Directionality Analysis on Functional Magnetic Resonance Imaging during Motor Task using Granger Causality*


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Abstract—Directionality analysis of signals originating from different parts of brain during motor tasks has gained a lot of interest. Since brain activity can be recorded over time, methods of time series analysis can be applied to medical time series as well. Granger Causality is a method to find a causal relationship between time series. Such causality can be referred to as a directional connection and is not necessarily bidirectional. The aim of this study is to differentiate between different motor tasks on the basis of activation maps and also to understand the nature of connections present between different parts of the brain. In this paper, three different motor tasks (finger tapping, simple finger sequencing, and complex finger sequencing) are analyzed. Time series for each task were extracted from functional magnetic resonance imaging (fMRI) data, which have a very good spatial resolution and can look into the sub-cortical regions of the brain. Activation maps based on fMRI images show that, in case of complex finger sequencing, most parts of the brain are active, unlike finger tapping during which only limited regions show activity. Directionality analysis on time series extracted from contralateral motor cortex (CMC), supplementary motor area (SMA), and cerebellum (CER) show bidirectional connections between these parts of the brain. In case of simple finger sequencing and complex finger sequencing, the strongest connections originate from SMA and CMC, while connections originating from CER in either direction are the weakest ones in magnitude during all paradigms.