Table II. Physiological Measures That Can be Extracted from NIRS Sensing.[2]

SYSTEM	MEASURE	INDICATION
Cardiopulmonary	Heart rate, heart rate variability	Hypoxia, dehydration, stress, anxiety
Hemodynamic Response	Cerebral blood flow velocity, blood oxygenation	Workload, attention, hypoxia, dehydration
Respiration	Respiratory rate	Hypoxia, anxiety
Brain Activity	Spatial and temporal information about brain activation	Arousal, workload, attention, hypoxia, dehydration

Not only must this potential operational fNIRS system address the cognitive and physiological multistate assessment previously mentioned, but an operational fNIRS system must also solve problems with sensor placement, movement artifacts, and environmental impacts to data quality (e.g., sunlight). Although there are many signal processing and analysis approaches that can be used to clean data signals, there is no substitute for clean data, and such methods often require significant computational resources for online operation. The form factor of the hardware has a significant impact on the signal quality and is generally the biggest challenge preventing the use of fNIRS in operational environments[5]. The primary sources of noise impacting the collection of fNIRS signals are: 1) motion of the light source and optodes, which causes disruption or fluctuation in the signal detected; and 2) individual differences in skin tone, hair color, and head shape, which cause variations in the quality of signal. These challenges can be addressed in the form factor of the design, placement of sensors, noise attenuation strategies, and, when necessary, machine learning or auto-preprocessing of data.

As indicated by Adamovsky et al.,[1] there is a need for an operational fNIRS system that satisfies the constraints typically faced in applied settings. Fortunately, the Defense Health Agency recently awarded a new Small Business Technology Transfer grant (DHA STTR 19B-001) to support the development of such a system. Performers on this project will explore the viability of an operational aerospace fNIRS system by evaluating form fit, sensors, data cleaning and processing, and multistate detection as outlined in this article. Furthermore, advanced techniques like hyperscanning and neurofeedback will be considered for their applicability in an aerospace environment for activities involving training, crew planning, flight performance, and many other potential areas of interest that are yet to be determined.

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