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Abstract

Rapid, Portable, and Low-Cost Water Quality Assessment Device Based on Machine Learning †

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Abstract: Water quality has a significant impact on public health. Inadequate water conditions are associated with diseases such as cholera, dysentery (shigella), hepatitis, and typhoid fever. Established techniques like Membrane Filtration (MF), Multiple Tube Fermentation (MTF), and enzyme-based defined substrate technology (DST) assays are used tomonitor bacteriological water quality, measuring indicators like *Enterococcus faecalis* (*E. faecalis*), *Escherichia coli* (*E. coli*), and total coliforms. Despite their high sensitivity and specificity, these methods take 24 to 48 h to produce results, as well as requiring access to laboratory facilities, specialized equipment, sample preparation steps, and trained personnel. This study presents a portable and low-cost UV-LED/RGB water quality sensor which includes a microfluidic device, a fluorogenic defined substrate assay for the detection of E. faecalis, RGB sensors for fluorescent data acquisition, ultraviolet-light-emitting diode (UV-LED) for sample excitation, a portable incubation system, and embedded systems for data storage and processing. The microfluidic device has a number of independent wells used to carry out Most Probable Number (MPN) analysis for bacteria quantification. The device is pre-loaded with the defined substrate assay and is self-loading when immersed in the target water sample for sample-preparation-free analysis. RGB sensors detect fluorescence from each well to automate the MPN results. Results from fluorescence-versus-time curves are used to generate a comprehensive database. Machine learning (ML) algorithms and real-time RGB data are used to predict whether each individual well will be positive or negative using only the first three hours of fluorescent data. Coupled with MPN, this method significantly reduces the timeframe of bacteria detection and quantification, making it a cost-effective and efficient solution for on-the-go water quality monitoring, addressing critical public health concerns, and underscoring the importance of swift and reliable water quality assessments.

Keywords: machine learning; microfluidic devices

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