Donders real-time fMRI

A MATLAB-based solution for real-time decoding and neurofeedback studies

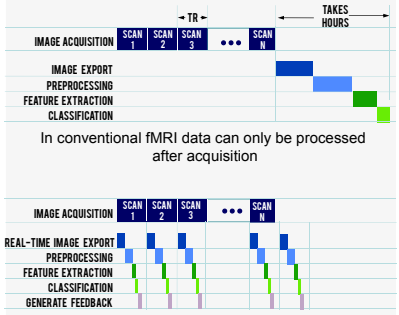
Adnan Niazi[1,2], Philip van den Broek[2], Stefan Klanke[2], Markus Barth[2], Mannes Poel[1], Peter Desain[2], Marcel van Gerven[2]

[1]Human Media Interaction group, Faculty of EEMCS, University of Twente
[2]Donders Institute for Brain, Cognition and Behaviour, Radboud University, Nijmegen

Introduction

Functional MRI (fMRI) is a magnetic resonance imaging (MRI)-based neuroimaging technique used to detect brain areas involved in a task, a process or an emotion. However, fMRI has a critical limitation that data analysis can only be carried out after all scans in a scanning session have been acquired. Unlike fMRI, rt-fMRI allows data analysis simultaneously with image acquisition. With real-time fMRI, an experimenter is able to modify stimulus presentation on-the-fly to reflect ongoing brain activity. The kind of brain-state dependent stimulation or neurofeedback is only possible with real-time fMRI.

Conventional vs. real-time fMRI



In conventional fMRI data can only be processed after acquisition

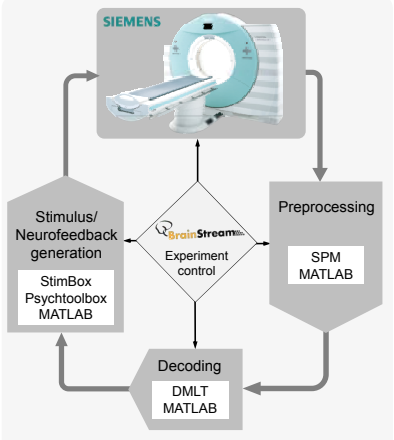
In real-time fMRI data is processed simultaneously with acquisition

Donders real-time fMRI

Donders real-time fMRI is set of Open Source MATLAB-based software tools to help you design any real-time fMRI decoding or neurofeedback study.

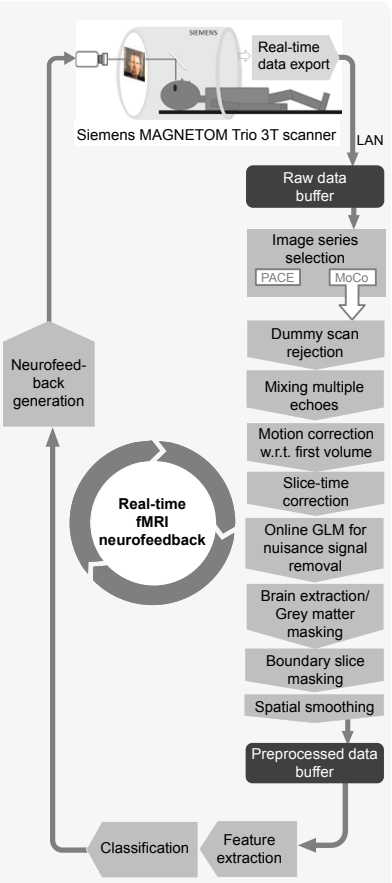
Why use Donders real-time fMRI ?

- Donders real-time fMRI is modular and highly customizable
- All modules are MATLAB-based so an entire study can be designed in just one programming language
- You can jump start your next real-time fMRI study from our ready-made templates



Overview of Donders real-time fMRI

Specifications

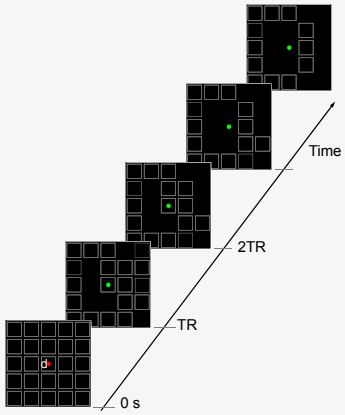


A detailed insight into Donders real-time fMRI implementation

Specifications	
Pipeline delay	Scan time + preprocessing delay = 1 TR + 0.2 s
Minimum possible TR	0.8 s
Prospective acquisition correction (PACE)	PACE and MoCo images series available
Support for multi-echo EPI	Work in progress
Retrospective motion correction	- Nearest neighbor interpolation - Trilinear interpolation - B-Spline Interpolation
Slice time correction	- Linear interpolation - Sinc Interpolation (Slow)
Online GLM for nuisance signal removal	Regresses out activations due to DC offsets, linear drifts and translational motion
Spatial smoothing	Gaussian kernel
Feature reduction	- Brain extraction to remove skull voxels or - Grey matter mask to remove all but grey matter voxels

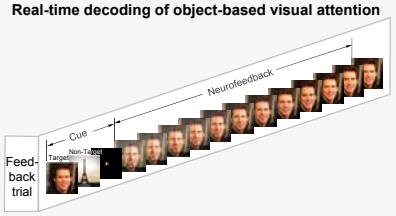
Demos

Real-time decoding of visual imagination



For decoding visual imagery, subject imagines a letter, in this case D, on the grid and the classifier prediction modulates the feedback seen by the user

Real-time decoding of object-based visual attention



Superimposed pictures of a face and place are presented and subjects are asked to attend to one of them. The semantic category of the attended pictures is decoded in real-time and the neurofeedback is provided by enhancing the attended picture.

Limitations of Donders real-time fMRI

The current implementation works only for SIEMENS fMRI scanners.

For GE and Philips scanners, only 'Real-time data export' functionality for exporting scans in real time from the scanner will need to be modified/implemented.

www.analyzed4d.com/rtfmri

adnaniazi@gmail.com