Listening to the Blink of an Eye:

Testing that Sonification of EEGs can Lead to the Recognition and Classification of Types of Brain Activity

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Background

Electroencephalograms (EEGs) monitor brain activity, comparing differences in surface voltages. The analysis and display of EEGs for visual analysis is ubiquitous. When one can understand a normal EEG, then identifying abnormalities and better understanding how the brain works follows.

Recent work indicates that auditory analysis may also be useful in detecting irregularities in EEGs. Because brain waves consist of frequencies inaudible to the human ear, it is necessary to use digital signal processing techniques to convert the signals to sound without losing valuable information. The analysis of EEG signals will help in the detection of abnormal EEG signals to better understand the human brain.

Methods

An EEG from patient one, a normal patient, was analyzed in order to find a blink artifact, which occurs at about 80 seconds. The window observed was seventeen seconds and includes the blink artifact followed by alpha rhythms.

Using EDF browser electrodes from the frontal, occipital and parietal regions were selected. These raw signals were read into MATLAB, combined using the Double Banana montage, and then a Butterworth filter was applied to remove noise.

The signals were then resampled and used to modulate others in the auditory range; namely, A3, E6, and C6 creating a chord. A sound file was created that was read into a digital audio workstation for further analysis and playback.

References

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Trevisan, Adrian A., and Lewis Jones. "A Low-end Device to Convert EEG Waves to Music." 128th Convention of the Audio Engineering Society. Audio Engineering Society, London, UK. New York: Journal of the Audio Engineering Society, 2010. Print.

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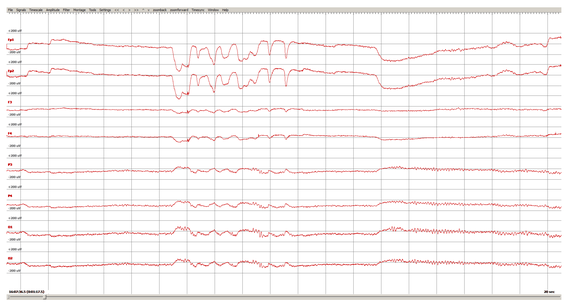
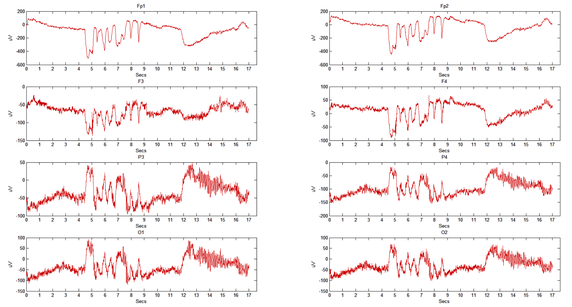
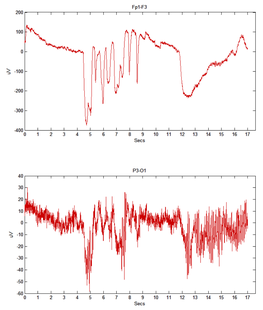
Data and Results

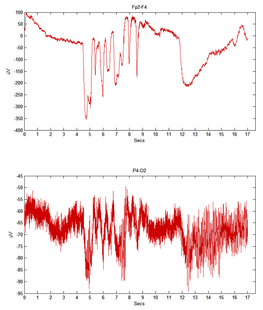


Raw Data Using a Referential Montage in EDFbrowser

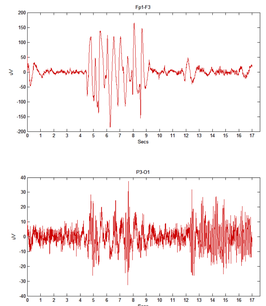


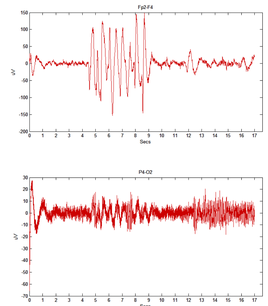
Raw Data Using a Referential Montage in MATLAB



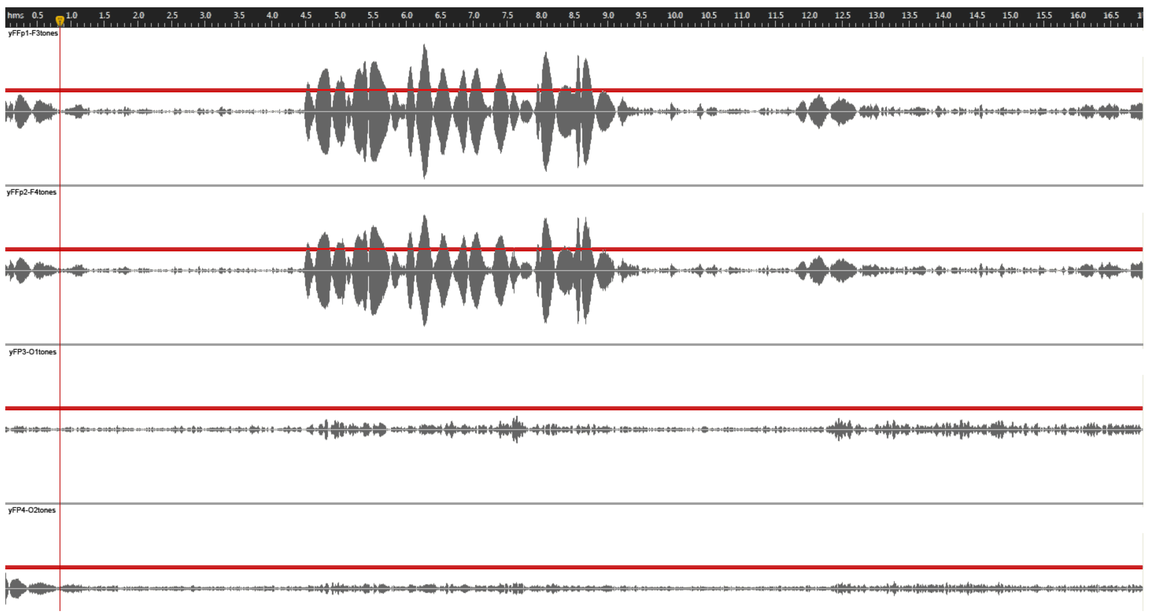


Raw Data Using a Bipolar Montage in MATLAB





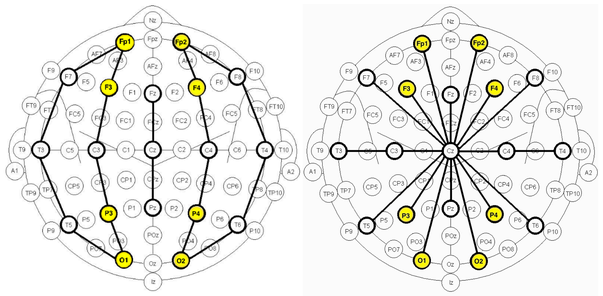
Butterworth Filter Applied in MATLAB



Blink of an Eye Converted to A-E-C Chord Using Adobe Audition Recording Software

Abstract

Ten patient Electroencephalogram (EEG) recordings were selected from a study conducted at a Lubbock hospital. These recordings include 8 normal and 2 abnormal EEGs, which were stripped of personal identifying information. Recent publications indicate that sonification (converting data to sound) allows the human ear to analyze series data and detect irregularities that might otherwise go unnoticed. Since brain rhythms are typically lower than the human hearing range, signal-processing techniques, including but not limited to modulation, Fourier transforms, wavelet analysis, and digital filtering, will be applied to convert EEGs to sound. Our objective is to demonstrate that in addition to traditional visual analysis, auditory acuity may be useful in the analysis of EEGs and aid in the early detection of abnormal EEG activity. The project will be a success if an algorithmic approach to sonification leads to the identification of important features of the EEGs by listening to the transformed signals.



Bipolar montage (left) and Referential montage (right) with primary electrodes highlighted that were used to create sound file

Conclusion

Although the blinking of an eye is visually an easily detectable artifact in an EEG, it is now possible to detect blinks and to determine whether the eye is open or closed simply by listening to the appropriate EEG channels.

As this research progresses, this study hopes to go beyond listening to and assessing blinking towards the analysis of other situations; for example, the detection of various types of seizures. Hopefully, this insight about brain signals will be helpful in the early detection of abnormalities.

By sonifying EEG signals it appears that new insight into EEG analysis is possible.