Washington University in St. Louis
Office of Technology Management

LIGHTWEIGHT, WEARABLE CAP FOR BEDSIDE FUNCTIONAL OPTICAL NEUROIMAGING

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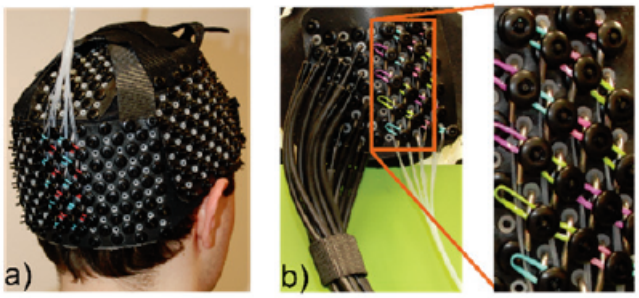
Technology Description

Researchers in Prof. Joseph Culver's laboratory have developed a patented, compact, lightweight functional neuroimaging device for long-term bedside monitoring. This technology, based on high-density diffuse optical tomography (HD-DOT), could be used as a surrogate for functional MRI (fMRI) while offering more portability, particularly in critical care settings.

Real-time longitudinal functional brain imaging has great potential as a clinical tool to assay the brain and inform therapy. For example, real-time readouts of functional connectivity (FC) can detect adverse clinically-induced brain ischemia during cardiac bypass surgery. The current gold standard for mapping functional connectivity, functional magnetic resonance imaging (fMRI), is incompatible with use in the OR or ICU due to both the logistics and cost. Functional near infrared spectroscopy (fNIRS) is more compatible with bedside applications, and new diffuse optical tomography approaches to fNIRS systems can provide improved image quality sufficient for FC mapping. Still, the full head DOT systems rely on large expensive electronics and, due to fiber coupling, are not wearable. The inventors have developed miniaturized opto-electronics that enable a wearable high-density DOT (WHD-DOT) system for use in ambulances, emergency rooms, operating rooms, and neurointensive care.



Stage of Research

Initial studies by the inventor demonstrated high density diffuse optical tomography (HD-DOT) with 15mm resolution sufficient for localizing brain hemodynamics to specific gyri (*Nature Photonics*). Using a portable (100 lb) but not wearable HD-DOT they have demonstrated feasibility of tracking cognitive deficits in acute stroke subjects (under review). Most recently they have built miniaturized opto-electronic modules that will enable a wearable (<2 lb) HD-DOT system (as part of NIH BRAIN initiative grant).

Applications

- **Functional neuroimaging** – bedside optical imaging in critical care or operating room environment with end-user applications such as stroke monitoring or functional assessment for patients with Parkinson's

disease

Key Advantages

- **Compact, lightweight and wearable**:
  - reduces weight to ~2lb by developing high performance miniaturized optoelectronics.
  - enables long-term continuous or frequent bedside monitoring in critical settings
- **High spatial resolution and wide field of view –** high density source and detectors provide near fMRI sensitivity with full head coverage mapping of distributed brain functions
- **Compatible with electronic implants –** DOT avoids the electro-magnetic safety concerns of MRI, therefore it can be used for patients with electronic implants such as pacemakers, cochlear implants or deep brain stimulation

Publications

- Eggebrecht AT, Ferradal SL, Robichaux-Viehoever A, Hassanpour MS, Dehghani H, Snyder AZ, Hershey T, Culver JP. Mapping distributed brain function and networks with diffuse optical tomography. *Nat Photonics.* 2014 Jun;8(6):448-454.
- Burke B, Sherafati A, Burns-Yocum T, Ferradal S, … Eggebrecht A. Bedside Diffuse Optical Tomography of Disrupted Brain Connectivity During Acute Stroke. Pre-print at *ResearchSquare*.
- Optical brain scanner goes where other brain scanners can't, *theSource*, May 19, 2014.

Patents: US 10,786,156; US 9,480,425; US 16/947,829; US 16/286,194

Related Web Links: Culver Profile and Culver Lab

Related Video: https://source.wustl.edu/2021/01/brain-signals-decoded-to-determine-what-a-person-sees/