**LITERATURE SURVEY**

1) **Scalable pCT image reconstruction delivered as a cloud service**

**AUTHORS:** Chard, Ryan, Ravi Madduri, Nicholas T. Karonis

We describe a cloud-based medical image reconstruction service designed to meet a real-time and daily demand to reconstruct thousands of images from proton cancer treatment facilities worldwide. Rapid reconstruction of a three-dimensional Proton Computed Tomography (pCT) image can require the transfer of 100 GB of data and use of approximately 120 GPU-enabled compute nodes. The nature of proton therapy means that demand for such a service is sporadic and comes from potentially hundreds of clients worldwide. We thus explore the use of a commercial cloud as a scalable and cost-efficient platform for pCT reconstruction. To address the high performance requirements of this application we leverage Amazon Web Services' GPU-enabled cluster resources that are provisioned with high performance networks between nodes. To support episodic demand, we develop an on-demand multi-user provisioning service that can dynamically provision and resize clusters based on image reconstruction requirements, priorities, and wait times. We compare the performance of our pCT reconstruction service running on commercial cloud resources with that of the same application on dedicated local high performance computing resources. We show that we can achieve scalable and on-demand reconstruction of large scale pCT images for simultaneous multi-client requests, processing images in less than 10 minutes for less than $10 per image

2) **Performance management of high performance computing for medical image processing in Amazon Web Services**

**AUTHORS:** A Bao, Shunxing, Stephen M. Damon, Bennett A. Landman

Adopting high performance cloud computing for medical image processing is a popular trend given the pressing needs of large studies. Amazon Web Services (AWS) provide reliable, on-demand, and inexpensive cloud computing services. Our research objective is to implement an affordable, scalable and easy-to-use AWS framework for the Java Image Science Toolkit (JIST). JIST is a plugin for Medical- Image Processing, Analysis, and Visualization (MIPAV) that provides a graphical pipeline implementation allowing users to quickly test and develop pipelines. JIST is DRMAA-compliant allowing it to run on portable batch system grids. However, as new processing methods are implemented and developed, memory may often be a bottleneck for not only lab computers, but also possibly some local grids. Integrating JIST with the AWS cloud alleviates these possible restrictions and does not require users to have deep knowledge of programming in Java. Workflow definition/management and cloud configurations are two key challenges in this research. Using a simple unified control panel, users have the ability to set the numbers of nodes and select from a variety of pre-configured AWS EC2 nodes with different numbers of processors and memory storage. Intuitively, we configured Amazon S3 storage to be mounted by pay-for- use Amazon EC2 instances. Hence, S3 storage is recognized as a shared cloud resource. The Amazon EC2 instances provide pre-installs of all necessary packages to run JIST. This work presents an implementation that facilitates the integration of JIST with AWS. We describe the theoretical cost/benefit formulae to decide between local serial execution versus cloud computing and apply this analysis to an empirical diffusion tensor imaging pipeline.

**3) Cloud-based medical image processing system with access control**

**AUTHORS:** Zhao, Tiecheng, Robert James Taylor, Gang Li, Junnan Wu

According to one embodiment, a cloud server receives over a network a request for accessing three-dimensional (3D) medical image data from a first user, where the cloud server provides image processing services to a plurality of users using a plurality of image processing tools provided by the cloud server. The cloud server determines user privileges of the users for accessing the 3D medical image data, where the user privileges are related to the 3D medical image data. The 3D medical image data was captured by a medical imaging device and stored in a storage associated with the cloud server. The availability of the image processing tools is limited to the user to process the 3D medical image data based on the user privileges.

4)**Secure Deepinfer: opensource deep learning deployment toolkit for image-guided therapy**

**AUTHORS:** A. Mehrtash, M. Pesteie, J. Hetherington, P. A. Behringer

Deep learning models have outperformed some of the previous state-of-the-art approaches in medical image analysis. Instead of using hand-engineered features, deep models attempt to automatically extract hierarchical representations at multiple levels of abstraction from the data. Therefore, deep models are usually considered to be more flexible and robust solutions for image analysis problems compared to conventional computer vision models. They have demonstrated significant improvements in computer-aided diagnosis and automatic medical image analysis applied to such tasks as image segmentation, classification and registration. However, deploying deep learning models often has a steep learning curve and requires detailed knowledge of various software packages. Thus, many deep models have not been integrated into the clinical research workflows causing a gap between the state-of-the-art machine learning in medical applications and evaluation in clinical research procedures. In this paper, we propose "DeepInfer" - an open-source toolkit for developing and deploying deep learning models within the 3D Slicer medical image analysis platform. Utilizing a repository of task-specific models, DeepInfer allows clinical researchers and biomedical engineers to deploy a trained model selected from the public registry, and apply it to new data without the need for software development or configuration. As two practical use cases, we demonstrate the application of DeepInfer in prostate segmentation for targeted MRI-guided biopsy and identification of the target plane in 3D ultrasound for spinal injections.

5) **3d slicer as an image computing platform for the quantitative imaging network**

**AUTHORS:** A. Fedorov, R. Beichel, J. Kalpathy-Cramer, J. Finet, A. Mehrtash

Quantitative analysis has tremendous but mostly unrealized potential in healthcare to support objective and accurate interpretation of the clinical imaging. In 2008, the National Cancer Institute began building the Quantitative Imaging Network (QIN) initiative with the goal of advancing quantitative imaging in the context of personalized therapy and evaluation of treatment response. Computerized analysis is an important component contributing to reproducibility and efficiency of the quantitative imaging techniques. The success of quantitative imaging is contingent on robust analysis methods and software tools to bring these methods from bench to bedside. 3D Slicer is a free open-source software application for medical image computing. As a clinical research tool, 3D Slicer is similar to a radiology workstation that supports versatile visualizations but also provides advanced functionality such as automated segmentation and registration for a variety of application domains. Unlike a typical radiology workstation, 3D Slicer is free and is not tied to specific hardware. As a programming platform, 3D Slicer facilitates translation and evaluation of the new quantitative methods by allowing the biomedical researcher to focus on the implementation of the algorithm and providing abstractions for the common tasks of data communication, visualization and user interface development. Compared to other tools that provide aspects of this functionality, 3D Slicer is fully open source and can be readily extended and redistributed. In addition, 3D Slicer is designed to facilitate the development of new functionality in the form of 3D Slicer extensions.