Project 1: A visual programming tool for medical image analysis

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Within the Medical Image Analysis laboratory, we have developed a software "ITK-Simulink" which allows the creation of an image processing pipeline by visually selecting various filters from a "toolbox," dragging them onto a "canvas," and then drawing lines to link them together.

The idea of a visual programming tool is of great benefit to the medical image analysis community, since it can enable non-programmers to accomplish complex image analysis tasks. Our current implementation of ITK-Simulink is limited to 8-bit-per-pixel, two-dimensional images. In this project we will build upon the previous implementation in two ways:

- In the first part of the project we will aim to enhance the software to allow processing of three-dimensional, 16-bit-per-pixel image volumes that are produced by CT and MR scanners.

- In the second part of the project we aim to include in the software advanced modules for 3D image registration. Image registration is the process of translating and rotating one image to match another, and is necessary for many medical image analysis tasks. The C++ code for image registration already exists in the ITK libraries and does not have to be written; the goal is to develop a framework that allows people to access this functionality via a drag-and-drop interface.

Requirements: excellent programming skills; some experience with C or C++ programming.

Project 2: Image Segmentation Using Phase Symmetry

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Image segmentation plays an essential role in many medical image processing approaches. Specifically to calculate accurate doses of radiation therapy in prostate cancer, it is essential to segment and identify the location of the Brachytherapy seeds implanted in the prostate.

In this project we will compare the performance, speed and accuracy of two categories of segmentation methods, namely phase-symmetry- and power spectrum- based approaches. The project includes two parts:

- In the first part of the project, we will use Matlab implementation of the two segmentation algorithms and apply them to phantoms where objects of interest are embedded at various depths, orientations and contain different materials. We will study the performance of each algorithm and the effects of various parameters on their segmentation capabilities.

- In the second part of the project we will implement a real-time C++ version of the Matlab phase-symmetry segmentation code. The Matlab code takes about 0.5 seconds per 2D ultrasound image. It is therefore expected that we can achieve real-time operation with C++. The implemented C++ version will then will be extended to segment panorama US images.

Requirements: Very good programming skills; familiarity with C++.