Chapter 9
Tracking of EEG Activity Using Motion Estimation to Understand Brain Wiring

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Abstract The fundamental step in brain research deals with recording electroencephalogram (EEG) signals and then investigating the recorded signals quantitatively. Topographic EEG (visual spatial representation of EEG signal) is commonly referred to as brain topomaps or brain EEG maps. In this chapter, full search block motion estimation algorithm has been employed to track the brain activity in brain topomaps to understand the mechanism of brain wiring. The behavior of EEG topomaps is examined throughout a particular brain activation with respect to time. Motion vectors are used to track the brain activation over the scalp during the activation period. Using motion estimation it is possible to track the path from the starting point of activation to the final point of activation. Thus it is possible to track the path of a signal across various lobes.

Keywords Brain activation • EEG • Topomaps • Motion estimation • Full search

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C. Sun et al. (eds.), *Signal and Image Analysis for Biomedical and Life Sciences*, Advances in Experimental Medicine and Biology 823,
DOI 10.1007/978-3-319-10984-8_9

9.1 Introduction

The motion information that is being extracted from a sequence of 2D images has a number of applications in the field of image processing, medical image investigation/analysis, object tracking, remote sensing, and video compression. Estimating the motion present in a video sequence using the motion vectors (MV) is called motion estimation. Hence using motion estimation it is possible to track the motion of an individual object or a group of objects in a video sequence [4, 9, 12]. Electroencephalography (EEG) is the recording of electrical activity along the scalp. The flow of current due to firing of neurons in the brain results in the voltage fluctuation that is measured as EEG. The visual image of brain changes with the change in the activation of brain. It means that images of brain taken at regular intervals will be different. Hence if consecutive brain images are acquired then we can observe the changes in the images. The changes in the images may correspond to some motion pattern that may be tracked or estimated. Hence, motion estimation techniques can be used to detect the changes in activation. The spatio-temporal correlation between consecutive frames in the sequence can be exploited to find the direction of motion and hence the flow of signal across various lobes in the human brain.

In this chapter, we are focusing on the motion vectors that are created from the EEG signal movement due to brain activity in the topomap sequence, and exploit these motion vectors for further analysis. Our video sequences will consist of topomaps generated from the EEG data in our experiments. Our key contribution is to exploit motion estimation algorithms for brain topomap analysis so that we can understand the mechanism of signal flow in the brain under certain activity. We will use full search (FS) block matching algorithm (BMA) for estimating the motion as this algorithm gives good estimation. Optical flow techniques are also used for motion estimation. However, we did not consider them due to their high computational complexity because they cannot be used for many real time applications of EEG. Although full search motion estimation algorithm has high computational complexity too, there are a large variety of BMA methods with very low computational complexity that are suitable for real time applications. The aim of this chapter is to provide the proof of concept for tracking EEG activity using FS BMA method. In future, we plan to utilize and optimize fast BMA techniques for real time processing.

Thus our goal in this chapter is three-fold: First to analyze the behavior of different brain lobes throughout a particular brain activity with respect to time. This can be done by tracking the path of motion across the brain lobes using motion vectors. Secondly, to track the paths followed by EEG signals during the overall activity and thirdly, to select the optimal path followed. For this purpose, we employ the full search BMA, which is the best among all other BMAs with respect to accuracy.

We organize the rest of the chapter as follows. In Sect. 9.2, we will explain the EEG signals and brain topomaps respectively. In Sect. 9.3, we will discuss motion