Enhanced Visualizations for Improved Real-Time EEG Monitoring

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An electroencephalogram, or EEG, is used to monitor the electrical activity in the brain through electrodes placed on the scalp. An EEG is a multi-channel time-varying signal describing voltages in different regions on the scalp, measured using electrodes. EEG recordings are interpreted using a montage, which defines the channels as differences between these electrodes. AutoEEG is a system that automatically interprets clinical EEGs and includes a variety of analytics that can be used to detect the onset of life-altering events such as seizures.

The goal of this project was to restructure the demonstration system for AutoEEG so that visualizations of new analytics can be easily integrated. The demonstration system for AutoEEG is a graphical interface which provides a wrapper for the detection technology and offers visualizations for the signals. The features of the demonstration system include: generation of time-aligned markers that indicate significant events within the signals; a graphical display implemented in the popular Qt framework that allows users to interactively view and manipulate signals; the ability to search for important EEG events such as seizures, PLEDs and GPEDs; and a portable implementation that runs across all platforms supported by the Python programming language.

There are significant advantages to this upgrade. Clinical neurology is a field that continues to change, and alternate ways of viewing EEG data (i.e. spectrograms) are becoming more accepted. Being able to keep up with popular visualization techniques helps to make the demonstration system more useful in a clinical context, and the ability to easily add these views makes the software more maintainable. We can easily add new analytics such as parameter trending, frequency tracking and new event classification algorithms.

Enhancements to the demonstration system described in this work include the following: integration of customizable and resource-efficient energy and spectrogram displays that make it easier to detect transient events such as seizures; a user-accessible view switching method to show or hide groups of plotting widgets; simplified class structure to allow for easier implementation of new plotting methods; and an integrated preferences window allowing users to set program parameters.

The architecture of the application window was changed significantly to accommodate mixed views. The original main window that showed all of the channels together with overlaid colored annotations was maintained since this view has significant legacy value. To accommodate the other views, a Qt object called a stacked widget (QStackedWidget) was used to separate the plotting area into "pages." The stacked widget shows one page at a time, and the page switching is triggered by changing the selected view. The default page consists of the original waveform view, while the secondary page handles the mixed plotting view. In the case of the mixed view, a scrolling area was implemented to make sure the user can see all of the channels. Within this scrolling area, there are labeled channel containers which hold the combinations of the plotting visualizations for each channel. To manipulate the plotting widgets, a dictionary was used to reference the plotting widgets. Functions can easily be performed on all widgets of a certain type. This approach to manipulating the widgets makes switching views very efficient and provides a nice way to manipulate all of the channel widgets.

New visualizations of EEG data are useful in a clinical context because they can provide valuable information that is not readily apparent from the waveform alone. This is especially true for continuous EEG (cEEG) monitoring because it allows neurologists to pinpoint areas of concern over long periods of time. A demonstration of our tool will be provided at the symposium.

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1. Research reported in this publication was supported by the National Human Genome Research Institute of the National Institutes of Health under Award Number U01HG008468.
2. Research reported in this publication was supported by the Temple University Honors Program's Merit Scholar Stipend Program.