Estimation of Cortical and Cortico-Muscular Neural Connectivity and Non-Linear Interactions using a Non-Parametric Implementation of Mutual Information

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Among various diseases of human body, neurological diseases are difficult to detect, manage and diagnose in the world of neuro-science. Over the past few decades, neurologists and researchers are progressing in detecting and diagnosing of neurological disorders. Various advanced technologies like electroencephalography and magnetoencephalography (EEG/MEG) assist the researchers to understand the undefined underlying pathological process.

By studying the relationship between cortical areas or interaction between two neurons aids in detection and diagnosis of the diseases. The neurologists examine the information transmission over the two areas. In this dissertation, estimating cortical connectivity and cortico- muscular connectivity using non-parametric methods to understand the information transmission. Many traditional methods such coherence and spectral density utilized to study linear interactions or properties. However, exploring non-linear properties with non-coordinate system would be challenging with traditional methods.

In this study, non-parametric implementation of mutual information utilized to estimate cortical connectivity and cortico-muscular connectivity and cross-validated against magnitude squared coherence. With Trinity Bio-medical Sciences neurological data, the EEG(C3,C4) and EMG(FDI) channels are employed to estimate the connectivity.
With density approximation method, mutual information is calculated and one of the distance metrics used in this study is Euclidean distance. Cross-mutual information theory is applied with time -lag ranging from 0 to 256 as per sample rate to understand the non-linear interaction between channels.

Cross-validated against bin-based approach and spectral coherence to study frequencies bands and estimate the connectivity. Alpha band is excluded because of volume conduction. This study might be helpful in assisting neurologist in examining specific cortical connectivity, movement associated disorders and in diagnosis of neurological diseases.