REMOTE RIVER WATER SAMPLING

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MECHANICAL TESTING

The device was tested to ensure three major constraints are met by the design:

1. The device pivots in the direction of water flow.
2. The device turns upright when lifted by the drone.
3. The device will break away if the weight exceeds the 2 lb limit for the drone.

To test this three types of water conditions were tested: still water, low flow and high flow. The device is lowered into the water in each condition and observed to ensure the three conditions are met. As of this point in the project, only the first two flow conditions were tested. The device met specifications and shows promise for future use. More testing will need to take place however.

STANDARDS & REGULATIONS

1. The drone must not exceed 400 ft above sea level for elevation.
2. The drone must remain within the visual line of sight of the pilot.
3. The drone's flight must not exceed a speed of 87 knots (100 mph groundspeed).

1. All sampling procedures must be thoroughly documented
2. All documentation must be sent to Region 8 of the EPA
3. Records of all changes and corrections to the procedures must also be documented and presented.

ASTM D3045 "Standard Practice for Heat Aging of Plastics without Load"

"ASTM D3045 is a standard practice for heat aging of plastics without load. It tests the exposure conditions to which plastics should be exposed to test their resistance to oxidation or other types of degradation occurring over time." (Micom Lab, 2019)

NEXT STEPS

The next steps for our project are:

1. SLA Printing of the prototype
2. Prototype testing with a drone
3. Prototype testing in the Verde River

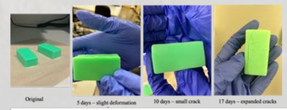
These steps would have been taken if we were able to be on campus working on the project, but they can also be taken by future students.

MATERIAL TESTING

The primary method of testing the degradation of the material is Accelerated Aging Testing per ASTM D3045

1. Accurate degradation rate calculation
2. Effective analysis what factors cause break down corrosion in this material

The test resulted in visible degradation at 17 days which is a simulated 9 months thus allowing us to conclude that the material would begin to safely degrade after 9 months submerged in the Verde River.



FUNCTIONAL REQUIREMENTS

REQUIREMENTS	VALUES	TESTING METHODS
Line length	25 feet	String Measurement
Weight	1.33 lbs apparatus	Weighing the complete system
Release Mechanism	2-3 lbs force	Force Testing
Material (non-contaminant)	Yes/No	Salt Spray Testing
No Swinging and Rotation	Yes/No	Multiple Sampling Trials on River
Size/Volume	115 mm x 65 mm x 165 mm	Printing Software

PRODUCT SPECIFICATIONS

Based off of functional requirements the product specifications were developed as follows. Four 25-foot long strings are connecting the drone and apparatus. With water and the apparatus the assembly weighs just under 1 lb. Four 1lb release lines give a desired breakaway force. The ECO resin is plant based and biodegradable from material testing. Four threaded eyelet connection points with four joints will minimize swinging and rotation. The apparatus assembles in two parts that are inside size constraints as well as the individual joints.

FUNCTIONAL REQUIREMENT	DESIGN SPECIFICATION
Distance from Drone	25 feet of string
Weight	1.67 lbs. For 2 sample apparatus
Release Mechanism	4 0.75 lbs. release rings
Material (non-contaminant)	Eco-friendly SLA resin
No Swinging and Rotation	4 string attachment points Joint halfway between drone and apparatus
Size/Volume	115 mm x 65 mm x 165 mm

JUSTIFICATION

The reason this device was needed was so that the research being done by the Verde River Institute could be done in a more efficient and easier manner. They study the contents of the water for a wide variety of reasons. This device will allow them to gather samples directly from the center of the river. Also, with the improvements made on their previous design it will help add a level of safety for their drone so it does not go down. The device will be made from eco-friendly resin on the SLA 3D printer purchased that will ensure that the device, if lost, will not introduce any harmful chemicals upon degradation to the ecosystem of the river.

RESOURCES

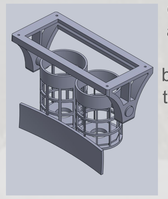
1. Drone Water Sampling 2-Vessel Rig. (2017, May 29). Retrieved from http://www.verderiverinstitute.org/WaterSampling/Water Sampling by Drone041317-1.pdf
2. Crawford, A. (2019). Grand Canyon University Project Proposal.
3. U.S. Department of the Interior, & U.S. Geological Survey. (2019, August 13). USGS Current Conditions for the Nation: USGS 09506000 VERDE RIVER NEAR CAMP VERDE, AZ. Retrieved from https://waterdata.usgs.gov/nwis/uv?site_no=09506000
4. Verde River. (2019, March 27). Retrieved from https://en.wikipedia.org/wiki/Verde_River.
5. Micom Inc. (2019). ASTM D3045 - Standard Practice for Heat Aging of Plastics Without Load. Retrieved January 25, 2020, from https://www.micomlab.com/micom-testing/astm-d3045/
6. Micom Lab. (1999). ASTM B117 Salt Spray Fog Test Offered at Micom Laboratories. Retrieved January 25, 2020, from https://www.micomlab.com/micom-testing/astm-b117/

PROJECT DESCRIPTION

This project was commissioned by the Verde River Institute and the Biology RDP. They wanted an improved version of their existing device for Remote River Water Sampling. Their original model was a homemade device consisting of PVC piping, bobbers, and breakaway rings. The Capstone group designed multiple iterations of a new sampling apparatus that tried different models. The original model was a linear shaped one that was similar to the one made by the RDP, which was then followed by a triangular model that was expected to provide stability and the ability to obtain a third water sample. The final design settled upon went back to a linear style that had two sampling container holders.

The final design has a rotating axis and fin that allows the sample jars to be angled facing upstream for the most efficient water collecting. The top of the device has a rectangular shape to provide stability. Then placed along the 25 foot length of string, there are four joints printed that will prevent excessive rotation so the device stays facing upstream and doesn't cause problems for the sampling.

FINAL DESIGN



A two sample apparatus was developed with minimal material and a fin to turn the sample upstream and keep samples sterile. The entire assembly weighs roughly 0.5 lbs when printed in PLA. The apparatus has four threaded eyelets to connect to the drone. Four joints separate the drone and apparatus to provide stability during flight. Four 1 foot fishing line made of 1 lb breakaway material is connected at the top to provide the pilot the ability to breakaway when wanted. The breakaway force must be larger than drone capacity to stop unwanted breakaways