Extendable Multimodality Imaging Framework with specific illustration of DTI

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INTRODUCTION

The frequent breakthroughs and a worldwide interest in research and development in MRI (*and associated protocols viz. DTI, Perfusion among others*) in last 2 decades have generated a need for tools and frameworks that allow rapid development of research grade software. Image Apprentice is one such C++ based Digital Imaging Toolkit for Microsoft Windows. A plugin based architecture allows developers to add further support for various file-formats, post-processing algorithms, 3rd party based visualization support (*OpenGl, DirectX, VTK etc.*), external C/C++ libraries (*like FFTW*) – to site a few examples. As an illustration, we are contributing a plugin for post-processing of Diffusion Tensor MRI data.

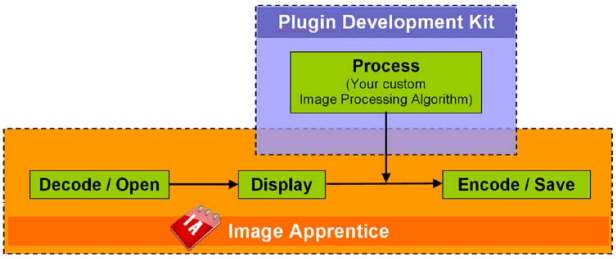

Figure 1: Architecture Schematic Diagram

METHODS

[A] Registration[1] - A 12 degree of freedom global affine registration technique is being used for registration of DTI directional stacks incorporating an optimization of mutual information. This optimization is being done by iterative binary search algorithm with given initial guess. **[B] Descalping**[2] - removes non-brain anatomies from b_0 images. **[C] Processing**[3,4] – Voxel wise tensor field is computed using the given input DTI data and gradient direction vectors. The tensor is diagonalized using the analytical diagonalization method to obtain the eigen values and eigen vectors followed by computation of DTI metrics. **[D] Fiber Tracking** - Various White Matter structures were separated using Principal Eigen Vector Field Segmentation (PEVFS)[5] approach. A single click on obtained segments provides the seed point for Streamline Fiber Tracking Algorithm[6]. **[E] Visualization** - All the data can be visualized in runtime or on need-basis. 3D Visualization is being done using VTK[7].

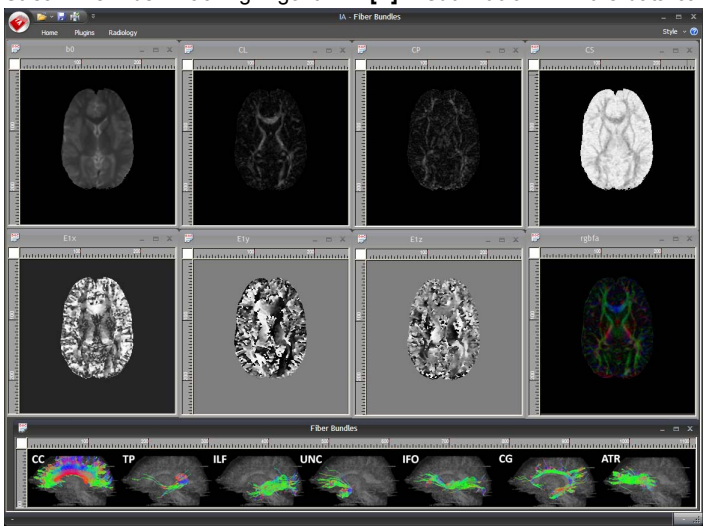

Figure 2: Various DTI Metrics and Tracts

RESULTS & DISCUSSIONS

The native C++ computations are relatively faster and the memory restrictions associated with Virtual Machine based platforms do not arise here. Image Apprentice[8], having a plugin based software architecture, is not only limited to DTI and can be extended to any imaging modality - be it clinical imaging protocols like Perfusion and fMRI or other industrial ones like Micro-CT. Nevertheless, the C++ based plugins are Java Native Interface supported so developers can use the C++ plugins in any Java based application as well. Parallel implementation (using Intel Parallel Studio) and GPU accelerated computing support (NVIDIA CUDA) is a work under progress – and would augment the scientific usability. It can also be used as learning toolkit for those undergoing courses in Imaging or doing research in concerned areas. Multi-monitor support adds to enhanced user experience.

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