Advanced Computational Microscopy, Cytometry and Sensing Platforms for Battlefield Medicine

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At a Glance

What it is

- Advanced Computational Microscopy, Cytometry and Sensing Platforms for Battlefield Medicine are rugged, field-portable devices for conducting analysis of water, blood, or other body fluids in remote locations.

How it works

- Incoherent lens-free digital holography, compressive sampling theory as well as nano-patterned substrates are used to create microscopy-equivalent devices, without the use of any lenses or other bulky optical components
- To attain high-resolution analysis of dense specimens, multiple lens-free intensity measurements are captured at a different heights from the detector-array
- Sophisticated image reconstruction and pattern recognition algorithms are used to reconstruct and interpret the acquired digital images
- Compact, COTS platforms such as cell-phones and laptops are modified to allow minimally processed sample introduction, analysis, and (if needed) image transmission from remote locations to medical centers.

What it will achieve

- This technology will provide new capabilities to rapidly conduct various biomedical tests, e.g., blood analysis in the field (including differential cell counts and platelet counts) or to specifically and sensitively screen for various pathogens/bacteria (e.g., Escherichia coli, Cryptosporidium) in bodily fluids, food or water using compact, light-weight and cost-effective designs.

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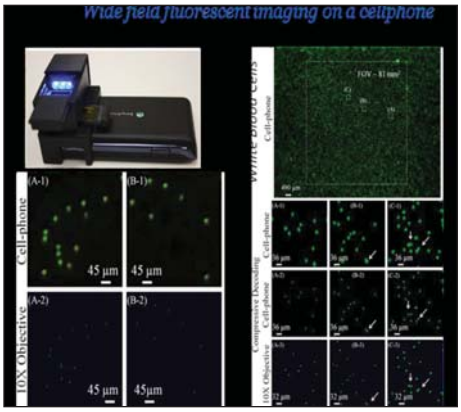
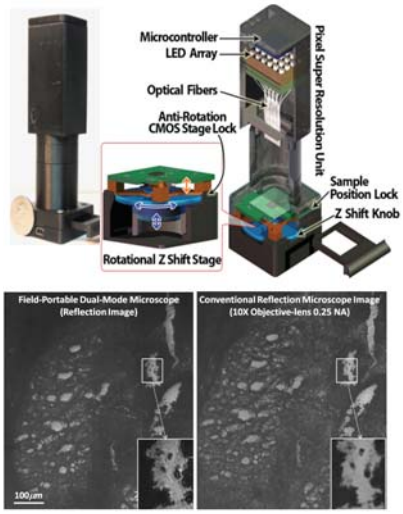
The Office of Naval Research (ONR) focuses on support of science and technology to enable new biomedical capabilities for use in austere settings. Rugged, miniaturized tools for far-forward diagnosis of infections, or contaminated food and water may save lives in both battlefield and humanitarian aid/disaster relief (HADR) scenarios.



- **Wide-field Fluorescent Imaging On a Cell Phone:** By adding a compact attachment to the existing camera unit of a cellphone, a 20-fold larger field of view (relative to a conventional microscope) can be imaged in fluorescent mode. Fluorescent tagging agents are added to the sample if the specimen is not naturally fluorescent. The images to the right shows a parasite (Giardia lamblia) often found in contaminated water, and labeled white blood cells. The cell-phone images compare well with conventional microscopy images.



- **Holographic Imaging of Dense Samples (e.g., tissue):** Densely packed or 'connected' cells present special challenges for imaging. The solution has been to acquire holographic images from various heights with respect to the sample, in reflection mode. A holographic imaging 'tower' has been design to attach to a cell-phone, enabling high-resolution of features in dense samples. New data analysis and processing algorithms allow image reconstruction which is comparable to that obtained with a conventional microscope, as shown with skin samples to the left. These advances may allow remote diagnosis of diseases, infections of food contamination.
- **Digital Holographic Imaging** offers a new, compact and rugged method for analyzing biomedical and other samples in remote locations which compares will with fragile, lens-based microscopies. Integration with a cell-phone platform allows transmission of images to experts located elsewhere for analysis. The impact of this technology is expected to be dramatic, especially in third-world countries where access to sophisticated medical facilities is limited.

Research Challenges and Opportunities:

- Acquiring sample images from densely packed biological samples (e.g., whole blood), with minimal sample processing
- Developing methods and algorithms to allow features of grossly different size and concentration (e.g. viruses, bacteria, protozoa, and blood cells) to be simultaneously imaged and analyzed