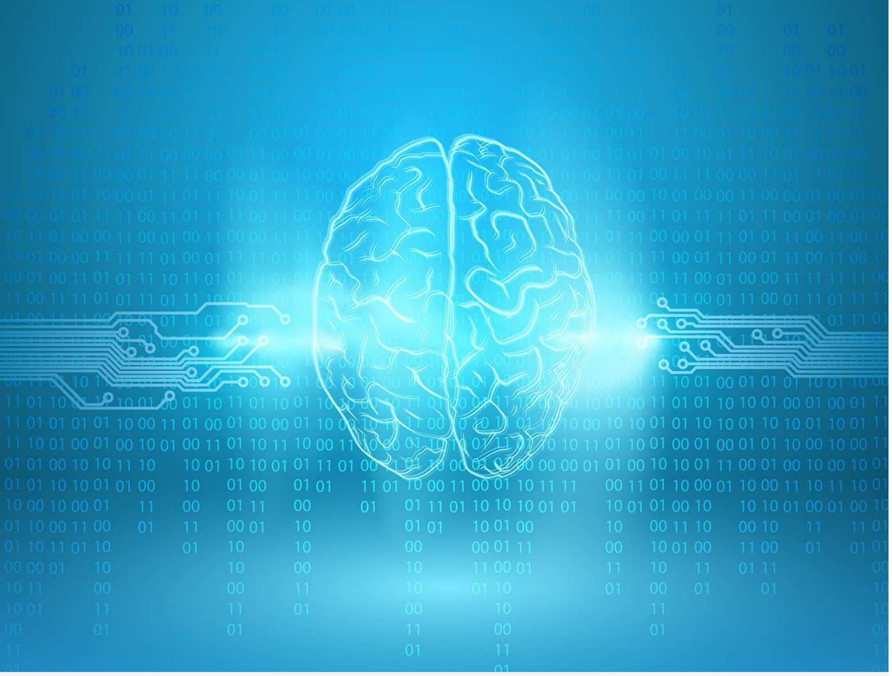


National Aeronautics and Space Administration

technology solution

Health, Medicine and Biotechnology

Functional Near-Infrared Spectroscopy (fNIRS) Cognitive Brain Monitor

New signal-processing techniques excludes motion artifacts to yield more accurate data

Innovators at NASA's Glenn Research Center have developed a Functional Near-Infrared Spectroscopy (fNIRS) Cognitive Brain Monitor with improved signal processing to obtain more accurate data. fNIRS has been used successfully to monitor cognitive states and activity, and Glenn's system can be used to continuously monitor brain function during safety-critical tasks, such as flying an airplane or driving a train. Using head-worn sensors, the technique employs near-infrared light and advanced signal processing to allow real-time, in-task monitoring. The system not only determines changes in cognitive state by tracking blood hemoglobin levels in the brain, but also filters non-relevant artifacts, such as the probes' own motion, rendering the collected data even more accurate. Glenn's novel use and refinement of fNIRS signals stands to improve safety in a wide variety of applications and environments.

BENEFITS

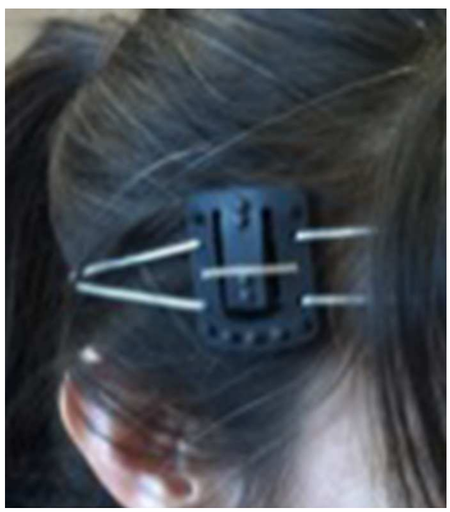
- Improved safety: Continuous monitoring of brain activity during safety-critical tasks could prevent serious accidents
- High accuracy: Removing motion artifacts allows real-world data capture to approach laboratory quality
- Portability: The system features comfortable head-worn sensors, and is compact enough to fit into smaller spaces

THE TECHNOLOGY

Functional near-infrared spectroscopy (fNIRS) is an emerging hemodynamic neuroimaging brain-computer interface (BCI) technology that indirectly measures neuronal activity in the brain's cortex via neuro-vascular coupling. fNIRS works by quantifying hemoglobin-concentration changes in the brain based on optical intensity measurements, measuring the same hemodynamic changes as functional magnetic resonance imaging (fMRI). With enough probes in enough locations, fNIRS can detect these hemodynamic activations across the subject's entire head, thus allowing the determination of cognitive state through the use of pattern classification. fNIRS systems offer low-power, low-cost, highly mobile alternatives for real-time monitoring in safety-critical situations.

Glenn's specific contribution to this field is the algorithms capable of removing motion artifacts (environment- or equipment-induced errors) from the device's head-worn optical sensors. In other words, Glenn's adaptive filter can determine the presence of a potential motion artifact based on a phase shift in the data measured; identify the artifact by examining the correlation between the phase shift and changes in hemoglobin concentration; and finally remove the artifact using Kalman filtering whenever changes in hemoglobin level and changes in the phase shift are not correlated. Glenn's breakthrough allows the advantages of fNIRS to be used for non-invasive real-time brain monitoring applications in motion-filled environments that could potentially save lives.

Glenn's system can be used to continuously monitor brain function during safety-critical tasks, such as flying an airplane



Glenn's innovation keeps motion artifacts from interfering with the data collected by the monitors head-worn sensors (pictured)

APPLICATIONS

The technology has several potential applications:

- Safety simulations, training, and monitoring for airline pilots, train and mass transit engineers, ship captains, truck drivers, crane and other heavy-equipment operators, and air traffic controllers
- Military simulations and training
- In-home, real-time monitoring and feedback during patient rehabilitation for cognitive impairment or depression
- Replacement for or supplement to functional brain imaging

PUBLICATIONS

Patent Pending

More Information

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NP-2015-04-1502-HQ

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LEW-18952-1