SIMPLE ELECTRICAL WATER TESTER

School Name: Skyline High School
Grade Level: 11th Grade
State: Utah
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Problem Statement:

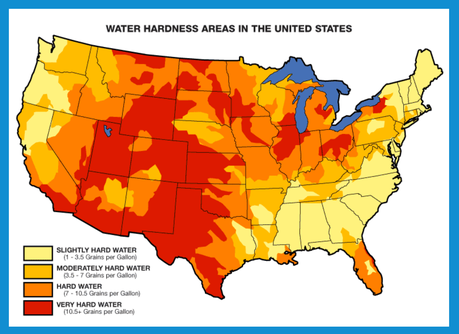
Our project will help people all over the world, but our target audience are those living in states that get their water from sources that violate the Environmental Protection Agency's (EPA's) Safe Drinking Water Act. They currently don't have proper access to reliable clean water and providing them with our device will allow them to check their water purity while also bringing attention to the issue at hand. The goal of our project is to solve water inequity in our world by allowing everyone to be informed about their water quality and to bring awareness to disparity.

Objective:

Our goal with this design is to have cheaper alternatives to expensive single-use water testers. Market priced water testers can go up to $100 while ours is a low $42 multi-use tester. This brings down the barrier of lower income families that want to be safe. Also allows these individuals to more easily access information about their own water quality to determine whether or not to take action. Furthermore, a simple interface and usability is a requirement to allow for more users to be able to pick up the device and use it easily, without having to learn anything new.

User Requirements:

Our prospective clients are people in low-income places around the world who have contaminated water and need to check their water on a frequent basis. Our prototype meets these needs better than what is currently available in the market because not only is it cheaper than most commercial water purity testers currently available, it can be used hundreds of times without needing to replace parts. This saves not only money for the consumer but also the environment since many of the cheaper products on the market are use and throw. Our product can also be shared within a community to check water purity in multiple homes, effectively identifying persisting problems so that the proper authorities can be informed and the problem can be solved.



Design Process:

Initial Research:

In order to determine a suitable design, first research needed to be performed to learn about what characteristics are used to measure the quality of water. It was determined that total dissolved solids (TDS), acidity/alkalinity (pH), temperature, and turbidity.

Design:

The initial design was to connect all the sensors that were required into a single integrated system. This was chosen to be accomplished using the Arduino MEGA 2650 due to its excellent choice of I/O for prototyping. To tie everything together for the end user, a touch screen was chosen to allow for easier accessibility for the end user to reduce the entry level learning curve. Specific sensors were chosen due to their functionality and their low cost, keeping the overall manufacturing costs low if the final product were to be mass produced.

Build Iterations:

The first build iteration was a test of the sensors and the display. This would allow for the basis of the code to be written for the sensors individually for testing and calibration. The design was very basic, being built on protoboard to allow for quick troubleshooting.

The second build iteration saw the introduction of an SD card for increased usability for logging data. A companion desktop application was developed to read and present the data from the SD card log, along with direct connection to the device.

The third build iteration saw the construction of the waterproof housing and mounting of the used modules. A 3D printed bracket was used to mount all the harware, as this allowed for a solid prototype to be constructed, along with easier functionality when testing one of its main features, portability.

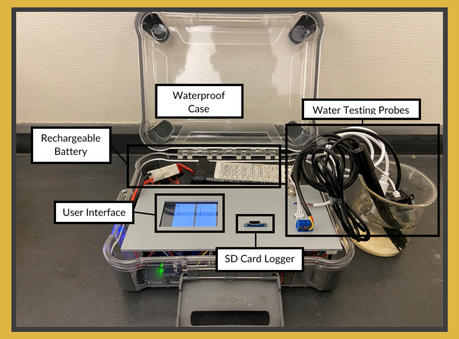
Testing and Revision:

At each stage, the main functionality of the sensors was prioritized, as this was essential for the projects success. If the circuit was unable to function, a new revision was not allowed to proceed until the issue was resolved. The secondary objective of each revision was to improve the end user's experience, so the addition of an SD card logger along with a portable sturdy case were optimal design choices.

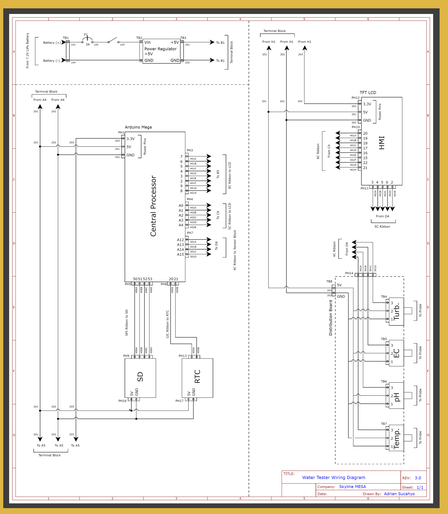
Further Improvement

Further iterations of this design would be to optimize a printed circuit board (pcb) for production models, along with a fully custom case. This can be done by 3D printing custom prototype cases for rapid testing, and pcbs can be manufactured in small quantity.

PROTOTYPE

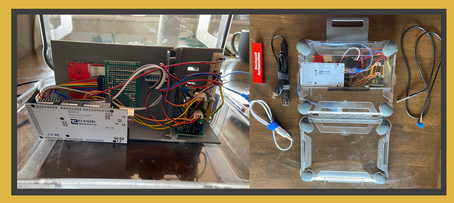


Above: Labeled Diagram of Prototype Water Tester revision 3
Right: Wiring Diagram of Prototype Water Tester revision 3



Overview

The latest revision includes the following
- The ability to log data onto an SD card for data processing.
- The ability to measure different characteristics of water, including pH, TDS, Turbidity, and Temperature.
- Wired direct connectivity to a desktop application to directly interface with the data collection.
- Easy to use touchscreen to allow for easy interface with the functionalities of the device.
- Portability in a waterproof and sturdy container for ease of use in wider locations.
- Rechargeable batteries to reduce the amount of E-waste produced from single use batteries.
- Easily replaced low cost sensor probes to allow for an extended working lifetime.

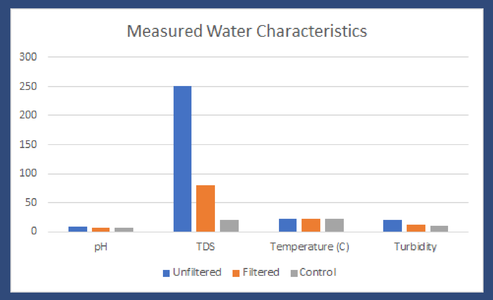


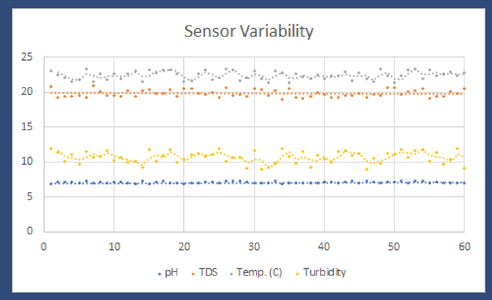
Above: Internal Wiring of Water Tester revision 3

Testing

Testing of the sensors was a necessary test to ensure the functionality of the device. The latest revision (rev. 3) was tested using 3 different samples of water, to make sure that it could detect a difference between them. The three selected samples came from two different residences, one with a recently installed water filtration system, along with another that does not have one installed. To act as a baseline, distilled water was used as it has the highest purity. The results are reported on the right.

Another test that was used was to test the drift of the sensors, and how noisy the data was. The test was performed with the control over a period of 60 seconds.





Conclusion:

In conclusion, building a cheap and affordable water tester will give families with lower incomes gives them the chance to test their waters without having to spending their money on expensive single-use products . We had some minor drawbacks with quick fixes such as the turbidity failing to operate after water managed to get in the system. Our successes included having the code and materials able to calibrate the pH levels correctly, and making the device easily portable. Some next steps we could take would possibly be making a mobile app to further simply the measurements given by the device. Further steps would be to design more production ready units that are easily manufactured and cost effective to produce and to sell.

Results:

We found results that were overall very similar when compared to data using other methods, and thus were confirmed to be accurate, however our way of collecting data is more efficient. Overall, we found that the prototype improves user capability as it provides a user interface that allows for quick assess to vital information on levels of temp, pH, turbidity, and TDS in the water samples. The prototype also utilizes an SD card for efficient data storage. The user's experience will also greatly be changed because they will no longer need to use multiple devices and systems to monitor and collect data through tedious methods. With the prototype data collection for multiple factors is simple and efficient.