Multiple Sclerosis

Visualization can be a critical tool to obtaining an accurate diagnosis for certain diseases that are difficult to detect, including Multiple Sclerosis (MS). The Buffalo Neuroimaging Analysis Center (BNAC), located at Buffalo General Hospital, is working with CCR to develop a system that can be used as a predictive tool in diagnosing patients with MS.

First, MS patients and non-MS control subjects are scanned in an MRI machine. An MRI scan of the brain can provide many useful clues in diagnosis. While an MRI is commonly performed for the purpose of discovering and observing brain abnormalities, in this case it is the detection of physical changes in brain structure that is critical. With MS, as the disease progresses, different brain structures atrophy and undergo a variety of observable changes. These MRI scans are archived. In addition to MRI scans, a full suite of cognitive testing is performed on the patients. The goal is to construct a database of physical changes in the brain and correlate them with observed cognitive manifestations in the individual.

CCR has developed visualization tools to view and measure the different brain structures of interest. In the MRI scans, researchers parcellate/segment out important brain structures that are known to exhibit changes in structure relating to the progression of the disease. The visualization of this data is very important. The first structures examined are the caudate nuclei. They are a part of the basal ganglia consisting of a pair of elongated structures, which contain a head, body and tail. The working hypothesis was that as MS
progresses, these structures will atrophy and the two halves will spread apart. While numerical calculations provide information on the change in volume of these structures, visualization is needed to show the change in shape. Furthermore, changes in shape are not necessarily accompanied by changes in volume.

A great deal of care is necessary when comparing an MS patient to a normal control. First, the subjects are divided into groups of the same sex and similar age. Next each caudate is corrected for whole brain size. That is, a correction factor is applied so that each caudate is scaled by an inverse of the whole brain volume of the subject. Once the data is normalized, a polygonal surface is constructed from the points describing the structure of interest.

Subsequently, polygonal surface representations of the caudate pairs for all the patients and all the normal controls are created. Next, a pair of caudates from an MS patient and a pair from a matched normal control are superimposed on one another. The bounding box center of each pair is computed and the structures are aligned with respect to that.

From a surface visualization of the structures, deformities that occur can be detected and any localized changes between MS and normal caudates can be identified. In this case, it has been observed that indeed the two halves of the caudate are atrophied in MS patients as compared to normal controls. Also, it is clear that the surface is not regular and smooth. Current work includes adding the ability to determine an average structure based on a series of representative components. That is, the ability to take on the order of fifty structures from the MRI scans of normal volunteers and construct an average structure that can be used as the basis of comparison. This work has been presented at several conferences and a journal article has been submitted.