Image Display and Planning System

This project will use OpenGL, Visual Studio and C++/CLI to build a basic image display system for medical images. The student will build an application from a basic (provided) source code base that already provides the basic visualization and data loading, and may be used as a starting point if desired. The student will be required to add functionality to the system to facilitate image manipulation, annotation and display.

Most modern commercial software systems for display and manipulation of medical image data do not make use of common research tools such as VTK, Matlab, 3D Slicer etc. except for prototyping. While these are ideal for research environments, commercial systems cannot usually tolerate the overhead of these platforms and the difficulty in validation for medical use.

OpenGL is a complex and powerful API for rendering and displaying 2D and 3D graphics, and benefits from extensive hardware assistance from GPU's. OpenGL's 3D texture mapping capabilities are extensively used in medical imaging to provide volume rendered images.

The exact form of the completed project will be up to the student and confirmed with the supervisor, but should build on the provided display of 2D and 3D images. The images should be able to be panned, zoomed, rotated, annotated, window level adjusted and various transfer functions available to manipulate the view.

The software should also include a basic planning task such as setting and displaying needle trajectories, manipulation of planes representing bone cuts or resection lines etc. which are represented as graphical object overlays on the 2D and 3D images.

Students selecting this project must have access to a computer with a basic GPU capable of rendering the OpenGL graphics. The programming environment can be challenging to students not familiar to it, especially within the context of the Visual Studio IDE and using C++/CLI. The provided example code should help.

Melanoma Detection Using Deep Learning

The incidence of melanoma, the most lethal of all the skin cancers, has risen every year since 1979 . Although most cases occur after the age of 40, incidence is rising among younger women, thanks in part to the increased use of tanning beds and other artificial tanning devices.

When melanoma is diagnosed at an early stage, simple excision is generally curative and the 5-year relative survival rate is approximately 98% . Unfortunately, despite the amenity of melanoma to early diagnosis through simple visual inspection, many patients continue to be diagnosed with more advanced disease. Most patients and general practitioners are not sufficiently trained to be able to distinguish melanoma from benign skin lesions.

In Canada, it is becoming increasingly difficult for patients to access dermatologists trained to make accurate diagnoses of melanoma as they turn to more lucrative areas of cosmetic surgery. As a result there can be a delay of many months before a patient can see a dermatologist which may cause the disease to progress to a stage that is not easily treatable. Before the arrival of checkpoint inhibitor drugs, the prognosis for these patients was extremely poor.

This project will address the area of automated melanoma diagnosis through the use of deep learning techniques. The student will make use of Python and Keras/Tensorflow to investigate the processes of (i) lesion segmentation, (ii) lesion attribute detection, and (iii) disease classification. Extensive high quality training data is currently available from the ISIC archive, the HAM10000 data set or other sources. One or all of the three tasks may be undertaken.

This project requires dedicated access to a high end GPU e.g. Nvidia 1070 or 1080 with 8+GB to perform model training. Limited GPU access from the School of Computing will be available. Prior experience with Keras, CNN’s, etc. is useful but not required.