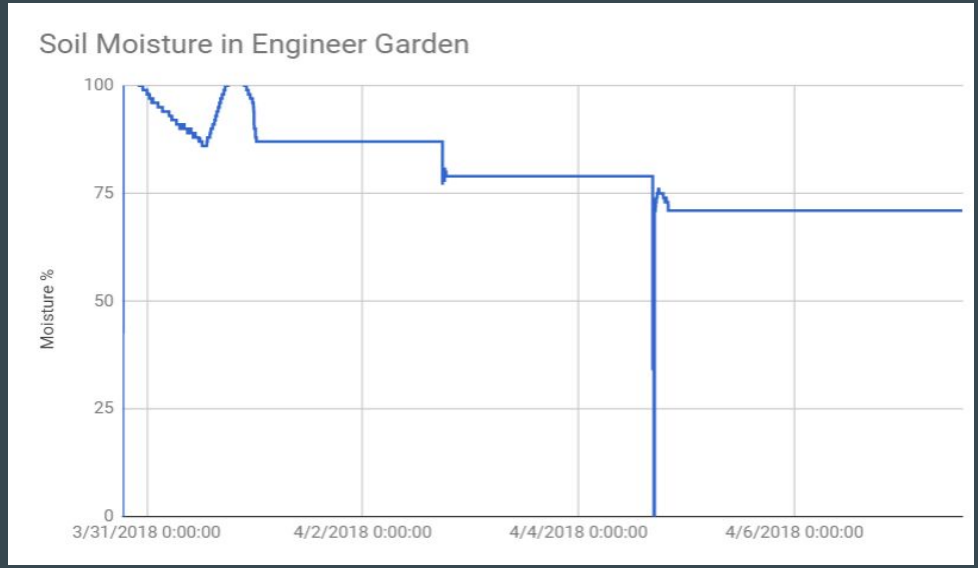
Testing

- Put the transmitter setup out in the rain garden for a week
  - Receiver was in nearby room hooked up to a computer
  - Data was recorded and posted every 30 seconds
  - Blynk app: utilized history graph widget
- Soil moisture levels were obtained and plotted in real time



Results

- Overall successful. Soil moisture plotted over the course of a week
  - Data collected & posted on the Blynk-server
  - Exported to a CSV and graphed →
  - Demonstrated at the UVA SEAS open house
- Rapid data collection
- Instant plotting



Obstacles and Solutions

- Probe Calibration
  - Code must scale probe output to match actual moisture levels. Calibrated with pure water (100%) and a dry paper towel (0%)
- Radio Transmission Range
  - Short range boosted with soldered antennas
  - Arduino Shield offers wifi capability for future projects
- Battery Life
  - Frequent transmission drains batteries quickly (roughly 30,000 transmissions per battery pack)
  - Storing data locally and sending less frequent packets dramatically increases lifetime

Future Work

- Pair with tipping bucket that measures rainfall intensity and depth
  - Correlate rainfall depth with soil moisture levels, increase predictability
  - Similar wireless transmission and data logging
- Use probe to automate valve controls
  - Moisture too high → Open drainage valves
  - Low moisture → close valves, activate sprinklers, etc.
- Improve sturdiness of design
  - Solder pins, build robust container, larger battery pack