



University  
of Idaho

# USDA FOREST SERVICE: STREAM VELOCITY MEASURING DEVICE

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(FOREST SERVICE)

# OBJECTIVES

- Develop Bluetooth technology for wireless communication two or more conductivity probes that can be used to measure small stream velocity.
- Provide readout about probe settings, probe data, and analyzed results via a tablet or smart phone.



# VALUE PROPOSITION



- I Update a system that has been used in USDA stream studies for ~20 years.
- I Create a safer (more ergonomic and trip free) working environment for field researchers.
- I Support more efficient data collection by using modern handheld devices, doing the math for the user, and saving results more securely.

# PROJECT REQUIREMENTS



## OPERATING ENVIRONMENT

- I Velocity range – 0 to 10 m/s
- I Stream Width – sample in USDA lab to Paradise Creek
- I Required Probe Separation – 6 stream widths
- I Physical Property Used for Measurement – water conductivity

## USER FRIENDLINESS

- I Remote Operation – wireless system that can read as far as 100 ft
- I Versatile Probe Support – may be used by operator for balance in rough terrain
- I Display – data available to user on tables or other wireless device
- I Set Up – device can be up and running within 20 minutes
- I Transportability – can be easily carried  $\frac{1}{4}$  mile by one person (less than 20 lbs)
- I Packaging – all components fit within a single waterproof carrying case

# PROJECT REQUIREMENTS (CONTINUED)



## DURABILITY

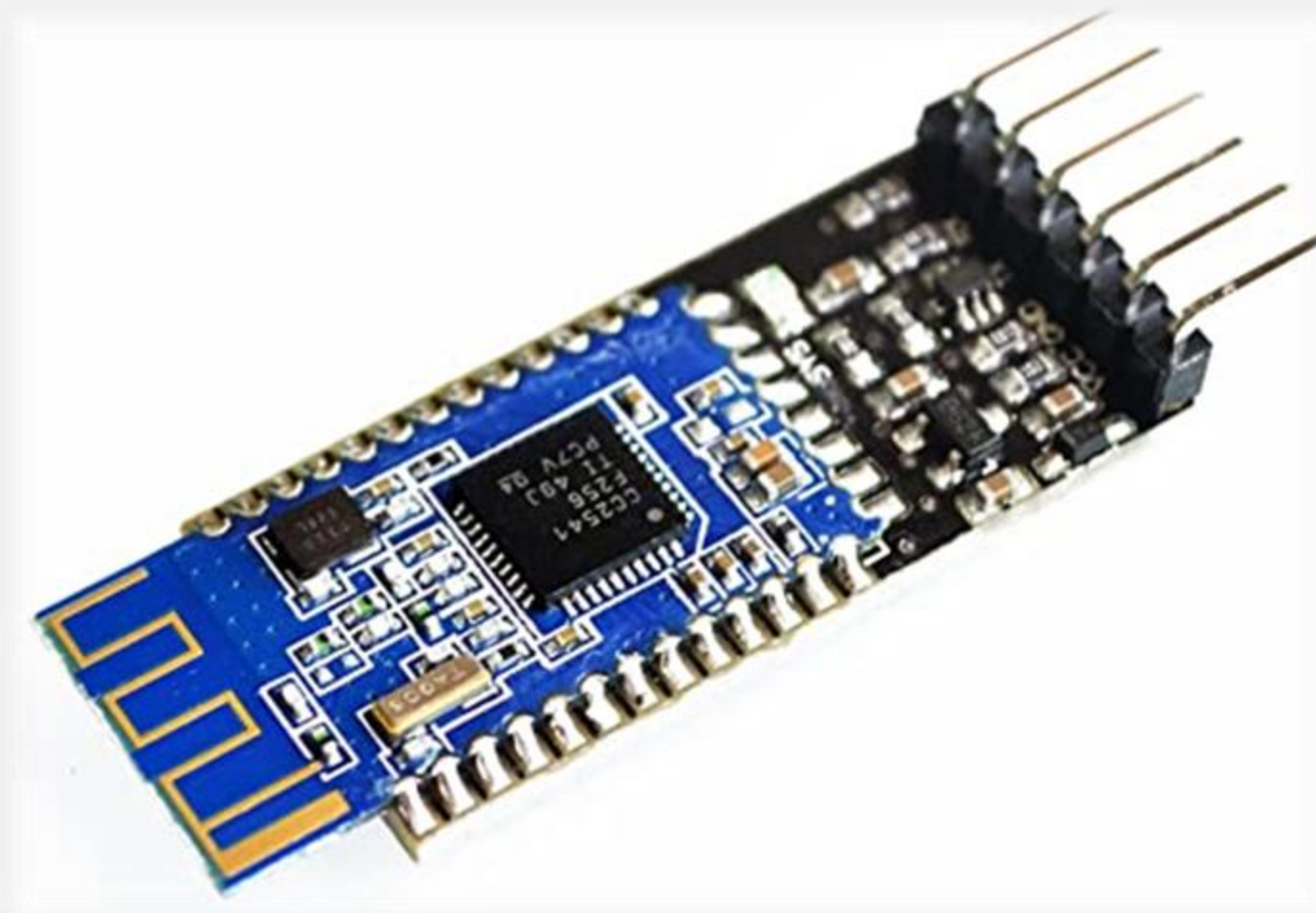
- I Must be suitable for use in all weather conditions, including rain/sleet/snow
- I Streams can be full of sediment that can interrupt testing
- I Cannot break in such a way that the device pollutes the environment
- I Batteries can support field operation for at least 10 hours with no recharging

## SOFTWARE

- I Velocity Calculation – probe separation divided by time between peak-to-peak concentrations
- I Reliability – integration of peak with 5% error
- I Data Logging – DAQ that runs on batteries equipped with Excel-like tool
- I Sampling Rate – 8 readings/sec with simultaneous sampling from two channels

# CONCEPTUAL DEVELOPMENT

- I We decided to use Arduino nanos as they are the only Arduino microcontrollers that will be able to fit inside the PVC tubing
- I We ended up using the HM-10 Bluetooth module over an HC-06 Bluetooth module as the HC-06 could not connect to devices using Bluetooth 4.2
- I We are using PVC as it is light, durable, and easy to replace



HM-10



Arduino Nano

# KEY SUBSYSTEM ATTRIBUTES



## PVC PROBE HOLDERS:

- I PVC design allows for durability in all-weather types.
- I Lightweight (less than 20lbs).
- I Waterproof casing for electrical components.
- I Usable for various stream sizes.

## NANO MICROCONTROLLER:

- I Able to take measurements from the conductivity probe at 8 readings per second.
- I Able to run for 10+ hours.
- I Calculates velocity within 5% error of the original setup.

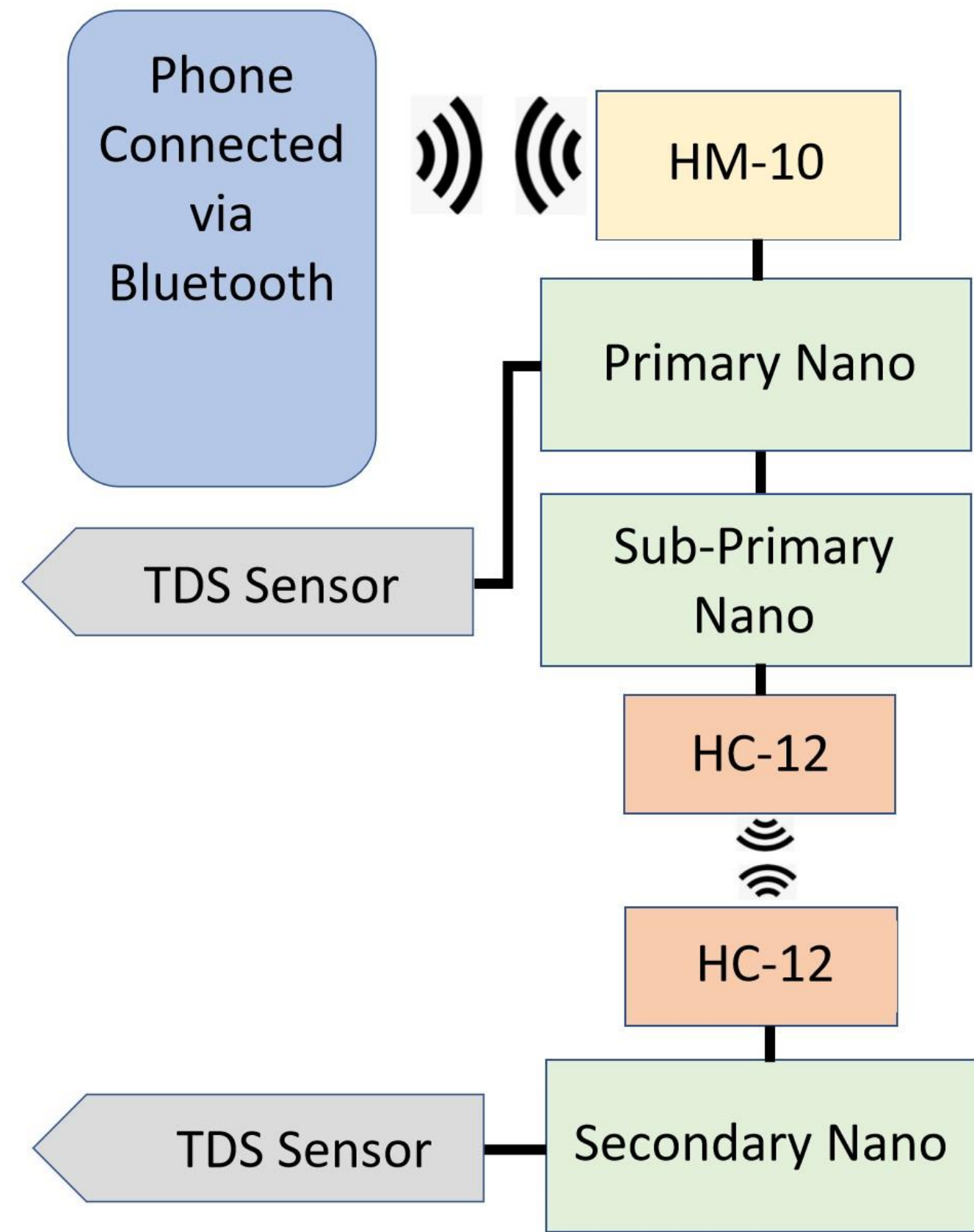
## WIRELESS COMMUNICATIONS:

- I HC-12 allows for a 1000m communication between probes.
- I HM-10 allows for a 100m communication between probe and control device.

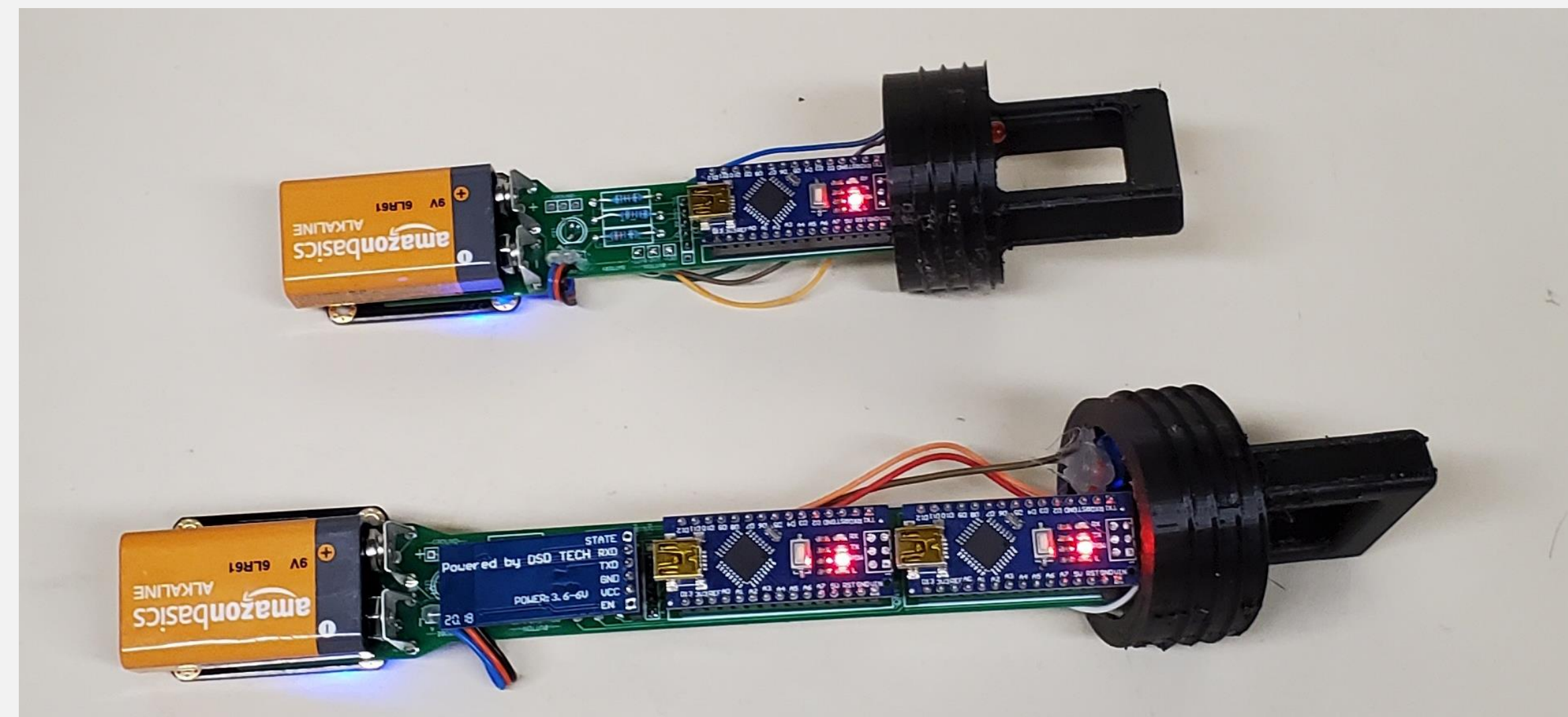
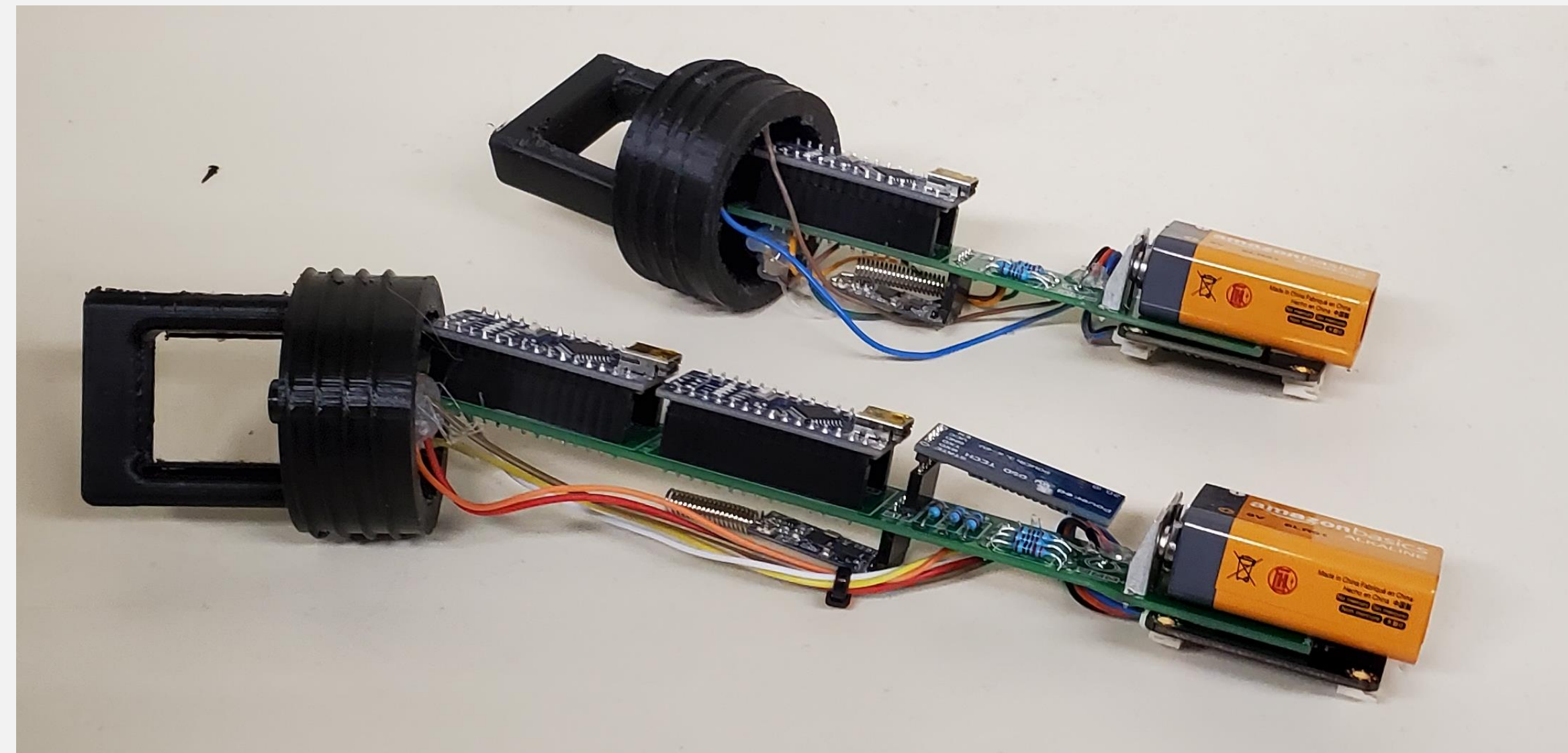
## STREAM VELOCITY APP:

- I Allows for wireless control over probes.
- I Able to store incoming data readings into an Excel file.
- I Displays calculated stream velocity.
- I Real-time graph of probe readings.
- I Compatible with phone or tablet.

# SYSTEM DESIGN



TRIPLE NANO SYSTEM DIAGRAM



TRIPLE NANO SYSTEM



# APP AND DATA STORAGE



Stream Velocity App

Help and Info

Scan Connect 00:00

Status:

Enter Excel Storage File Name

Feet Meters

Set the Distance

Start Stop Reset

**Stream Velocity: 0.000**

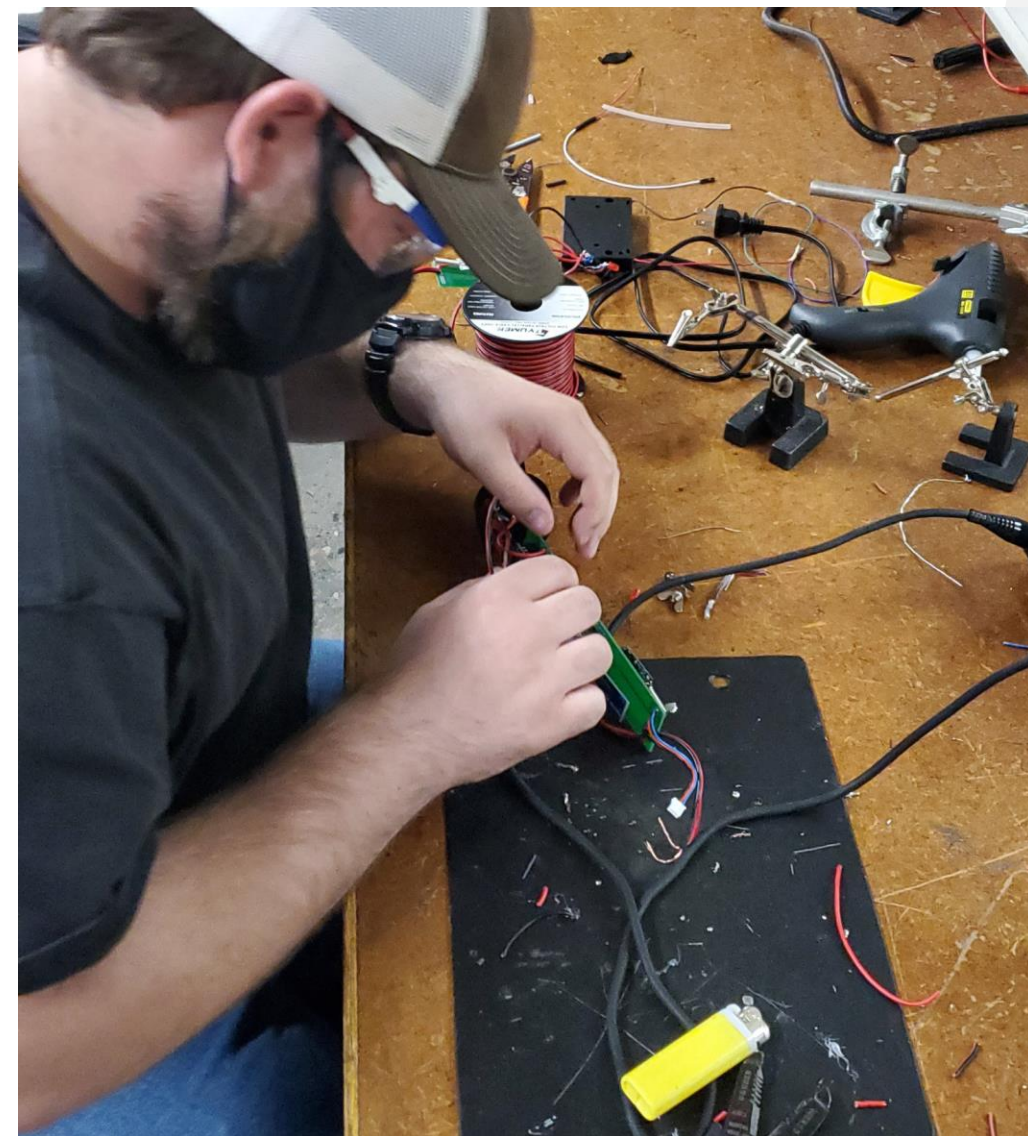
TDS Sensor 1:	0.0	ppm
TDS Sensor 2:	0.0	ppm

XRecorder

# FINAL DESIGN



# MANUFACTURING PROCESSES



## COLE AND JOSH (EE)

- I Assemble the probe electronics
- I With all components, can be assembled in 1-2 hours

## ANTHONY AND MAX (ME)

- I Assemble the probe housing
- I Can be assembled in approximately 1-2 hours, with appropriate time afterwards to let sealant cure.

## METHODS USED

- I 3D Printing
- I Soldering
- I Basic Power Tools



# PROJECT MANAGEMENT AND RESULTS



**I Schedule**

**I Budget**

**I Design  
Validation**



# RISK MANAGEMENT

- I Water Damage – ACTION: Test everything for a proper seal prior to allowing the electrical components near them
- I Durability – Ensuring that the material can take a fall as well as mitigate damage to the internal system
- I Lack of Power – LED battery indication lights
- I Losing grip – a wrist strap
- I Connection issues – Range is far more than what is required
- I Damage of Probes – waterproof clip that allows for replacement

# RECOMMENDATIONS

- I Adding a specific housing around the PCB
- I Spring loaded reel system for the excess wire
- I Make wires more easily attachable/detachable from circuit board
- I Design system to make PCB more easily attachable/detachable from the threaded cap.





**FEEDBACK / QUESTIONS?**