Open-source surface watercraft for riverscape mapping

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EGU2020-4291

Abstract

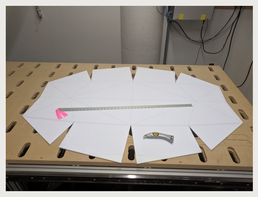
- Recent research postulates that both high-resolution and river-extent information are necessary to understand fundamental questions of river processes, such as patterns of critical habitat, sediment links, and river instability.
- As part of a larger NSF-funded research project, we have developed an open-source, boat-based mapping approach to measure river geometry, sediment size patterns, hydraulic habitats, and riverbank erosion patterns.
- The design is meant to be "garage build friendly", utilizing a minimum number of common tools and basic construction techniques.
- The sensor package will be user-friendly enough for non-expert use, allowing the boat to be deployed for citizen-science based data collection by loaning it to groups like watershed councils or volunteer conservation organizations.

Design

Pontoons

2 – 4' × 8' sheets 4mm Polypropylene [Cloroplast] (≈$25)

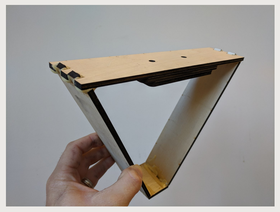
- The pontoons are cut and creased from a single sheet
- The final shape is 'origami' folded to provide a seamless surface below the waterline.




Bulkheads

Laser-cut Plywood (≈$15)

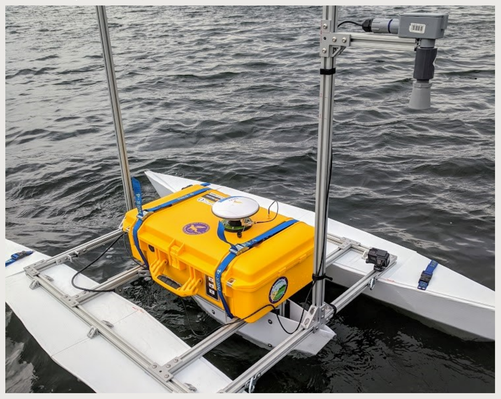
- Three triangular bulkheads are placed fore, mid, and aft inside the pontoon to provide a mounting point for the frame.



Frame

1-inch extruded aluminum profiles (≈$500)

- The base frame is constructed from custom cut lengths of aluminum T-Slot profiles and connected with brackets (all from 80/20 Inc.)



Motors

2 – Blue Robotics T200 Thrusters ($169/ea)

- Custom 3D printed + PVC pipe jet housings
- Controlled by 30 amp ESC and powered by two 10 Ah (10,000 mAh) 4-cell lithium polymer batteries (16 volts)
- Steering accomplished with differential thrust



Sensors

Blue Robotic Ping Sonar
Single Beam Sonar

Water Depth, 0.4-30m
$279

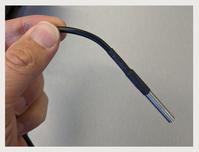
Humminbird Helix 5
Side-imaging Sonar

Water Depth and Bed Texture
$300

Maxbotix Ultrasonic
Distance Sensor

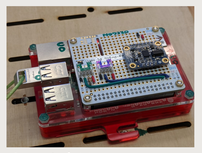
Water Surface Elevations, $115
HRXL-MAXSONAR (MB7389)

Adafruit DS18B20

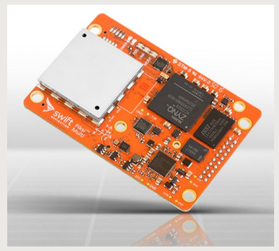


Waterproof Temp Sensor, $10

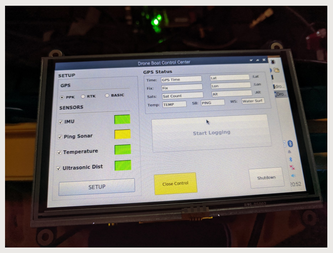
Adafruit BNO055



Inertial Measurement Unit (IMU), 9-DOF (Accel, Gyro, Mag)
$35



SwiftNav Piksi Multi
High-Precision GPS
RTK or PPK
≈$2000
(Base/Rover Pair)

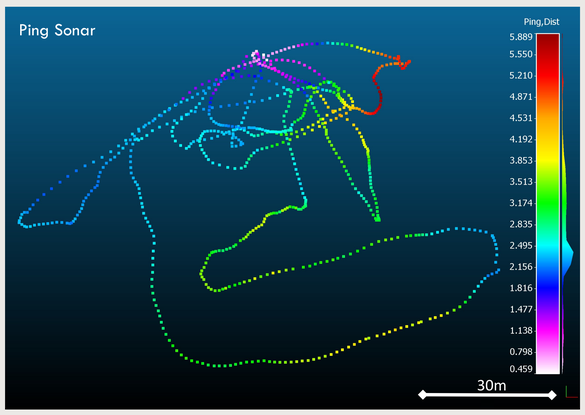


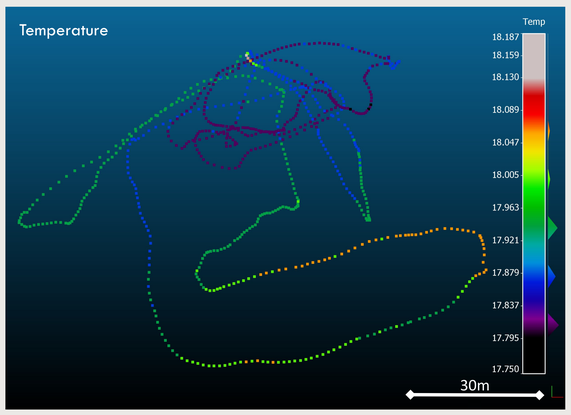
Raspberry Pi 3 B+
1.4GHz Cortex-A53, 1GB RAM, $35
HDMI 5" Touchscreen Display, $75
- Custom Python-based data logging software

Total price of base configuration
$3500 (€3200)
w/ multi-camera array $7000 (€6400)

Preliminary Field Testing

Example of sonar depth and water temperature on the Willamette River





Swift water motor tests. Alton Baker Mill Race, Eugene, OR

Kayak towing test and R/C Control Long, Tom River, OR

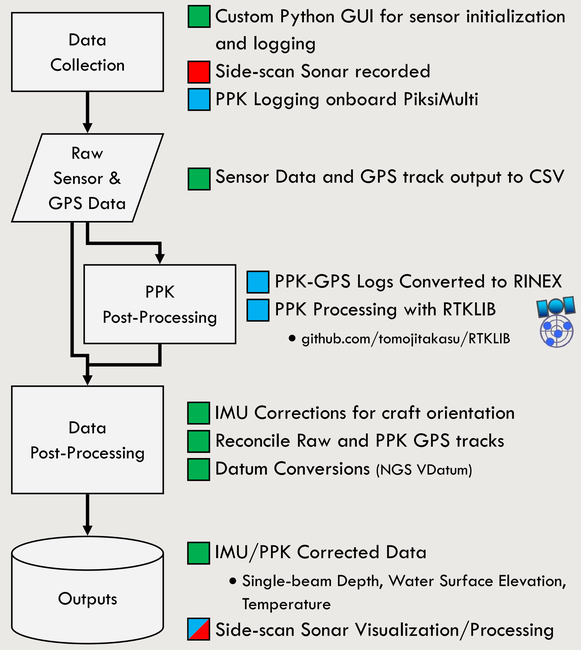
GitHub
NextGen_RiverscapeMapping

Designs and Code will be available Summer 2020 after our initial testing is completed

This research was supported by the National Science Foundation EAGER Award #1934253

Workflow / Software

- Custom (Included in the NextGen Riverscapes Github)
- Open-Source (both Free and Commercial)
- Commercial



Riverscape Mapping & Remote Sensing Validation

The boats will be able to provide high-resolution data critical for longitudinal mapping and building riverscape-scale datasets. The data will also be valuable for validating remote sensing datasets.

Citizen Science

Another goal of the project is to loan preconfigured boats to watershed councils, non-profit and volunteer conservation organizations to allow them to collect data on their own streams.

Possible Future Add-ons

Multi-camera Array: SfM-based 3D mapping of banks and bed
Laser Line Scanner: for shallow water depth mapping

Open water test. Willamette River, Eugene, OR