POSTER COMPETITION FINALIST

Leveraging Smart Technology to Address Water Quality Challenges: Transforming Turbidity Measurement for Safer Water Access

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Introduction

- We developed and piloted a low-cost (<$5) turbidimeter comprised of a graduated cylinder and water-proof, high-contrast sticker, used in conjunction with a mobile phone camera and ImageJ, an open-source, image-processing software tool, to approximate turbidity using two different methods: gray value difference and circularity.
- Community scientists can use this technology to monitor surface water or as an early warning for well damage or surface-water intrusion.

Turbidity

Turbidity measures water opacity. [1]

- Can reflect biological, chemical, and physical conditions[2]

Traditional turbidity measurements (turbidimeters, secchi disks) can be costly, cumbersome, and complex

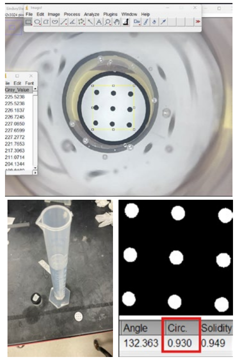
Turbidity values[3]:

- Drinking water- usually < 1 NTU (visual detection limit)
- Surface water- ranges from > 1 NTU to >100+ NTU depending on environmental conditions

Image J

ImageJ is a free, open-source image processing software developed by the National Institutes of Health. [4]

ImageJ used to analyze pixel data, determining maximum and minimum gray values (top image) and average circularity for high-contrast stickers (bottom right image)



Methods

- 4000 NTU Formazin was used to perform serial dilution of seven points ranging 0.1 to 100 NTU.
- Expected values were measured using the HANNA HI 98703 Portable Turbidimeter.
- An iPhone 12 was used to capture images of 100 mL samples in a plastic graduated cylinder, with a high-contrast sticker featuring nine equidistant 0.06-inch diameter dots placed on a washer at the bottom of the cylinder.
- Triplicate images were imported into ImageJ, where they were cropped to focus solely on the dots (region of interest) minimizing outside light interference.
- The images were analyzed in ImageJ to generate list of pixel gray values and calculate the average circularity.
- Data compiled and graphed via Excel.

Discussion

- The method achieved quantitation above 1 NTU.
- The standard curve based on gray value difference (R^2 = 0.9504) showed a stronger correlation than the one based on circularity (R^2 = 0.775), suggesting that gray value analysis may be more reliable for turbidity estimation.
- Further efforts will seek to improve sensitivity and automate image analysis.
- Next steps will involve field validation, in which we plan to assess the system's performance using water samples with unknown turbidity.

Preliminary Results

Logistic Relationship between ImageJ Analyzed Cell Phone Image and Known Turbidity Values Using Gray Value Difference

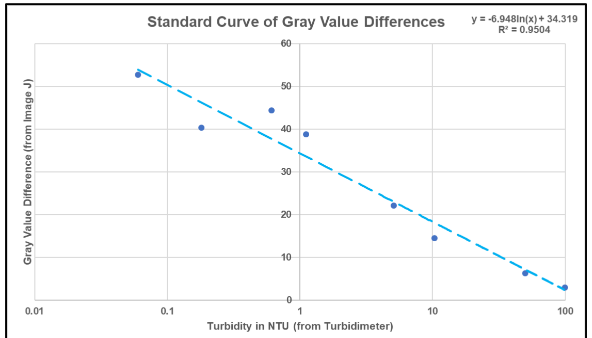


Figure 1. Standard curve showing the gray value difference (maximum - minimum) from ImageJ analysis for triplicate laboratory trials. R^2 value = 0.9504.

Logistic Relationship between ImageJ Analyzed Cell Phone Image and Known Turbidity Values Using Circularity Values

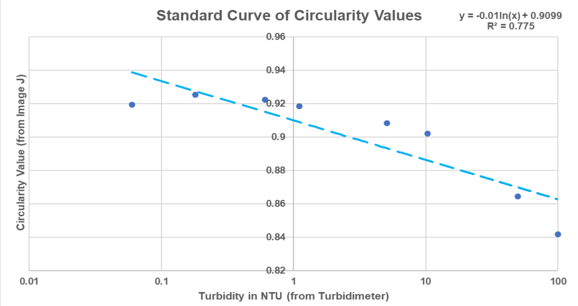


Figure 2. Standard curve showing the circularity values from ImageJ analysis for triplicate laboratory trials. R^2 value = 0.775.

References

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3. Kitchener BG, Wainwright J, Parsons AJ. A review of the principles of turbidity measurement. *Progress in Physical Geography: Earth and Environment*. 2017;41(5):620-642. doi:10.1177/0309133317726540
4. ImageJ. https://imagej.net/ij/

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