CAMD セミナー

（Center for Development of Advanced Medicine for Dementia ）

脳磁図データ解析法の最新トピック

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脳磁図研究で世界をリードするフィンランドより、２人の講師を招いてデータ解析法の最新のトピックである MaxFilter と Beamformer について講演していただきます。MaxFilter はノイズや被験者の頭部の動きに弱かった脳磁図の弱点をカバーする革新的な方法であり、また、Beamformer は従来のダイポールモデル法では困難であった複雑な電源推定を可能にする、現在もっとも注目されている電源解析法です。かなり専門的な内容ですが、ご興味のある方は是非いらして下さい。

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Lecture 1: MaxFilter

Signal Space Separation (SSS) is a method that utilizes the fundamental properties of electromagnetic fields and harmonic function expansions in separating the measured MEG data into the brain signals originating inside of the sensor array and to external disturbances arising outside of the sensor array.

The disturbing magnetic interference is suppressed by omitting the harmonic function components corresponding to unduly high spatial frequencies, by neglecting the external component, and by reducing the noise. Since the method is based directly on Maxwell's equations, the operation can be called Maxwell filtering.

The temporal extension of the SSS method (tSSS) widens significantly the software shielding capability, because tSSS can suppress also internal interference that arises in the patient, such as disturbances caused, for example, by magnetized pieces in/on the subject's head or by pacemakers or stimulators attached to the patient.

Maxwell filtering inherently transforms measured MEG signals into virtual channels in terms of harmonic function amplitudes. Because the virtual channels are independent of the device, they offer a straightforward method for estimating corresponding MEG signals in other sensor arrays. This function called MaxMove provides an elegant way to transfer MEG signals between different head positions and to compensate for disturbances caused by head movements during recordings.

Lecture 2: Beamformers

The current distribution in the brain can be obtained using beamformers. The beamformer is a spatial filter designed to extract electrical activity from a target location in the brain while suppressing contributions originating outside the target. Thus beamformers can reduce interference from other parts of the brain, from other electrically active tissues in human body, and from the environment. The beamformer can be used to construct volumetric image of the averaged local electrical activity (power or some other related parameter), or to extract the time course of the source activity originating from a target location. The beamformer spatial resolution depends on signal-to-noise ratio (SNR) of the target current source. For low SNR the beamformer spatial resolution is low and a point current dipole is detected as an extended 3D spot. Conversely, for high SNR, a point source is manifested as a spatially small high-power point in the investigated region of interest (ROI).

Two beamformer types are: the vector (LCMV) beamformers and scalar beamformers. The vector beamformers operate without any specific information about the source orientation by decomposing the source vector along two or three orthogonal directions. The scalar beamformers determine source orientation as that which corresponds to maximum power or maximum Z^2.

The basic beamformers outputs can be further combined and manipulated to adapt them optimally to various applications. As a result, dual state, event related, statistically normalized beamformers can be constructed, or the beamformer outputs can be transformed to emphasize special property, e.g., spikes in epilepsy.