



Virtual Laboratory for Functional MRI

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Introduction

Functional magnetic resonance imaging (fMRI) is a popular tool used to study brain function. The basic idea is to scan the subject while he/she is submitted to brain stimulation via physical or cognitive activity. Several instruments are used during the acquisition of fMRI images, such as the scanner and a computer that controls the stimulation. After acquisition, the images are analysed to determine the locations of brain activation with image processing techniques that are computationally demanding.

In summary, fMRI studies involve the management and analysis of large amounts of data that are acquired, analysed, compared, annotated and stored for future reference. The users of fMRI (e.g., psychologists, psychiatrists, radiologists) typically face several difficulties to organize their workflow comfortably and efficiently using an adequate IT infrastructure. To face such problems, the Virtual Laboratory for e-Science (VL-e) Project has taken initial steps to build a grid-enabled infrastructure to facilitate data management and analysis for fMRI studies.

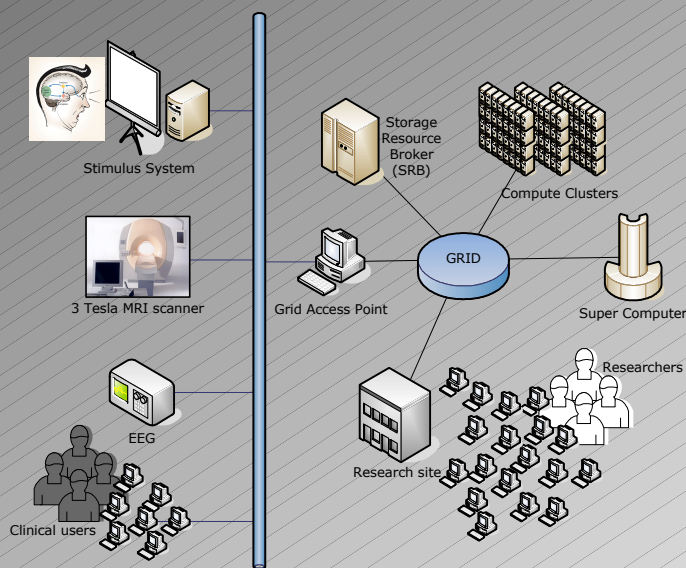


Figure 1 - Computational Resources of the Virtual Laboratory for fMRI.

Virtual Lab for fMRI Studies

The Virtual Lab for fMRI will provide a shared infrastructure with hardware, software and services to efficiently, reliably and securely perform large scale studies.

The specific goals are to:

- facilitate data gathering from disperse and heterogeneous equipments;
- facilitate data storage and archival, providing large capacity and long-term storage resources;
- provide access to high performance computing resources for high throughput;
- facilitate data logistics, providing tools for workflow automation;
- provide remote and controlled access to the data; and
- facilitate data retrieval, providing tools for metadata storage and query.

The computational resources are provided by the Proof-of-Concept environment of the VL-e project (VL-e PoC). The resources are illustrated in Figure 1, consisting of the Storage Resource Broker (SRB) for data storage and a cluster for computation.

Ideal Scenario

The functional components of the Virtual Lab for fMRI are illustrated in Figure 2, including facilities for data acquisition, storage, analysis and shared access.

In an ideal scenario, an fMRI study would be performed as follows. When scanning is completed, the data are collected from the scanner and the stimulus computer and transferred to the SRB. The identity information of the subjects is automatically removed. The user is notified about the storage location on the SRB. Then he/she schedules jobs to perform data conversion and analysis on the high-performance computing facilities of the VL-e PoC. The results are automatically stored in the SRB, together with metadata about the performed analysis. The user can then inspect the results and the original data, using interactive browsing and viewing facilities that can be activated from a workstation at any research site. Optionally, the data and results can be downloaded to the local workstation for further analysis or for publication. Additionally, the user can query data based on metadata. Access to the data is controlled based on user and group identity within the Virtual Organization.

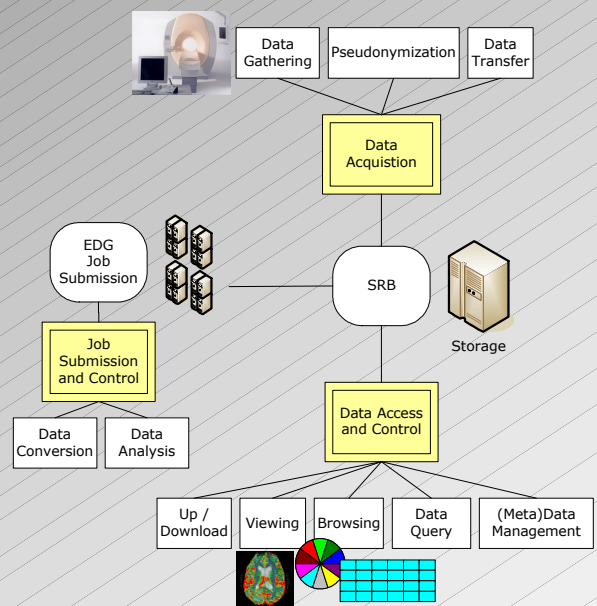


Figure 2 - Functional Components of the Virtual Laboratory for fMRI.

Current Status and Concluding Remarks

A pilot implementation of the Virtual Lab for fMRI studies is under construction. In the first phase, the functional components use existing solutions as much as possible. Access to the SRB is performed with the InQ SRB browser, and jobs are submitted to the VL-e PoC resources using the LCG-2 middleware of the European Data Grid (EDG) Project. The fMRI image analysis and viewing is performed with the fMRIB Software Library (FSL). Workflow automation is obtained by scheduling data conversion, analysis and storage directly after the acquisition.

The IT infrastructure proposed by the Virtual Lab for fMRI studies has the potential to alleviate to a large extent usual problems faced by users of fMRI, since it offers large and long-term storage capacity, remote and controlled access to distributed and heterogeneous data, facilities for metadata storage and query, access to high-performance computing resources, and workflow automation. The construction of an infrastructure with such high ambition requires multi-disciplinary expertise of several partners of the VL-e project.



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