Water Filter Device for Crowdsourcing Water Quality Control

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ABSTRACT

Recent research suggests that crowdsourcing water quality control might be viable and beneficial, not only for improving data collection and access, but for engaging and educating local communities, helping citizens make informed decisions that affect the local water in positive ways. *World Bank* has published "Crowdsourcing Water Quality Data : A Conceptual Framework" [1], containing a proposal on how this might be achieved, as well as detailing a pilot program. The framework leaves room for plenty of opportunities for innovative technology to facilitate this mission. In this paper we present a design that we will argue fits well into the aforementioned framework. We have designed *Droplet*: a water quality sensor that connects to an ordinary PET-bottle as well as a smartphone to make crowdsourcing water quality data easier and more engaging.

INTRODUCTION

Contaminated drinking water remains as one of the most dominant human health hazards in the world. While millions of people have gained access to quality drinking water over the last few decades, there are also trends going in the opposite direction, with water sources being subjected to pollution from industrial discharge, lacking sanitary infrastructure as well as unsustainable agricultural practises.

One key measure in solving water quality issues is dependable quality monitoring. To manage water quality, we must first have a method to measure it and we must understand what it is we are measuring. This is a problem especially in areas lacking infrastructure and resources for reliable testing and data logging. Traditional water quality testing requires expensive laboratory equipment as well as specialists proficient with testing procedures and protocols, making widespread testing very hard to accomplish. However, recent technological developments in sensors are making it possible to design accurate, affordable and portable testing equipment [2]. There are even methods being developed for testing water for bacterial contamination in only 10 minutes [4]. These trends together lead toward the opening up of entirely new design spaces for tackling the quality monitoring problem.

The idea of crowdsourcing water quality testing has been examined by the World Bank [1] as recently as 2016, and with promising results. The method suggested combined crowdsourcing with citizen science, defined as "the practice of public participation and collaboration in scientific research to increase scientific knowledge" [5], to empower citizens by both participation in the scientific process as well as increasing knowledge and understanding of their local water supply. Involving and informing the public offers many benefits, both in the long and the short term. [5]

The technology that enables this kind of project will then need to account for data collection as well as logging and transmission. The technology needs to be as portable and cheap as possible, as well as usable for a wide range of people. Inspired by this problem space, we designed Droplet.

OUR IDEA

Droplet is a combination of a water filter and a water quality meter, designed for use together with a smartphone. It is designed specifically with crowdsourcing water quality data in mind. Using Droplet as a water filter simply involves filling up a PET bottle with the water you want to filter, attaching Droplet in place of the cap, and finally squeezing the bottle with your hand to dispense the filtered water. The ingenuity of Droplet is that while filtering the water it simultaneously takes a series of measurements on the water, both before and after filtering. Using a

smartphone equipped with the Droplet App, the user will be given a tour of the measurement results. Most importantly, the app will be able to inform the user whether the water should be considered of drinking quality, but it will also show what result the filtering process had on the water. The data is also put into a broader context of test results from other users in the area, showing how the user's test compares to others'. One of the most interesting possibilities with the app is to be able to educate the user on how the water might have picked up its constituent parts. Having access to both geographical location of testing, water measurements and a wider context of previous tests, it will be possible to give the user a quite sophisticated analysis of the data. This might for instance inform the user about local geographic features affecting the water, seasonal causes, pollution and contamination caused by human activity et.c.

The fact that Droplet serves a practical purpose besides data collection — it being equipped with a water filter to produce water of drinking quality — is a feature with the ulterior motive of piquing the user's interest and getting them more engaged with the water from their local water source. Using the mobile application to educate users about the particularities of their local water as well as the efficacy of the filter adds another dimension of interaction, which according to [1] is an important part of empowering the public as viewed within the paradigm of Citizen Science.

MODULAR DESIGN

Droplet is designed for use together with a standard PET-bottle, in place of its regular cap. The bottle serves the purpose of water container, holding the water that is to be tested and/or filtered. This way the Droplet stays portable, as long as you are able to get a hold of an empty PET-bottle. It makes the production of Droplet less resource demanding and makes it trivial to change a leaking or dirtied bottle.
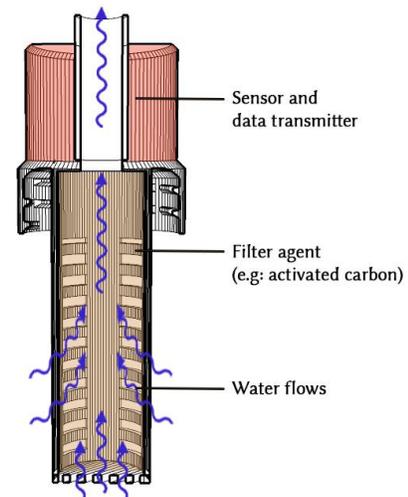
SENSOR CAPABILITIES

Droplet is equipped with sensors to measure a variety of different water parameters. In our prototype we have considered measuring TDS, total dissolved solids, pH, conductivity, as well as some chemical pollutants. There is however a lot of promising research in the area, perhaps even enabling small enough sensors capable of detecting bacterial contamination without the need for culturing in a laboratory setting. [4]

SMARTPHONE COUPLING

Droplets portable design is made possible because it is only responsible for collecting data and forwarding it to a smartphone. The Smartphone is responsible for data processing, analysis and further transmission. Using the GPS of the smartphone we can associate the measurement data with a geographical location. We believe that designing IoT devices intended for use together with a

smartphone is an effective way of reducing resource needs and facilitating a lean design.

WATER FILTER

We have prototyped Droplet with a simple water filter using activated carbon as a filtering agent. This filter design can most definitely be improved upon, and also varied according to the particular needs of the user. The characteristics of a particular watercourse dictate the needs for different filters.

MOBILE APPLICATION AND INTERACTION

To use the application, users simply connect the device to the smartphone and input a passcode that is written on the device. The passcode allows user to connect with unique Droplet devices and secure the authentication step. The main view after the authentication step is the report view where all the numbers for water quality parameters are displayed. The report also includes the history of water quality in the same area. This feature allows user to collect periodical information about water quality in one location.
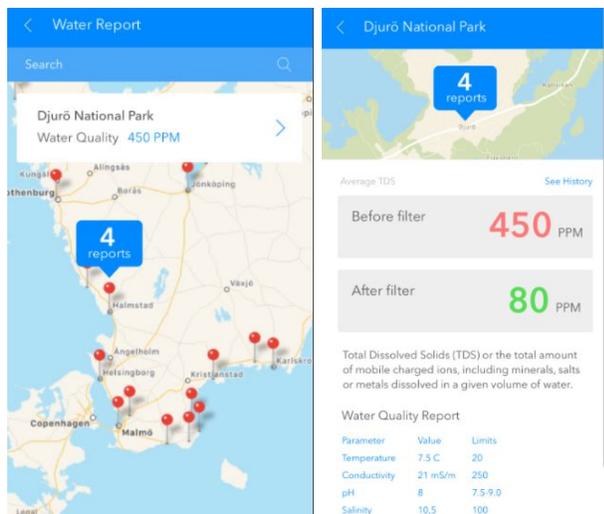
Figure 1. The map displays information about water quality report from all Droplet's users

Another feature is to see all of the water quality reports based on the location. A screen with a map will be shown so that the user could explore the water quality report in all locations that have been accessed by Droplet's user.

IN CONCLUSION

The combination of water filter and water quality meter enables Droplet as a supporting device for water quality data crowdsourcing. An assembly of sensors technology and mobile app, Droplet allows the community to engage in collecting water quality data at the same time get the benefit of accessing clean water through a portable and easy to use device.

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