Adaptive and Accessible Data Acquisition for Platform-independent Water Quality Monitoring

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Background

Globally, according to the CDC, more than "3.6 billion people, nearly half the world's population, do not have access to safely managed sanitation in their home," (CDC 2022). As a direct result, improperly managed sanitation commonly results in cross contamination between sewage and drinking water sources, causing more than 829,000 deaths per year (Prüss-Ustün et al., 2019). Sources of pollution such as improperly managed agriculture runoff and illegal dumping of organic waste also contribute to the depletion of freshwater, often causing adverse health effects such as cancer and serving as a vector for water-borne diseases (U.S. Department of Health and Human Services 2012). Coupled with more than "2 billion people [already lacking] access to safely managed drinking water," global water insecurity is a pressing issue that requires immediate attention (CDC 2022).

Even in the face of continued technological development and advances in purification technologies, water insecurity continues to be a global issue. One root cause is the lack of economic resources and accessible monitoring technologies. Even though the water may be clear and appear "clean", many harmful contaminants require sensor sampling. When examining the human development index, there is a direct "link between HDI and capacity for water quality monitoring," as countries that tend to lack the financial resources to facilitate effective monitoring of water quality are also more affected by water-insecurity (Kirschke et al.).

Research Questions

- To what degree do sensor manufacturers obfuscate or intentionally make their communication protocol hard to adapt to new platforms?
- Is it possible to design an intermediate module that can consolidate sensor data into a single dashboard, thus replacing the need for more costly data acquisition units?
- Electrical current outputs may not be a linear curve in relation to the concentration of the substance/ion being measured, how effective would developing a quadratic/exponential model aid in accurate sensor readings?

Experimental Setup

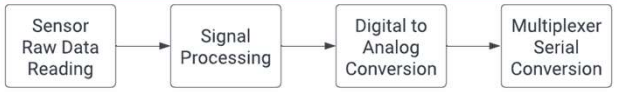
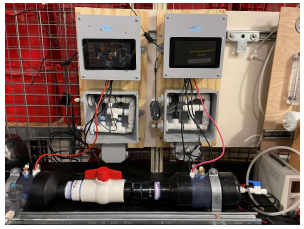


Figure 1. Data acquisition and processing pipeline for platform-independent water quality monitoring



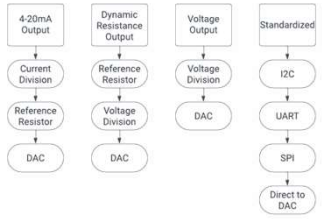


Figure 2a (left). Sensor array used for testing data acquisition into the NI LabView dashboard

Figure 2b (right). Data type to circuit processing pipeline

Technical Challenges

- Sourcing SoC that met technical requirements (ongoing)
- Acquiring components throughout the course of experimentation
- Microcontroller clock rate and interrupt artifacts
- Sensor polling issues

Results

- Viability of modularity involved within the circuit processing pipeline
- Little to no accuracy concerns as a result of conversion process
- Significant loss of precision for sensors demanding a high range of measured values (stemming from the DAC resolution)
- Further work will focus on improving signal processing and adapting signal processing pipeline to a wider array of sensors

Citations

CDC. "Global WASH Fast Facts ." *Centers for Disease Control and Prevention*, 31 May 2022, www.cdc.gov/healthywater/global/wash_statistics.html.

Kirschke, Sabrina, et al. "Capacity Challenges in Water Quality Monitoring: Understanding the Role of Human Development." *Environmental Monitoring and Assessment*, vol. 192, no. 5, 19 Apr. 2020, https://doi.org/10.1007/s10661-020-8224-3.

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Prüss-Ustün, Annette, et al. "Burden of Disease from Inadequate Water, Sanitation and Hygiene for Selected Adverse Health Outcomes: An Updated Analysis with a Focus on Low- and Middle-Income Countries." *International Journal of Hygiene and Environmental Health*, vol. 222, no. 5, June 2019, pp. 765–777, www.sciencedirect.com/science/article/pii/S1438463919310484, https://doi.org/10.1016/j.ijheh.2019.05.004.

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