Open-source, In-field Android and iOS Detection and Mapping of Waterborne Diseases via Time-Based Spectroscopic Sensing and RGB Luminance with a New 3D Printable Optical Interface

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An interesting dilemma in today's society is that even in the most underdeveloped nations, there is an unprecedented, widespread access to smartphones. Adapting the increasing technological capabilities of smartphones to novel scientific applications is necessary, and in this project, a cross-platform spectrophotometric/colorimetric smartphone system has been created to detect bacteria in water. Both the iOS and Android detectors are incredibly low cost compared to traditional lab grade spectrometers, and possess a number of unique advantages, such as their portability and the ability to instantly upload data from the smartphone to a public water quality map. For the Android spectrometer, an optical system was created using a series of lenses and the phone's flashlight as the light source. Over time, the ambient light sensor tracks the change in absorbance through the water sample--as bacteria grows in the water, it causes it to become more turid and thus scatter and reflect more light. Using pre-integrated calibration curves, the Android spectrometer can detect bacteria to within 5% of lab-based spectrometer measurement. The iOS device serves a similar purpose, but uses colorimetry instead of spectroscopy. The phone's front facing camera is used, with RGB to luminance algorithm that convert RGB values to relative light intensity on each pixel. A continuous video shot off the phone's rear-facing camera is automatically fed into a Python script for analysis. On each frame, a normalized white-value is calculated for a user defined aperture, which can then be graphed against absorbance. The iOS colorimeter similarly falls within 5% error of the Android spectrometer and the Lambda 2 lab-grade spectrometer.