Cloud Computing Framework Design for Cancer Imaging Research

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Abstract

In this paper we introduce our framework design, based on Microsoft technologies, existing software solutions, and image processing and visualization toolkits, to overcome various issues that medical image analysis researchers face during their research work such as re-implementing existing methods, developing and deploying new software solutions and the tedious and consuming process to generate ground truth by manually segmenting target shapes. We introduce how the use collaborative visual tools enhance the way image analysis research is conducted.

1. Introduction

At Oxford, image analysis researchers are collaborating with clinicians at John Radcliffe and Churchill Hospitals in the development and deployment of new software solutions for image analysis of colorectal and liver cancer images.

When a researcher addresses a new challenge for the analysis of medical images he/she must consider existing solutions to determine if they are suitable or not. Generally, either the re-implementation, in case a piece of software is not available for that solution, or the re-use of a solution might be limited by various instances such as the lack of implementation details, researchers not familiar with programming languages or even solutions not compatible with their own development environments. Medical image analysis (MIA) researchers spend around 30% of their research time implementing and evaluating existing solutions, which represents a significant amount of time. Furthermore, the evaluation and validation of the new software solutions is limited by the way that these applications are deployed. User interfaces is a big challenge for MIA researchers as they need to spend additional time defining a suitable interface for visual input data as well as for presenting the results when advance visualization is needed. MIA researchers are often concerned about proving concepts and learning new programming languages, and image and visualization techniques sometimes is not an option.

On the other hand, the generation of ground truth outlined shapes is relevant for the validation of image segmentation algorithms. Ground truth, in the image processing scenario, consists in examples of target shapes that image segmentation should ideally provide as results. These shapes are generated by either radiologists or MIA researchers by means of manual segmentation, which is often, performed using the mouse. This could be both tedious and time consuming. We have assessed how the use of graphics tablet technology improves manual segmentation in time and accuracy.

In this paper we introduce our approach to overcome the issues mentioned above and the way interactions among clinicians and researchers could be enhanced by the use of collaborative visual tools.

2. Cloud computing imaging use case

Although sharing information is quite a challenge for some researchers who believe their research is threaten since their data and algorithms are exposed for someone else to use them, it has been the solution to similar issues in different scenarios such as chemistry [4] and neuroscience [5]. The creation of data repositories along research centres and universities in UK has been accepted as a way to preserve and disseminate research data.

However, sharing algorithms and software solutions is a challenge. The deluge of programming languages and image processing toolkits might difficult the plug and play functionality desired when sharing such resources. A cloud computing framework allows a platform independent access to remote computing

services. Web services allow end-users to fully interact with data, information requests as well as applications with a low level of user interaction. However, some image applications require higher levels of interactions that web services do not provide in an efficient way. Therefore, for our use case we propose a combined solution considering a portal (thin client) for low level interaction interfaces and a desktop enriched application (thick client) for applications demanding interactive interfaces and advanced visualization.

Given previous investments in similar solutions it makes sense for us to adopt and adapt existing software environments. However, adopting an existing solution has underlying challenges and a suitable and exhaustive analysis of use case should be performed.

We develop our framework using existing software solutions, imaging toolkits and Microsoft technologies as MIA researchers are already familiar with them. For instance, we will use Visual Studio as our development environment, SQL server as our database manager, and Microsoft Workflow foundation as our workflow engine, which is part of the Microsoft .NET Framework 3.0 [3].

The use of collaborative visual tools such as multi-touch surfaces [1, 2] would enhance manual segmentation and the interaction among researchers and clinicians as well as the engagement of clinicians with medical image analysis applications in a subtle and intuitive way.

3. Future Work

We have defined a number of work packages for our project to:

- Evaluate existing software environment solutions.
- Design standard datasets, metadata and web services.
- Design workflow orchestration and enactment using Windows Workflow Foundation
- Incorporate existing imaging and visualisation toolkits.
- Design mechanisms and tools to enhance software usability for clinicians.
- Evaluate collaborative tools for ground truth data generation and the enhancement of interaction among MIA researchers and clinicians.
- Create links to permanent and online repositories of research publications such as Oxford University Research Archive.

There are a number of challenges to face. As mentioned earlier the adaptation of existing software will require an exhaustive analysis and may require significant time.

Unbound up toolkits from specific languages is a recurrent problem for interoperability solutions. We will try to explore various solutions such as the MATLAB® Builder™ NE for Microsoft® .NET framework.

On the other hand, contributions should be defined under specific procedures controlling their quality but facilitating the way researchers do it. The design of mechanisms to provide such facility must be analyzed and evaluated.

The design and development of suitable user interfaces for clinicians is challenging, however, we are convinced that use of multi-touch technology should provide a better interfaces to improve the interaction with image analysis applications as well as the learning experience.

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