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Applied Math 120 Final Project

Introduction

The MRI (Magnetic Resonance Imaging) is one of the most accurate and available types of medical imaging that is used to detect diseases throughout the body, ranging from severe bleeding to cancerous growths (SOURCE A). The prevalence of MRI imaging as a diagnosis is well represented by the sheer number of the expensive yet critical equipment. In the United States, there are over 10,000 MRI machines (SOURCE B). When a doctor administers an MRI imaging (we will use the brain as the organ of study from this point onwards), the machine stores many 2D slices of the brain from multiple angles to provide the most accurate representation of the brain. From this collection of slices, the doctor must look through each frame for possible irregularities that could confirm the existence of a tumor. The person reading the MRI image must flip through each frame systematically – there is no shortcut to knowing about where a tumor could be. The requirement of such a methodical but tedious search inspired us to develop approaches to automate the reading of a set of MRI images. For the scope of this project, we explored a couple independent techniques to identify possible tumor candidates from a given 2D image (one slice of the brain). At the bare minimum, the techniques we explored could reduce and simplify the number of images that a doctor would have to peruse in search of a possible growth.

Method

We tried two independent approaches: the first was using watershed segmentation to filter various foreground objects – hoping to identify the tumor as one of the fewer remaining objects. The second method was to simplify the MRI image through edge detection algorithms. Theoretically, a tumor would generate a closed object in our image. With this abstract picture, we wanted to use the natural symmetry of the brain to detect the tumor. A tumor would be an irregular growth and would not have a symmetric counterpart.

Watershed Segmentation

The goal of the watershed segmentation method is to map the image to a topological equivalent, and “flood out” various “basins” to represent different levels of foreground. The first step would be to convert to grayscale. The intensity of the grayscale code would be mapped to relative height. Conceptually, once this grayscale mapping is complete, the “whitest” pixels would represent areas of maximum height (or intensity or density in the case of an MRI image).

Edge detection and Symmetry

The first step to edge detection involved picking an edge detection algorithm. We saw that

Mention smoothing, thresholds, edge detection

Move to how you did the symmetry

Results

For both cases, we started with this 2D MRI snapshot <original.jpg>. For the Watershed segmentation method, we will also show the output for a given colored image, this lily pad landscape <lilypad.jpg>.

Watershed Segmentation

2) Edge Detection and Symmetry

Discussion

Use both

Watershed detection tends to overcomplicate – false positive

Edge detection tends to oversimplify – false negative

Future Work and Conclusion

Our project has demonstrated two possible directions to approach the problem of automating tumor detection.

References

<http://www.mathworks.com/products/image/examples.html?file=/products/demos/shipping/images/ipexwatershed.html#2>

SOURCE A <http://www.medicinenet.com/mri_scan/article.htm>

SOURCE B <http://www.magnetic-resonance.org/MagRes%20Chapters/21_03.htm>