

Community-Wide Rapid Detection of Pathogenic Microbes Using Low-Cost Digital in-line Holographic Microscopy in Microbial Fuel Cells

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When diagnosing the presence of pathogenic microbes, direct imaging of live microbes in situ even in a drop of liquid is very challenging as they move and spread out in the entire volume. Digital in-line Holographic Microscopy (DIHM) is employed to directly image and reconstruct moving particles in a sample. Although this method eliminates the need for toxic stains and fluorescent labeling needed in standard microbial imaging, the reconstruction requires substantial computational resources making it prohibitive for routine use. The key idea of this project is to realize a cost-effective and easy to use method for imaging live microbes in situ with substantially reduced computational resources. This is accomplished first by coaxing most bacteria in the sample to one surface and then performing DIHM in a small volume close to this surface. The first step of coaxing the microbes to a surface is achieved by designing, constructing and demonstrating low-cost microbial fuel cells (MFC) capable of detecting bacterial load in <1 mL water sample under a minute. This MFC features (i) flexible low-cost foam construction material (ii) novel carbon anode for bacterial attachment as well as providing food (Potassium Acetate) and thermal (Magnesium Sulfate) gradients for faster colonization by anaerobic bacteria (iii) low-cost PDMS (Polydimethylsiloxane) based Proton Exchange Membrane (PEM). Next DIHM was demonstrated on a glass slide mimicking an MFC. HoloPy, a free Python-based tool is employed to reconstruct images from holograms obtained using a smartphone camera. The technique can be further improved and deployed community-wide to collect and recognize harmful microbes. Such low-cost solution will be extremely helpful during floods or other calamities.