Developing Cellulosic Biocomposites for Water Purification and Smartphone-based Analysis

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This interdisciplinary study employs a novel computer vision algorithm with a cellulosic biocomposite for the rapid classification and elimination of water contaminants. In-lab water diagnoses are currently expensive, time-consuming and inaccessible to many rural communities. However, the ubiquity of smartphone technology provides a powerful platform for water analytics. A biocomposite was engineered to filter various contaminants whilst retaining water samples for analysis with a smartphone camera system. A random forest (RF) computer vision approach was designed to categorize image features to generate a probability map. K-means clustering grouped similar pixels and a secondary RF validated different cell regions for species identification. After training, the algorithm identified heavy-metals and individual bacterial species within seconds with 90.16% accuracy. Biocomposite filtration through a sample with a surface area of 265cm2 removed 2,671 parts per billion (ppb) of Pb(II), 2,234 ppb of Ni(II), 96% of bacteria and 100% of solid particulates; initial exposure to biocomposite casein resulted in 100% coliform bacterial inactivation within the filtrate in 10 minutes. This study develops a novel, rapid and accessible system for field-analysis, mapping global water quality and purifying water in developed and developing countries.

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