A Low-Cost MRI Compatible Computer Mouse

M. Richter[1], K. J. Behnke[1], P. Hutter[1], C. Yee-Chan[2], A. Dettwiler[1], W. Richter[3]

[1]Center for the Study of Brain, Mind, and Behavior, Princeton University, Princeton, NJ, United States, [2]Department of Chemical Engineering, Princeton University, Princeton, NJ, United States, [3]Department of Chemistry, Princeton University, Princeton, NJ, United States

Introduction

In many magnetic resonance imaging (MRI) experiments, it is desirable to monitor or record subject behavior. For this purpose, numerous MRI compatible devices have been developed, such as button pads, joysticks, and keyboards (1). However, there are applications in which it is desirable to record gross hand movement. For this purpose, we have developed a low-cost MRI compatible computer mouse which can easily be built in any MRI laboratory.

Methods and Results

The MRI mouse was constructed from a commercially available nonmagnetic mouse. We shielded the device with a double layered sleeve of electrically conductive fabric, sewed in-house. We also covered the mouse pad with a layer of the same electrically conductive material. This ensures that there is a permanent radio frequency (RF) seal around the device. The device was connected to a computer in the control room with a series of shielded USB cables through a filter in the penetration panel. By implementing these two RF suppression techniques, artefacts were removed as shown in Fig. 1.

We tested the mouse in a series of phantom and human studies using our Siemens Allegra 3 Tesla Head MRI system. Imaging parameters for phantom: EPI, TR=3000 ms, TE=30 ms, matrix = 64x64x25, FOV=192x192x82 mm^3; for human: EPI, TR=1800 ms, TE=30 ms, matrix = 64x64x30, FOV=220x220x150 mm^3.

Phantom study: We performed a block-design experiment consisting of “control” and “activation” conditions. In the control condition, an operator, standing just outside of the magnet bore, moved an inert object on the mouse pad at the same location where a subject would hold the mouse. In the activation condition, the operator moved and clicked the mouse in the same manner. There were no visible artefacts in the images. A t-test, corrected for multiple comparisons, showed no significant difference in the MRI signal for the activation condition vs. the control condition. In addition, we compared this experiment with an otherwise identical baseline experiment in which there was no mouse in the scanner room and no movement took place. The distributions of t-scores were identical (Fig. 2).

Human study: We again performed a block-design experiment. During the control condition there was no movement, and during the activation condition the subject used the mouse to move the cursor to a series of circularly arranged, individually instructed targets on a screen. The subject received visual feedback indicating accuracy of hand motion. This was compared with an otherwise identical experiment in which the subject moved an inert object on the mouse pad, rather than the mouse, in approximately the same manner (though of course lacking the visual feedback). There were no visible artefacts in the images, and the activations maps were similar in both experiments (Fig. 3).

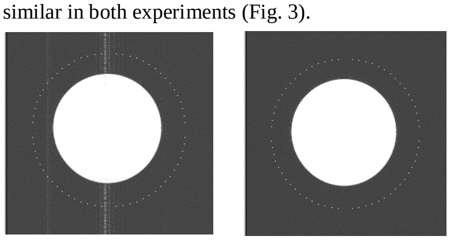

Fig. 1: Gradient echo localizer images. Note the elimination of RF artefacts (left) by the shield (right).

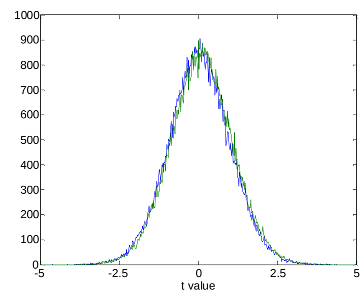

Fig. 2: Phantom Study: Voxelwise histogram of t-values. Green: Block-design experiment. Blue: Baseline experiment. There is no significant difference in the distributions.

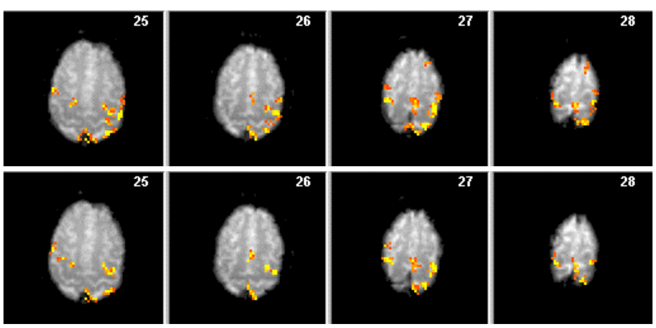

Fig. 3: Human Study: Activation maps for movement of inert object (top row) and mouse (bottom row). Note that the tasks are slightly different because no visual feedback was given during the movement of the inert object. Quantitative analysis showed that the signal-to-noise ratio was not degraded by the mouse movement.

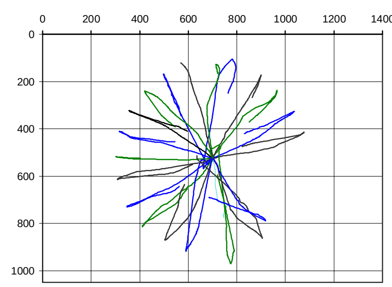

Fig. 4: Trace of mouse movement during human study. The task consisted of radial movements toward targets on the perimeter of a circle.

Conclusion

We constructed a low-cost (< $250) MRI compatible mouse. The operation of the mouse does not interfere with anatomic or functional imaging within the scope of our experiments, and the trajectory of the mouse can be recorded in time and space. This may be of use in numerous fMRI experiments in which gross hand movement is to be studied, or in which the mouse is the preferred response device.

Reference:

(1) James, G.A. et al. *Proc. of ISMRM.* **11**: 1728 (2003).