Image Segmentation Project - Open source software practices class

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October 18, 2007

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Abstract

This document describes implementation of two Level-set segmentation algorithms using Insight Toolkit ITK www.itk.org. The algorithms chosen for implementation are are 1) Geodesic Active contour Levelset segmentation and 2) Shape Detection Levelset segmentation. The project is oriented to expose the concepts of Open Data, Open Source and Open Access which form the pillars of open-source software ideology.

The project involved obtaining a data from an open source repository and perform minimalistic segmentation on the data using ITK. This report explains some of details of the algorithm, and parameter selection steps required in segmentation procedure.

The algorithms are developed using filters and modules from the open source softwares like CMake 2.4, Insight Toolkit 3.4, Paraview 2.2 and MinGW 5.03. The data is obtained from a open access data source. The main purpose of this work is to show an implementation of the above packages for an application involving 3D medical images.

The algorithm implemented in this report are Geodesic Active contour levelset segmentation and Shape Detection Level set segmentation. These algorithms are developed on Level set framework, which is of the widely used segmentation approaches in the medical imaging community. The difference between the approaches lies in the way level set is evolved with time. While the geodesic active contours use the edge information for optimizing the levelset function, the Shape Detection active contour uses the properties of the evolving curve.

1 Obtaining the data

The data is obtained from an Open Access database available from Kitware Inc. called Multiformat Image and Data Analysis *MIDAS*. The data that was used for this work is at http://insight-journal.org/dspace/handle/1926/609, and appears in collection Normal-002 under the Designed Database of MR Brain Images of Healthy Volunteers. The datafile named Normal 002 - T.mha was used for developing the code. The next section gives a brief description of the Algorithm used.

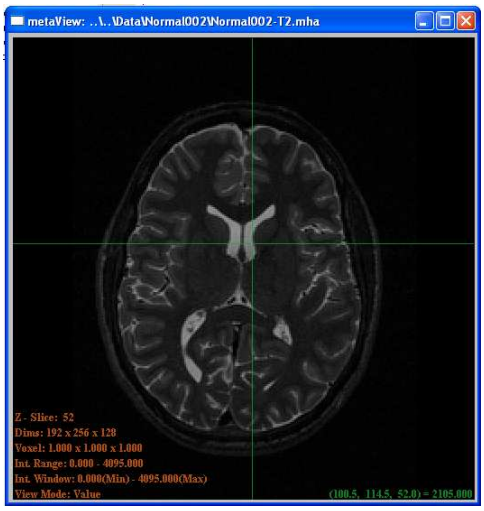

Figure 1: The ImageViewer GUI is used for selection of initial seed points.

2 Image Segmentation using Geodesic Active Contour Level-set and Shape Detection Level-set

Both algorithms are developed on the level-set framework. The algorithms needs to be initialized using seed points, which are manually chosen to initiate the Levelset function. The Levelset Functional then evolves using a fixed time step until the stopping criteria is reached. The stopping criteria is either reaching 800 iteration or the relative error, i.e., change in error between successive iterations is less that 0.002.

The other parameters that needs to be set are Curvature Scaling, and Propagation Scaling for the active contour. This are taken as user inputs from the command prompt.

There are few more parameters as well, which are less sensitive and thus are hard-coded in the code. These parameters include standard deviation of the Gaussian used for smoothing, the initial distance at the location of the seed points in the fast marching method and the image boundaries in fast marching method. The standard deviation of the Gaussian filter is set at 1, which assumes that any structural information less than one pixel wide is not important. This is fairly a reasonable assumption given that the object of interest is several pixel in size. Fast marching used to initialize the Levelset function requires an initial distance value, which should be set to a value equal to the distance of the front from the boundary of the object. We have selected seed points that lies inside the object of interest, and which are at least 5 pixel away from the boundary. So, to be on the safer side, we select this parameter value equal to 5.

The magnitude of the gradient image pixel values from 0 to 800, so in order to set the sigmoid function in such a way that it bisects this range, we set β equal to 400 and α equal to 10.

The seed points to initialize the fast-marching contour is selected manually. The seed points are hard coded in the data for the time being. Since the seed points are specific to the data, this code can work only for the given data. In order to make the algorithm generic for all dataset, some seed point detection mechanism needs to be added to the code, which could be GUI-based interface.

3 Illustration of Segmentation results

The seed detection is done manually using the ImageViewer utility in the ITK. This has a cross hair and user can move through the z-layers and pick the seed points. The seed points are collected in a text file, which can be retrieved later.

For the purpose of Geodesic active contour segmentation, the Propagation scaling is set to 50 while the Curvature Scaling is set to 1. The result of this segmentation is shown in Figure 2. The Segmentation starts from the output of the Fastmarching filter, which assigns distance map in the image starting from the seed point.

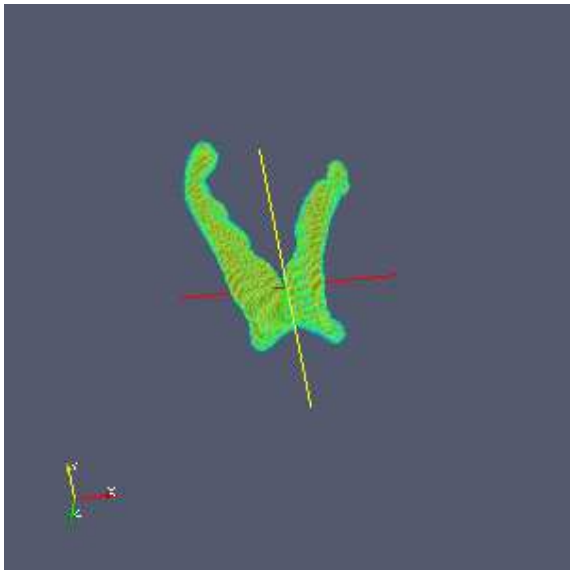

Figure 2: The result of segmentation of the ventricles using Geodesic Active Contour Levelset Segmentation, starting from the seed points manually selected.

The Shape Detection Active contour segmentation was obtained using the following set of parameters. The Propagation Scaling was set to 10 and the Curvature scaling was set to 0.1. It is shown in Figure 3.

For the execution of the code type the following command. It assumes that the data file is the same directory as the code.

```
.\Project1a.exe [data_file_name.mha] [result_file_name.mha]
[Choose algorithm: 0-ShapeDetectionActiveContour 1-Geodesic ActiveContour]
[Curvature Scaling] [Propagation Scaling]
```

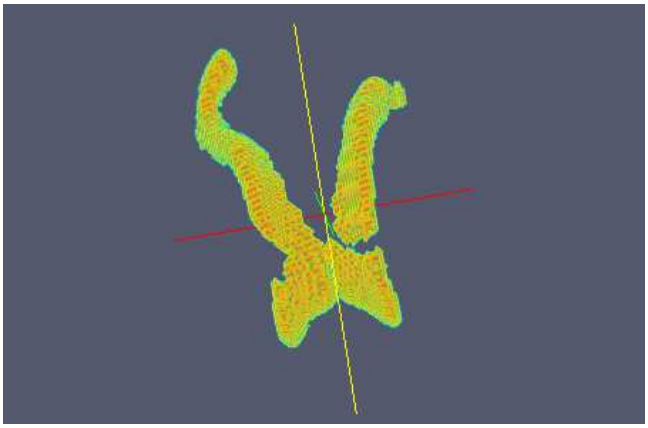

Figure 3: The result of segmentation of the ventricles using Shape Detection Active Contour Levelset Segmentation, starting from the seed points manually selected.