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COS IW05 – Advisor: Dr. Alan Kaplan
Project Proposal

SAFE WATER

Motivation and Goal

Water is life. It is a universally known fact that humans need water to survive, yet the task of finding clean water to drink is, even today, a tough one for many, especially for those without regular access to resources and survivors of natural disasters. During the notorious Flint Water Crisis in 2014, the town's decision to switch their water source to the Flint River led to lead contamination in the citizens' drinking water. In the aftermaths of Hurricane Maria in Puerto Rico, only 63.2% of the population had access to clean water.[1] The goal of my project is to make the task of analyzing water content and determining its safety more efficient. With a mobile device that could diagnose the potability of water samples, users wouldn't need to worry about the water they are drinking, not only in emergency situations but also in situations where they need to find their own drinking water, such as extended hiking/backpacking trips.

Problem Background and Related Work

I have found three projects that have attempted to address this issue. The first is a research project at the University of Illinois, titled "Cellphone-Based Portable Bacteria Pre-Concentrating Microfluidic Sensor and Impedance Sensing System."[2] The authors of this paper designed a sensor that detects bacteria in water samples, which is connected to an Arduino which relays this information wirelessly to a smartphone. This project is very similar to my approach; however, the limitations are that it can only sense bacteria, and will be unable to detect other chemical impurities in the water. The second is a product called TestDrop by Lishtot, an Israeli company that builds water quality testing devices.[3] The TestDrop claims to be able to determine the potability of water by just pointing the device at it, without any direct contact, and is able to connect to a smartphone. However, there have been no studies published that demonstrate the accuracy of the device, and it doesn't provide the user with detailed statistics on the quality and content of the water. The last is Riffle, an open source water monitoring project on Public Lab.[4] Part of Public Lab's Open Water Project, the Riffle involves an Arduino-compatible datalogger with several designs for sensing different water quality parameters. However, the Riffle board only logs data to an SD card without any wireless capability, and lacks the versatility of an actual Arduino to read data from several sensors at once.

Approach

My project will address all the limitations of the two related projects, by prototyping a cheap, comprehensive device that, when paired with a smartphone, will analyze water samples based on

[1] https://www.telesurtv.net/english/news/Puerto-Ricans-Drinking-Water-from-Hazard-Sites-Due-to-Crisis-20171014-0001.html
[2] https://arxiv.org/pdf/1312.0329.pdf
[3] https://www.lishtot.com/TestDrop-Pro.html
[4] https://publiclab.org/wiki/riffle

several different parameters, and make a conclusive diagnosis on whether or not it is drinkable. On the hardware side, I plan to use a Bluno, a variant of the Arduino Uno with integrated Bluetooth, paired with several sensors from DFRobot, an open source hardware provider.[5] The sensors measure temperature, turbidity, pH, ORP (Oxygen-Reduction Potential), and conductivity. The device will relay readings from these five sensors to a smartphone app, which will display the readings and its diagnosis. On the software side, I plan to use the React Native framework (which conveniently allows deployment to both Android and iOS) for frontend, Google Firebase as a backend, and Bluetooth to connect to the Arduino. In addition, the app will implement a crowdsourcing feature, where users can report their results to a map (possibly using Google API), which will display local water quality statistics based on location.

Plan

The first step in this approach is to acquire materials, and build the device. All of the hardware is available online and can be shipped. Next, I will have to develop an algorithm to make a yes-or-no diagnostic based on the five measured parameters. To do this, I will have to look into the range of values for each parameter that are acceptable for clean water.

Timeline:

- Week 1 (10/1) – finalize and submit proposal
- Week 2 (10/8) – submit funding proposal, purchase materials
- Week 3 (10/15) – build device
- Week 4 (10/22) – start programming device to take measurements
- FALL BREAK (10/27 – 11/4)
- Week 5 (11/5) – finish programming device
- Week 6 (11/12) – develop diagnosis algorithm
- THANKSGIVING BREAK (11/20 – 11/25)
- Week 7 (11/26) – start programming mobile app
- Week 8 (12/3) – finish programming mobile app, submit oral presentation
- Week 9 (12/10) – run evaluation tests, start writing final report
- WINTER BREAK (12/14 – 1/6)
- Week 10 (1/7) – submit final report and poster

Evaluation

Evaluating my project is simple; I will test it on many different water samples from different sources, such as tap water, filtered water, salt water, rain water, water from Lake Carnegie, etc. Corner cases could include non-water liquids such as alcohol, urine, and vinegar. To test specific parameter measurements, I would add a known amount of contaminants to a water sample and test its accuracy. In evaluating my measurements and algorithm, I will have to take into account the accuracy ranges of the sensors. While many rounds of fine tuning and improvements will certainly be necessary, simply put: if my device outputs “safe” for clearly potable liquids and “unsafe” for non-potable liquids, then my project would be a success.

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[5] https://www.dfrobot.com/