Fully Reconfigurable Modular Body-Worn Sensors

A breakthrough technology invented by researchers at the University of Memphis is the first to allow fully modular and rapidly reconfigurable sensor networks to reduce cost and increase patient-centric care options. This patent-pending technology is available for exclusive licensing.

Applications

- Fully modular body-worn sensor networks including any type of body-worn sensors (EEG, EKG, SPO2, others)
- Physiological monitoring requiring fast and customizable sensor deployment
- Homecare monitoring
- Vitality, cardiac, and neurological monitoring

Advantages

- Modular hardware design allows sensors for each type of monitoring system to be added or removed from the network in Lego®-like fashion, i.e., "snap-on" style sensors.
- Upgrade or redesign hardware of each sensor type without complete system redesign.
- Lower long-term costs for healthcare customers while assuring your company is the sole vendor of disposables for all sensing modes supported by the system.
- Clinicians and first responders will have the flexibility to customize sensor arrays in response to changing clinical needs without changing platforms.
- Sensor and central nodes can perform some real-time processing of sensor data and send notification and alerts to user smart devices.
- Data processing can be dynamically reconfigured to adapt to the varying requirements of the natural environment.
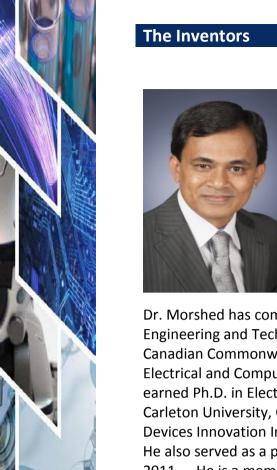
The Technology

In traditional sensor network architectures, neurological and physiological data collection and processing devices are disjointed and overly customized for specific signals. While they are highly optimized for specific applications, they do not allow fully reconfigurable architecture. This becomes even more problematic for bioelectric signals, as in Electroencephalography (EEG) and Electrocardiography (ECG/EKG), which require driven right leg (DRL) circuit which prohibits modularization.

This novel technology is a sensor-level modular and fully-reconfigurable EEG system along with other body-worn sensors that will allow Lego®-like connectivity of multimodal sensors on the body. This is achieved by elimination of the DRL circuit from the traditional EEG (and ECG) circuit design with a new analog front end design that is independent for each channel. Consequentially, this technology will enable a system in which the number of EEG channel can be one or many, independent of the design, and can be customized at the time of deployment in a Lego®-Like fashion. Such a system can incorporate any type of body-worn sensors (both neurological and physiological sensors) through microcontroller equipped sensor nodes (connected with wire or wirelessly) with the network comprised of a Central Node. Additionally, the Sensor Nodes can be utilized to perform some computation on the local sensor data, such as removal of artifacts and calculation of events of interest that will enable distributed intelligence. Central Node can communicate with the user smart device for data logging, notifications, as well as alerts via Bluetooth. The outcomes will greatly enhance capabilities of neurological and physiological data collection of natural environments.

Technology Development Status
We have demonstrated that (1) Noise analysis without DRL degraded only up to 2dB at 60 Hz using a prototype AFE for a single-channel EEG signal. (2) An I2C wired network for 5 homogenous sensor nodes s has been functionally verified with a 100 kbps bus (upgradeable to 400 kbps) with lower-power microcontrollers at each node. Sensor nodes collected EEG signals at 512 sps, and central node aggregated these data, in addition to status enquiries and message broadcasting for ADC synchronization at sensor nodes. Low-power long-duration operation, and communication with smart phone via Bluetooth.

The Inventors

Bashir I. Morshed, Ph.D., a Canadian Commonwealth Fellow and Director of ESARP lab, is a tenure-track faculty member at the Department of Electrical and Computer Engineering, Herff College of Engineering, the University of Memphis. His primary research area is embedded systems with the applications focused towards biomedical devices. His current research interest focuses on wearable embedded devices for medical application specifically targeting disorder patients.

Dr. Morshed has completed B.Sc. in Electrical Engineering from Bangladesh University of Engineering and Technology, Dhaka, Bangladesh in 2001. Awarded the prestigious Canadian Commonwealth Fellowship, he completed M.A.Sc. in 2004 at the Department of Electrical and Computer Engineering, the University of Windsor, Windsor, Canada. He earned Ph.D. in Electrical and Computer Engineering from the Department of Electronics, Carleton University, Ottawa, Canada in 2010. He was a post-doctoral fellow at the Medical Devices Innovation Institute (MDI2) of the University of Ottawa, Ottawa, Canada till 2011. He also served as a part-time faculty at Algonquin College, Ottawa, Canada from 2009 to 2011. He is a member of The University of Memphis faculty since 2011.

Ruhi Mahajan Ms. Mahajan earned the Bachelor of Technology in Control and Instrumentation Engineering from Punjab Technical University, Punjab, India in 2006, the Master of Technology in Control and Instrumentation Engineering from Dr.B.R. Ambedkar National Institute of Technology, Punjab, India in 2009 and is currently pursuing the Ph.D. at the Department of Electrical and Computer Engineering, the University of Memphis under the direction of Dr. Morshed.

Her experience includes signal processing domain and design, verification, testing of development boards for biomedical applications. Her areas of interest includes bionics, body-worn sensor system, biomedical signal processing and BCI applications.