A Novel Multiparameter Optical Sensor Using CMOS Imagining and Remote Neural Networks for Microbial Analysis

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The multiparameter CMOS optical sensor developed in this research utilizes visual parameters to determine the existence of microbial forms in water samples. Though current PCR and bacterial growth procedures exist for water quality analysis, with over 2.5 billion individuals without access to adequate sanitation in 2016, an accessible low-cost methodology for microbial analysis remains to be developed for widespread use. Current pixel classification techniques allow for the segmentation of images and an ease of classification based on relational data within images. This novel prototype represents the first design to successfully deliver an accurate application of neural networks and image recognition to identify and categorize microbial particles using a CMOS camera. The design provides localized identification of contrasting particles against a glass surface, sourcing images from glass cell suspensions. Following the classification of the images, the data is entered into an artificial neural network trained through a gradient descent optimizer, with the intelligent selection of weights allowing for future images to be classified according to the training set. Results correlated strongly with microbial and abiotic particle counts. The final model tested at a speed of acquisition of approximately 10 minutes per sample, identifying homogeneous particle suspensions at 90 ± 5% accuracy and mixed type suspensions at 95 ± 5% accuracy at 1.5x10^2 particles/mL for single particles to colonies of 1x10^6 - 5x10^6 particles/mL.