Detection of Brain Activity using Wavelets in Functional MRI

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Abstract

Functional Magnetic Resonance Imaging (fMRI) provides "instantaneous" photographies of the brain activity. It is often used to localize which part of the brain is active when the patient is subjected to a specific stimulus (auditive, visual,...), or performs a given task (speak, move, ...). Compared to standard MRI settings which are unsuitable for functional studies due to their low acquisition rate, the fMRI modality provides functional informations, at the expense of a substantial noise increase though. The problem of localizing the activation based on a repetition of these informations (typically, in an on-off experiment) amounts to testing each voxel imaged for the active/non-active hypothesis.

However, given the very high noise level, spatial correlations of the activation patterns have to be taken into account. To this end, we present a new wavelet-based framework that provides an "integrated" approach: the data is processed in the wavelet domain (e.g., by thresholding wavelet coefficients), and a suitable statistical test procedure is done in the spatial domain. This method is based on conservative assumptions only and therefore it has a strong type-I error control.

The main contributions of our technique are demonstrated by experimental results. An implementation of our framework is readily available as a toolbox (WSPM) for SPM, the standard software for neuroimaging.

Biography of Speaker

Professor Thierry Blu got his M.Sc. in Ecole Polytechnique (France) in 1986 and his M.Eng. and Ph.D in Telecom Paris (France) in 1988 and 1996 respectively. Before joining the Department of Electronic Engineering of the CUHK as a Professor in 2008, Professor Blu was a project leader and lecturer at the Swiss Federal Institute of Technology (EPFL) in Lausanne, Switzerland from 1998-2007. From 1988-1998, he had also worked as a Chief Telecommunication Engineer at France Telecom R&D.

Professor Blu was the recipient of two best paper awards from the IEEE Signal Processing Society (2003 and 2006). One of his papers on wavelet image denoising

was cited in the "Reader's Choice" column of the IEEE Signal Processing Magazine (September 2007 and January 2008 issues). Patented aspects of his research related to the interpolation of "Finite Rate of Innovation" signals have also been transferred to Qualcomm Inc. (San Diego, CA) for applications to Ultra Wide Band communications. Between 2002 and 2006, Prof. Blu has been an Associate Editor of the IEEE Transactions on Image Processing and since 2006, of the IEEE Transactions on Signal Processing. He is currently an IEEE Senior Member and a member of the Technical Committee "Signal Processing Theory and Methods" of the IEEE Signal Processing Society. Professor Blu's research interests are in wavelets, multiresolution analysis, multirate filterbanks, interpolation, approximation and sampling theory, image denoising, psychoacoustics, optics, wave propagation. More generally, the interplay between the acquisition of physical data and their sampling, with a special focus on biomedical applications.