Closing the Loop!

A MOVIII Demonstrator Project

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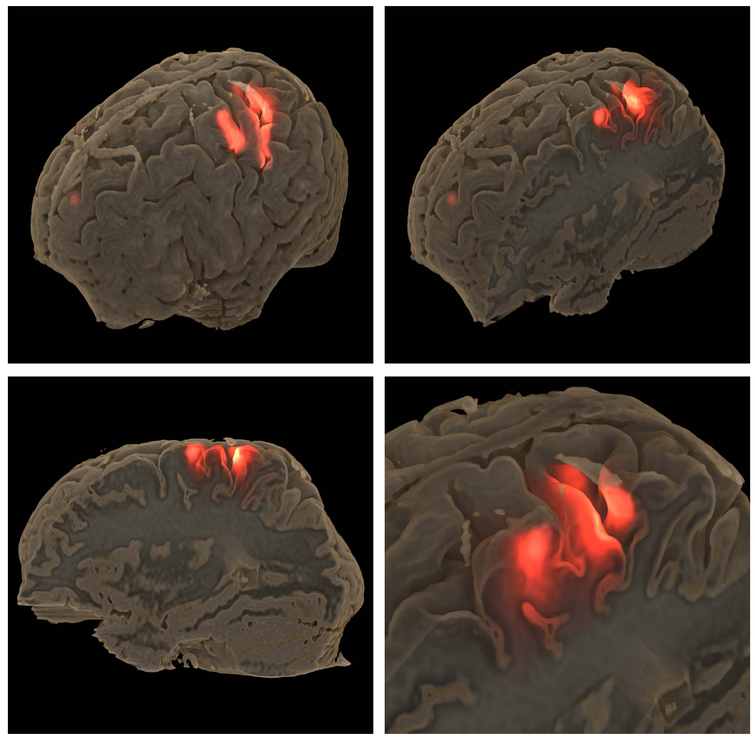
In standard fMRI, data is acquired for several minutes while the subject is exposed to a pre-determined stimulus. The entire data set is then analyzed to detect active brain regions. In this demonstrator project we "close the loop" and let the brain activity control the stimuli.

We can tell where you look!

Using techniques from system identification and image processing, a system was developed to predict where the person in the MRI scanner is looking from measurement of its brain activity. The system was then able to tell if you are looking to the left or right with a delay in the matter of seconds [3].

Look at your own brain activity

We have developed methods for real-time visualization of brain activity. The visualization can be fed back to the subject in the scanner to give an immediate feedback of its brain activity. Our approach distinguish itself from the other works by treating fMRI signal as a light source illuminating the anatomical T1 brain volume instead of blending them together. To produce this effect we have chosen to use the Local Ambient Occlusion technique, as presented by Hernell et al. [2]. This technique produces smooth shadowing effects, making the brain tissue structure easy to perceive.

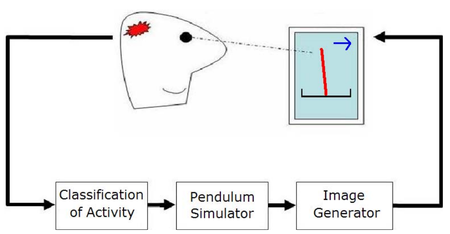


Images showing brain activity caused by movements of the left and right hand.

To create an adaptive filter, a neural network is trained to recognize brain activity. This is then used in the visualization to filter out brain activity from the noisy fMRI measurements.

Balancing an inverted pendulum

We have implemented a brain computer interface (BCI) where the subject can balance an inverted pendulum by thinking left and right [1]. A neural network was first trained with a 240 second long training phase. The classifier could then determine if the subject was thinking left, right or resting.



Conclusion and future work

- Successfully reached demonstrator goals
- Improve spatial and temporal resolution in bio-feedback
- Collaborations with neuro-scientists to use the demonstrator as a research tool
- Evaluation of clinical value of the developed system
- Structural and functional data fusion

References

[1] A. Eklund, H. Ohlsson, M. Andersson, J. Rydell, A. Ynnerman, and H. Knutsson. Using Real-Time fMRI to Control a Dynamical System. In *ISMRM*, Honolulu, USA, 2009.

[2] Frida Hernell, Patric Ljung, and Anders Ynnerman. Local ambient occlusion in direct volume rendering. *IEEE Transactions on Visualization and Computer Graphics*, 2009. Accepted for publication.

[3] Henrik Ohlsson, Joakim Rydell, Anders Brun, Jacob Roll, Mats Andersson, Anders Ynnerman, and Hans Knutsson. Enabling bio-feedback using real-time fmri. In *Proc. 47st IEEE Conference on Decision and Control*, December 2008.