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Distributed Workflow Management System for Automated Medical Image Analysis and Logistics

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Introduction

ADVANCES in medical image analysis have increased the need to integrate and deploy image analysis software in daily clinical routine and in epidemiological studies. We have developed a Distributed Workflow Management System (DWMS) that supports a wide portfolio of medical image analyses in different CT and MRI application domains. The workflows are executed fully automatically upon receipt of the medical images. After processing, the results are routed to a diagnostic viewing station for review and further analysis, a neuro navigation system or an image archive (PACS).

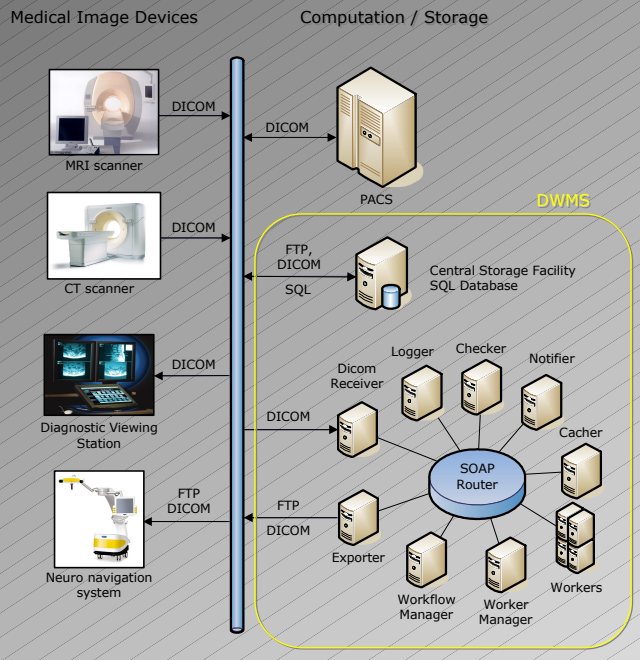

Figure 1 – The DWMS embedded in the clinical network environment.

Workflow Management

Workflows are defined as a set of pre-defined (depending) tasks to automatically carry out the medical image analysis and the logistics involved to direct the analyzed data to the requested location:

image import ➔ perform analysis ➔ submit results ➔ notify requestors

The DWMS supports software components for image import/export, caching, processing and notification that are distributed on a heterogeneous grid of commodity computers, see Figure 1. Communication between the components is performed by exchanging SOAP messages on request of standard compliant Web services. By virtualizing MS Windows and Linux computer resources the DWMS delivers high computational capacity for demanding applications.

The DWMS will be presented by Dr. J.G. Snel at the IEEE Computer Based Medical Systems Congress in Salt Lake City, U.S.A., June 2006.

Application Domains

Portfolio of automatic medical image analyses (see Figure 2):
- CT Angiography (CTA): removal of bone tissue for the visualization of blood vessels in the brain and neck using matched masked bone elimination (MMBE);
- AutoVR: techniques for automated volume rendering (VR) of MR and CT scans;
- Perfusion MRI (pMRI) and Diffusion Tensor Imaging (DTI): calculation of blood perfusion maps and water diffusion maps for determination of tumor properties in the brain;
- Functional MRI (fMRI): calculation of brain activation maps for pre-operative planning in neuro surgery and post-operative evaluation of brain function before and after tumor resection respectively.

Figure 2a – CTA scans, non-enhanced (left), contrast-enhanced before (middle) and after application of MMBE (right).

Figure 2b – Volume rendering of the blood vessels from a CTA scan pre-processed by MMBE.

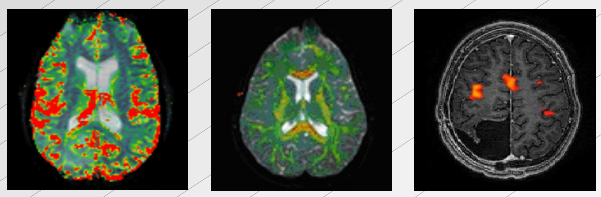

Figure 2c – Different functional maps: cerebral blood volume in pMRI (left), fractional anistropy in DTI (middle), and brain action maps in fMRI (right).

Conclusion

The DWMS improves the interoperability between image acquisition devices, clinicians and researchers by making image analysis applications available in a transparent way, which accelerates the uptake of new research techniques. Through distributed computing, the workload is balanced and results can be obtained quicker. As the availability is guaranteed at a 24/7-hour basis, the system provides a reliable and completely automated solution for demanding image analysis tasks in a multi-vendor environment.

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