HUMAN-COMPUTER INTERACTION RESEARCH AT THE GSU BRAINLAB

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The overall goal of the GSU BrainLab is to determine the most effective paradigms of human-computer interaction for direct control of a computer using brain signals. Our central research focus is on applying brain-computer interface (BCI) technologies to real-world problems. We aim to provide significant quality-of-life improvement to users with severe disabilities as well as studying ways of utilizing brain-computer interfaces for everyone. The BrainLab currently has ongoing projects in several BCI and assistive technology areas:

New User Interface Control Paradigms

The aim of this research is to explore the human-computer interaction field to determine possibilities for alternate paradigms of brain signal control (in addition to proportional 2-D spatial navigation such as a mouse emulator). We are studying several approaches, including hysteretic ("nudge and shove" thresholding) control, which allows several control signals to be generated from a continuous neural signal. We have also collaborated with researchers from Georgia Tech to adapt 2-D spatial interfaces to serialized interfaces, which can be then neurally controlled. We adapted several applications, including a web browser, for serialized access. We are also studying logical vs. proportional control to improve speed and accuracy of BCI control.

BrainTrainer - Subject Training

The BrainTrainer project is researching the most effective ways of teaching a person to control brain signals in order to interact with a device. The BrainTrainer toolset allows trials to be composed, providing simple tasks such as targeting, navigation, selection, and timing that can be combined to produce an appropriate-level task for a particular subject. It also allows the researcher to incorporate different forms of biofeedback (visual, auditory, and haptic). BrainTrainer automatically instruments the resulting application for data recording such as error rates, speed, and accuracy of task performance. We are working with Neil Squire Foundation to determine the atomic tasks, benchmarks, and standardized data formats that BrainTrainer will support.

Neural Art - Biofeedback

The Neural Art project is exploring different methods of representing brain signals, both for biofeedback and training purposes, and for creative expression and recreation. The Neural Music program we have developed translates brain signal and brain signal patterns directly to MIDI, allowing for a tonal representation of the signal. This has been tested in offline analysis with brain signal recordings and is currently being ported to allow real-time presentation of the auditory data. We also implemented a signal visualizer, which allows the signal to be represented graphically according to configurable signal characteristics.

Quality of Life Applications

· Neural Internet - We have developed a neurally-controlled web browser that serializes the spatial

internet interface and allows logical control of a web application. We have also developed a neurally-controlled email program that accompanies the web browser, allowing neural signals patients to send and receive written communications from the internet.

· Aware 'Chair - The "Aware 'Chair" is a context-aware intelligent power wheelchair which integrates environmental control, communication, and multilevel prediction based on context and user history. The communication and environmental control systems are informed by environmental sensors, user history, time of day, medical status and other information in order to predictively narrow the selection space, thereby improving user performance. We are currently adapting the Aware 'Chair for neural control, working with UC Berkeley to incorporate their prediction algorithms.

Collaborations

The GSU BrainLab currently enjoys active collaborations with researchers at the Wadsworth Center, Neil Squire Foundation, Georgia Institute of Technology, and the University of California at Berkeley. Our funding sponsors include the National Science Foundation, the National Institutes of Health, DARPA, and Georgia State University.