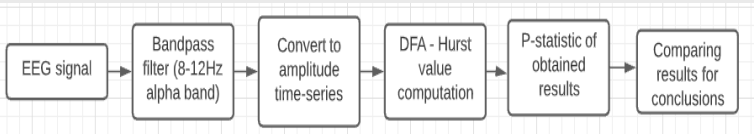
Investigating EEG Signals of Autistic Individuals using Detrended Fluctuation Analysis

Abstract

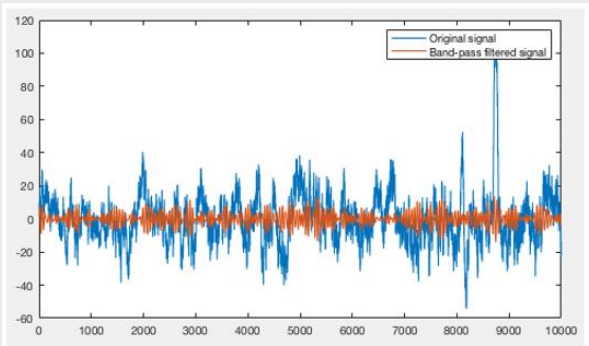
Autistic behaviours are hard to distinguish, varying from mild impairments, to intensive interruption in daily life. The non-linear signals using EEG arising from various lobes of the brain have been studied with the help of a robust technique called Detrended Fluctuation Analysis (DFA). Here, we study the EEG signals of Typically Developing (TD) and children with Autism Spectrum Disorder (ASD) using DFA. The Hurst exponents, which are the outputs of DFA, are used to find out the strength of self-similarity in the signals. Our analysis works towards finding better diagnostic at early ages to prevent and help children with ASD.

Methodology

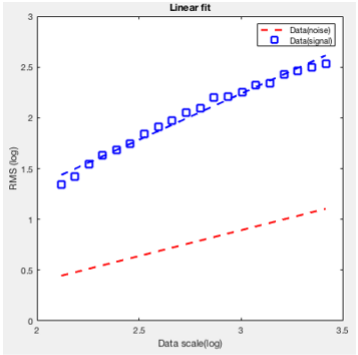
The EEG signal is first passed through a band pass filter to extract the alpha band, after which it is converted to an amplitude time-series form using Hilbert Transforms. DFA is performed on this signal and the obtained results are statistically inferred. Permutation-based statistical methods were used for analysis.



Procedure and Graphs



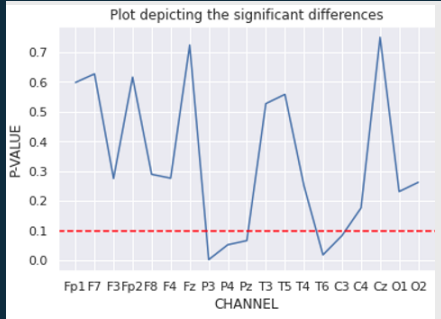
Original (blue) and bandpass filtered signals (orange) superimposed for comparison.



Sample of the linear fit of the log scales and the log RMS for both the signal and the random noise input. Slope of the linear fit of the signal gives the value of the Hurst parameter. Here, the observed fit is for the Fz electrode of a TD child, H = 0.9069.

Once the amplitude time-series signals are obtained, DFA is performed on the signal. The obtained RMS values are plotted on a log domain versus the log scales to get the linear fit. Its slope gives us the Hurst Exponent.

Results and Graphs



Plot depicting the p-value for all the channels. Red line marks the 0.1 threshold.

Amongst all the 5 channels which showed significant importance with p-values below 0.1, the C3 channel with p = 0.08, showed a 71% accuracy while differentiating between TD children and children with ASD.

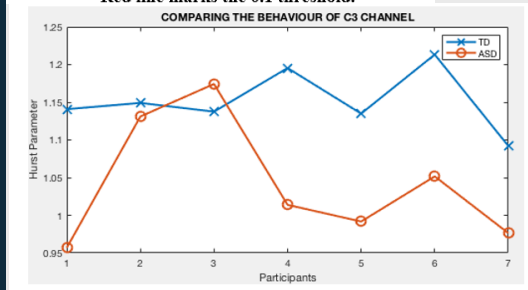


Fig.10: The C3 channel (p=0.08) showed the highest accuracy while differentiating, amongst all other channels that had p-statistic values < 0.1.

Conclusions

While the Hurst exponent can tell us about the strength of positive auto-correlation of a signal very well, it is quite specific to the signal being analysed and the activity being performed by the individuals thus helping us distinguish further.