Riverscape mapping with an open-source “autonomous” surface watercraft

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Abstract

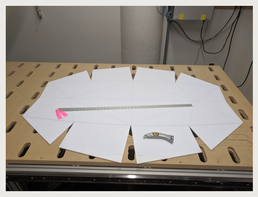
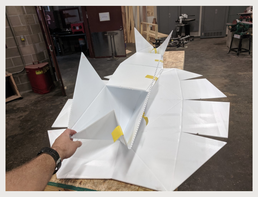
- Recent research postulates that both high-resolution and river-extent information are necessary to understand fundamental questions of river processes, such as patterns of critical habitat, sediment links, and river instability.
- As part of a larger NSF-funded research project, we have developed an 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)

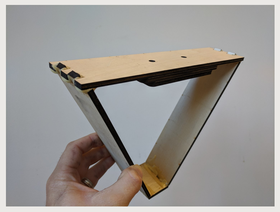
- The pontoons are cut and creased from a single sheet
- The final shape is ‘origami’ folded to provide a seamless surface below the waterline.

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 jet housings
- Controlled by 30 amp ESC and powered by two 20 Ah (20,000 mAh) 6-cell Lithium polymer batteries
- Steering accomplished with differential thrust



Sensors

Blue Robotic Ping Sonar
Single Beam Sonar

Water Depth, 0.4-30m
$279

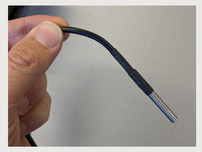
Humminbird Helix 5
Side-imaging Sonar

Water Depth and Bed Texture
$300

Maxbotix Ultrasonic
Distance Sensor

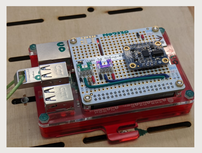
Water Surface
Elevations, $115
HRXL-MAXSONAR (MB7389)

Adafruit DS18B20

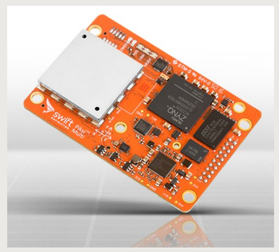


Waterproof Temp
Sensor, $10

Adafruit BNO055



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



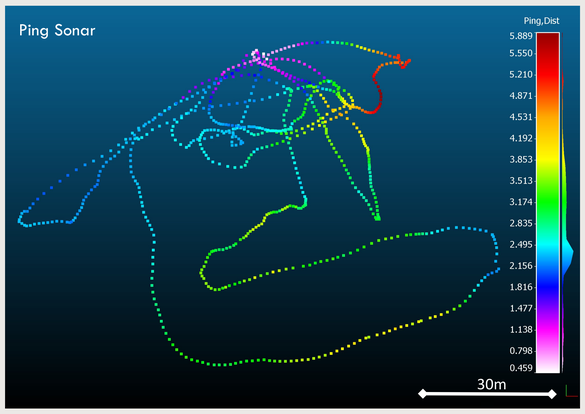
SwiftNav Piksi Multi
High-Precision GPS
RTK or PPK
≈$2000
(Base/Rover Pair)

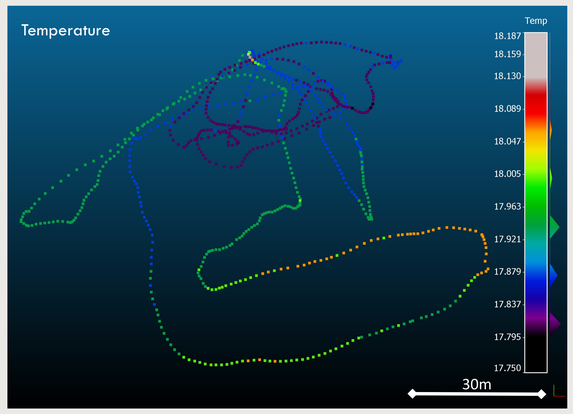
Raspberry Pi 3 B+
1.4GHz Cortex-A53, 1GB RAM, $35
HDMI 5" Touchscreen Display, $75

Custom Python-based data logging software for GPS and sensors.

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 April 2020 after our initial testing is completed

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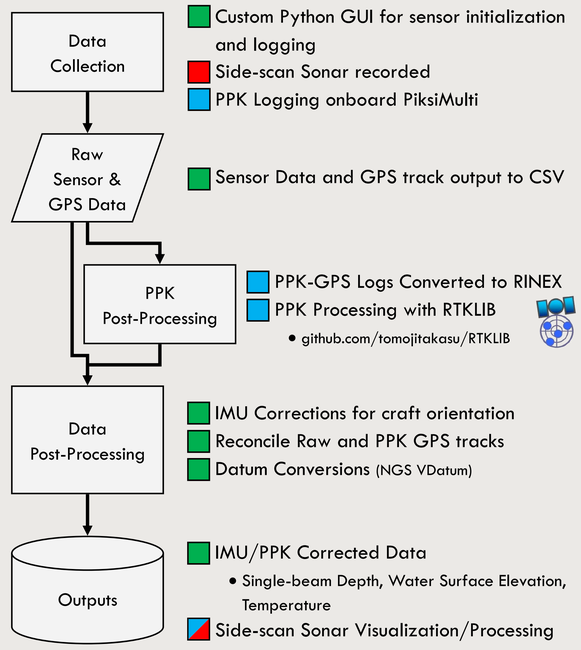
Workflow / Software

- 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