Final Project Report

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1 Abstract

People used to use quantify methods to evaluate the registration results. Unfortunately these methods are difficult to give feedback to improve the registration method for it hard to reflect the differences between different methods. We propose a visualization method on image registration. We can easily check the results and figure out the weak points of the registration method Through this method.

2 Introduction

Image registration is an important field in medical image processing. There are several methods to evaluate the results, such as overlap between outcomes and ground truth[1], or based on point set[2], or based on contours manually annotated[3][4].
Basically all of these methods are focus on quantity of comparison results. They are easy to measure but are not good at evaluate results. Two registration method with the same error rate will perform different. So these methods are difficult to give us feedback to improve registration results.
Here we plan to introduce a visualization way to compare image registration results directly, especially for MRI and fMRI images. There are several advantage for our method. Firstly, we can check registration results in different scales. The error in structure of images and error in the details should not be treated as the same. Secondly, it is more convenient to find out the differences between results and ground truth. For example if the result only has one pixel shift for the ground truth, we can see it easily from visualization, which is difficult for quantity methods.

3 Data preprocessing

In our data set we have MRI brain images and fMRI brain images which are from the same person and scanned at the same time. Unfortunately they are not matched. The MRI data has the matrix size 256×256, 170 slices and voxel size is 1.0×1.0×1.0 mm. And the fMRI data has the matrix size 64×64, 48 slices, and 140 volumes, voxel size is 3.3125×3.3125×3.3125 mm. Besides these we also have a canonical template whose gray matter is separated as 120 zones. Our purpose is to registration the fMRI with this template.

We use SPM12 for fMRI image preprocessing. We begin with discarding the first 10 fMRI image volumes for magnetization equilibrium[5]. Then the procedures of slice timing, motion correction are applied[6]. Then spatial normalization is followed[7]. Basically in this step we don't match fMRI with template directly, instead we match MRI image and the fMRI and use it as a middle step because MRI image has higher resolution. After registration of MRI image and fMRI image, MRI image is registered with the template and generate the transformation matrix. Then we use the same transformation matrix on fMRI to match fMRI data and the template.
So at the end each volume of fMRI image, MRI image and the template are matched, and all of them have the matrix size 91×109, 91 slices, voxel size is 2.0×2.0×2.0 mm. What we need to check at here is the matching between fMRI and MRI, MRI and the template, and fMRI and the template.

4 Visualization method

There are two goals for our implement. Firstly we want to know whether the whole brain of MRI, fMRI and template are matched or not. Secondly we try to check the 120 zones of MRI and fMRI are separated well or not. We implement two programs. For the first program we use volume rendering. We load three images: MRI image, fMRI image, and the template in the program, then set all three images with high level transparency so we can see all images at the same time, then we set different colors for the images. So if the images are not matched, we can see it from the transparent images, as shown in Figure 1a. We also can see how well the images are matched from the overlap of the colors, as shown in Figure 1b. Then we can select a zone from the template and set low level transparency for in the corresponding part of MRI image and fMRI image so we can see them through the brain,

as shown in Figure 2a. At here we normalized MRI image and fMRI image so the pixel value changes between 0 and 255. In visualization it means the color from light to dark. If MRI and fMRI have same structure in the same zone, then the color should change the same way. So we can see the differecies of specific zone of MRI and fMRI by the mixture of colors, as shown in Figure 2b. However for this program we can see the differences of MRI and fMRI, we cannot see the specific zone of MRI or fMRI is segmented well or not.

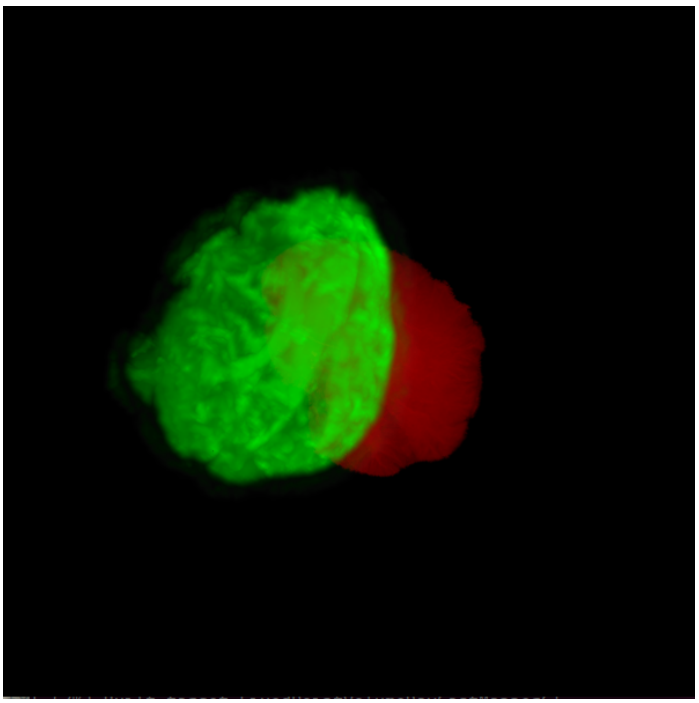

Figure 1a: MRI and fMRI images are not matched.

In our second program, we plan to visualize the volume of a specific zone and one frame of image about this zone at the same time. In this program normalize MRI and fMRI images the same as program one . Then we do volume rendering for a zone of MRI or fMRI image. And set the outside of the zone totally transparent so we only can see the region we are interest at, as shown in Figure 3a. We also render one image that cut the region. For the purpose that we want to see the intersection part of the image and the zone, we set one side of the cutting as totally transparent, as shown in

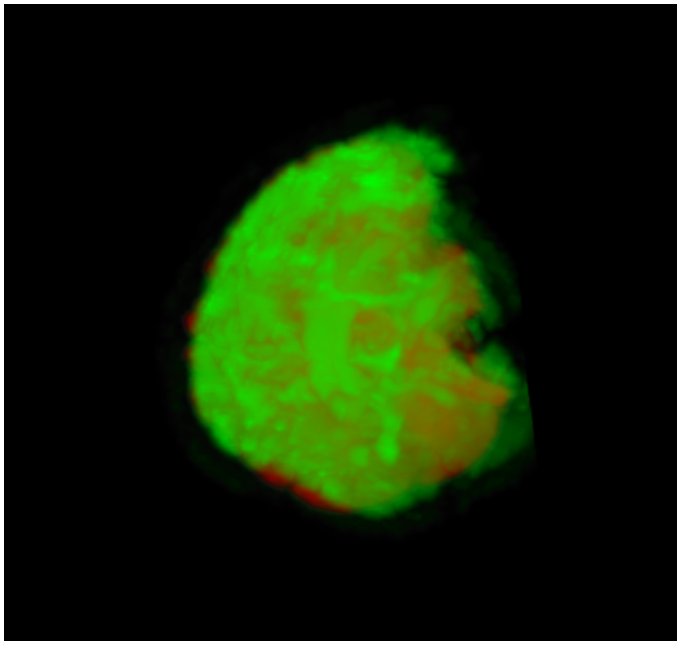

Figure 1b: MRI and fMRI images are matched.

Figure 3b.

5 Improvement

Next step we can add interaction to both of these programs. For the first one, we want to check different zones without compile again, i.e. set index of region of interest as a parameter in vtkRenderWindowInteractor. For the second one, we want to check the images frame by frame. We also can achieve it by modify or define our own vtkRenderWindowInteractor.

6 Reference

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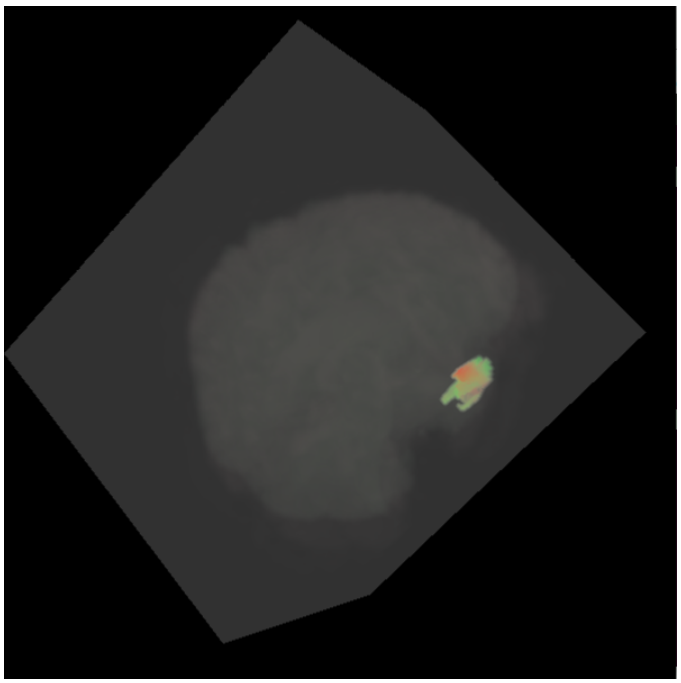

Figure 2a: MRI and fMRI images are matched, the region of interest is shown with color.

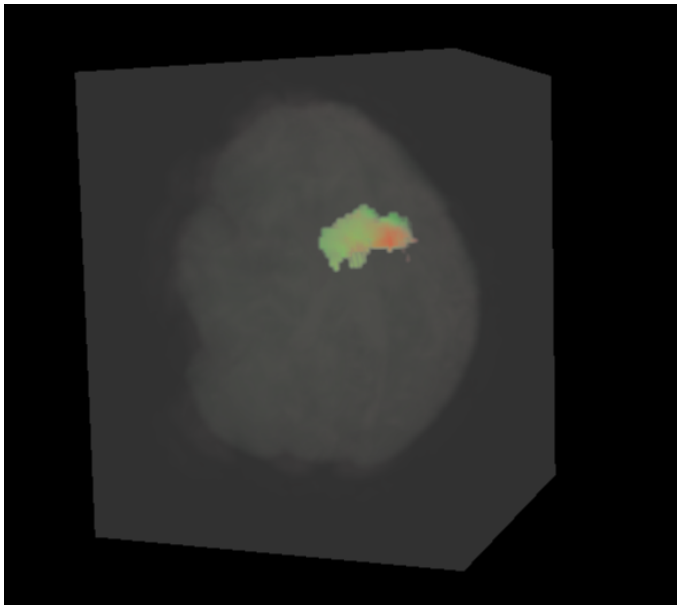

Figure 2b: Color shows the differences between MRI and fMRI.

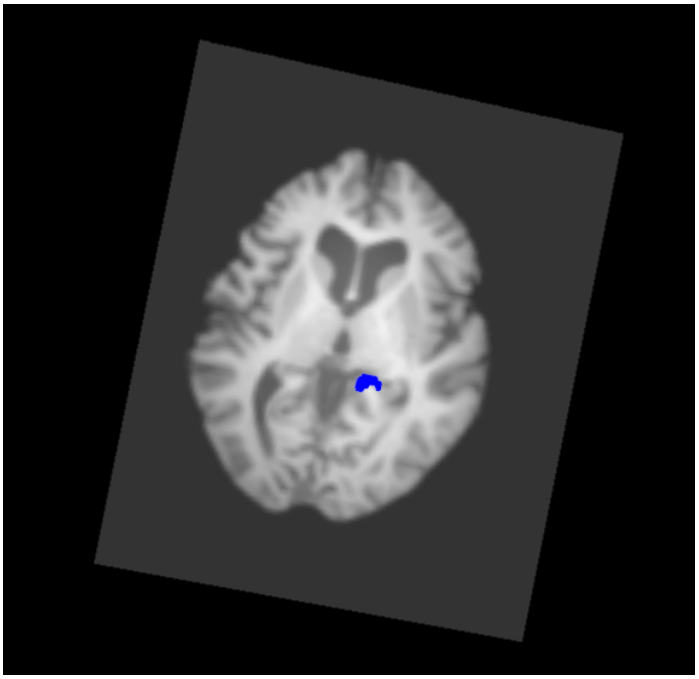

Figure 3a: The region we are interest at.

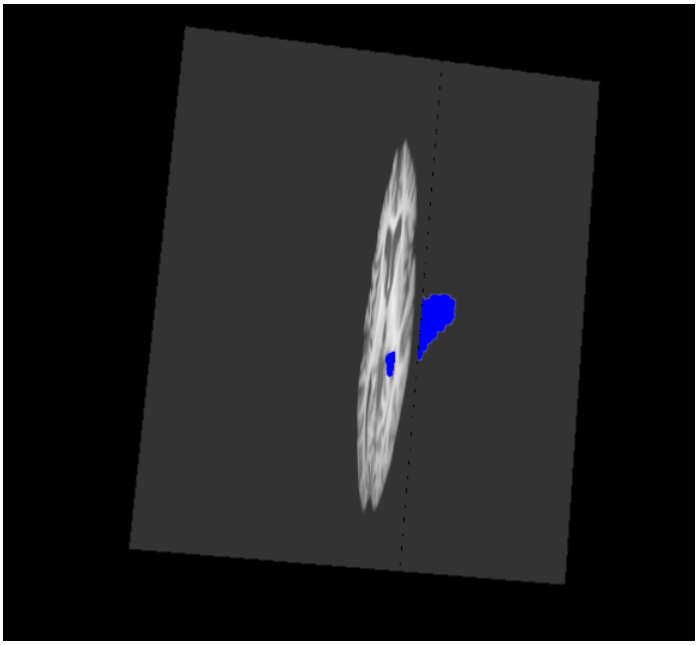

Figure 3b: One side is totally transparent.

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