Development and Real-time Monitoring of an AI-Integrated UV Water Filter for School-Based Microbial Decontamination

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Abstract:

Access to safe drinking water in schools is essential for student health, yet microbial contamination in public fountains remains a widespread and underaddressed problem. Existing filtration technologies are often optimized for chemical contaminants such as lead or chlorine but do little to eliminate harmful bacteria and viruses. In this study, we developed and tested a

low-cost, 3D-printed water filter that combines ultraviolet (UV) disinfection with sensor data that is analyzed using AI to create readable statistics for school administrators to monitor the cleanliness of water real-time. Water samples collected from multiple metro-Atlanta schools

were assayed for microbial content, including opportunistic pathogens and antibiotic resistance genes. The filter was designed to incorporate a UV-C light source (LED) to eliminate microbial contamination. Additionally, embedded sensors were linked to a custom neural network for

continuous assessment of water quality. The results showed that the filtration system achieved over 95% reduction in bacterial concentration while maintaining feasible flow rates for school use. The AI model demonstrated relatively high accuracy in predicting contamination severity and provided continuous and interpretable risk scores for the end users (school). This approach offers a potential, novel solution to improve water safety and improve public health.

Keywords:

Microbial contamination, Waterborne pathogens, Antibiotic resistance genes (ARGs), UV disinfection technology, Photolysis in water treatment, Advanced water filtration, Membrane filtration dynamics, Hollow fiber membrane filters, AI-based water quality monitoring.