Slicer3 Tutorial:
Registration Library Case 14

Intra-subject Brain PET-MRI fusion

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Overview

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Note: if wish to skip parts of the tutorial, you will find the data generated by individual steps in the Example Data Folder. You may load these individually via the "File/Add Data…" menu.

The SlicerScene file that comes with the tutorial will only load the initial volume data.

Introduction / Scenario

- We have a PET-MRI image pair to be fused, such that structural/anatomical information from the MRI can guide evaluation of the PET.

- The MRI DICOM files have the default orientation and voxel information stripped. The MRI thus first loads in the wrong orientation and aspect ratio

- The images represent the same subject, hence we expect good alignment, although some residual differences due to distortions are expected.
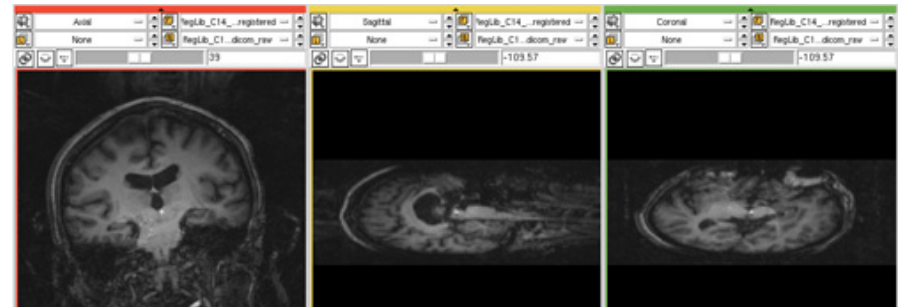
The MRI as loaded from the DICOM has incorrect aspect ratio and orientation. Note that the coronal and axial views are switched.
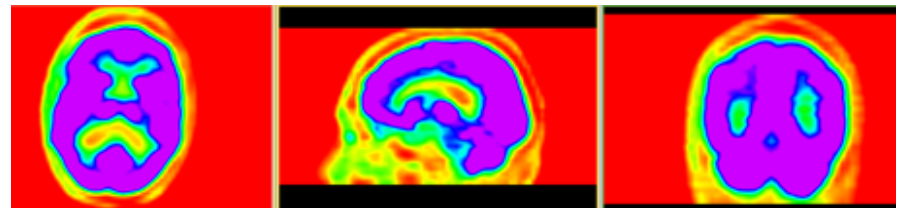
The PET loads correctly, acquired in axial slices with ~ 4mm isotropic resolution.

Modules Used

- To accomplish this task we will use the following modules:

    - Volumes Module

    - Transforms Module

    - Register Images   Modules: Register Images

    - Data Module

Prerequisites

- Slicer version 3.5 or later

- Example Dataset: download and extract the dataset for this tutorial: RegLib_C14_BrainPET-MRI.zip, which should contain this tutorial and all original and intermediate solution data files.

- Tutorials to complete first (optional):
  - Slicer3Minute Tutorial
  - Loading and Viewing Data

1. Loading Example Dataset

To get the Example Dataset loaded into Slicer:

1. **File** Menu: File: Load Scene…

   – Select the Slicer Scene file that comes with the downloaded example dataset, called: RegLib_…._SlicerScene.mrml

   – This will load all the necessary images. If this fails, use the "Add Data…" menu to load the files in the data directory.

2. Select Layout: From the icon bar, click on the Layout menu and select "Conventional Layout".

3. Link Views: Click on the Ring Icon in any of the slice views to link all the views together. This will save you the work of making selections for each slice window separately.

4. Choose Foreground: RegLib_C14_PET

5. Choose Background: RegLib_C14_MRI_dicom_raw
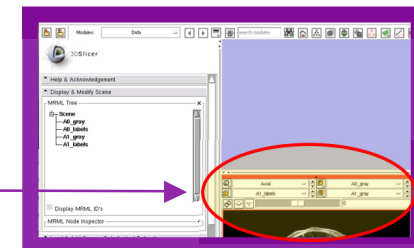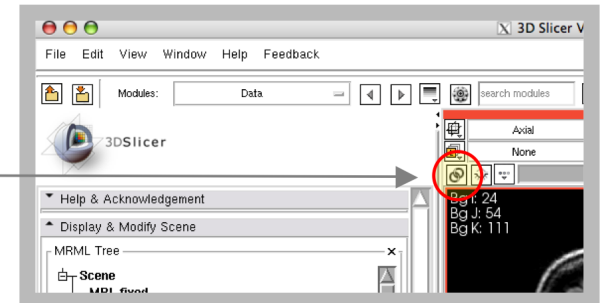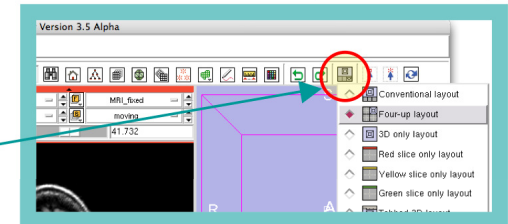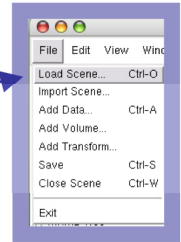
Adjust Views

1. Click on the little upward-facing triangle to collapse the 3D view.

2. If the images do not appear as shown on the right, adjust the window&level:

3. Go to the "Volumes" module and select the MRI volumes. Expand the "Display" tab.

4. For the MRI adjust the Window & Level slider until views look as shown on the right.

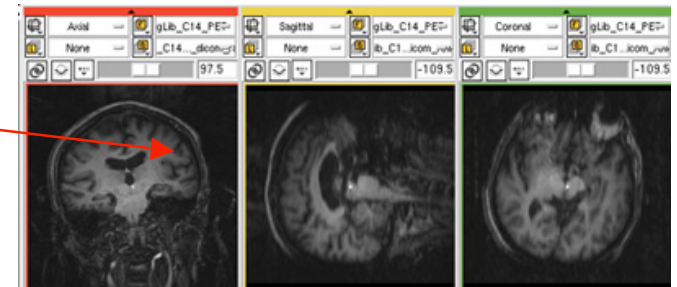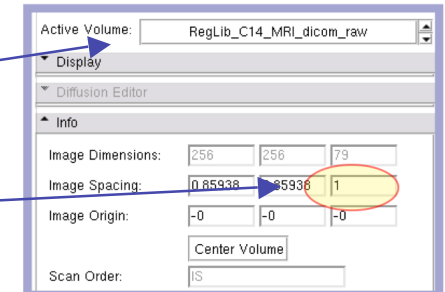5. For the PET images, click on the "PET" icon.
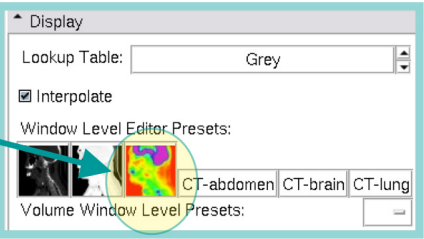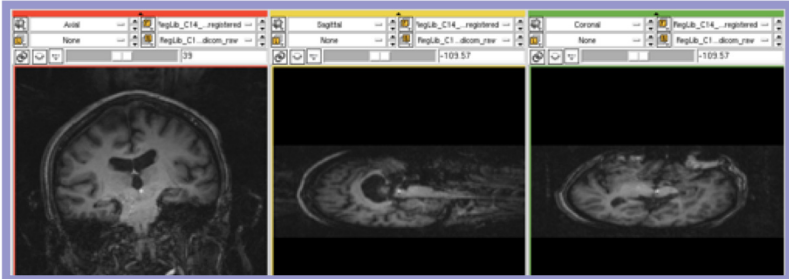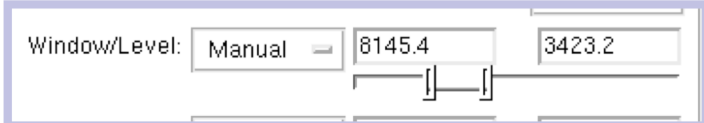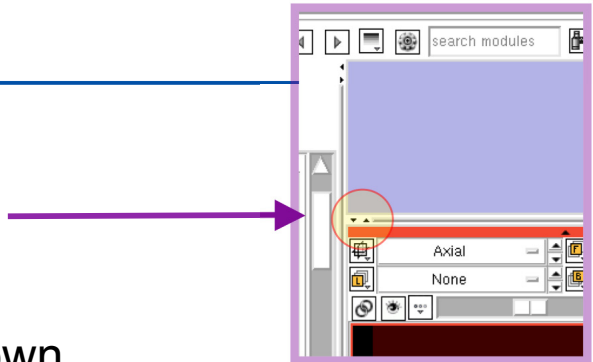
Fix MRI aspect ratio

1. We first correct the aspect ratio of the MRI:

2. You can obtain the correct slice thickness from the DICOM header. The quickest way is to select "Add Volume…" from the File Menu and navigate to the DICOM folder. In the browser view you see the header fields, including "Slice Thickness", which says 2.5mm. Click "Cancel" to close the browser.

Add Volume…

3. Go to the "Volumes" module

4. Select the MRI: RegLib_C14_MRI_dicom_raw

5. Expand the "Info" tab. Under "Image Spacing" you see 1mm as axial slice thickness. Change this to 2.5mm and hit the tab or return key.

6. The image should now look as shown on the right below. Orientation is still wrong, but aspect ratio is now correct.

Fix MRI axis orientation

1. Go to the "Data" module. Right click on the node called "Scene" and select "Insert Transform Node" from the context menu. A new node called "vtkMRMLLinearTransformNode6" or similar will be created.

2. Expand the "MRML node inspector" and rename the node, e.g. "Xform_MRIfix"

3. Drag the node for the MRI image ("MRI_dicom_raw") inside the transform. The MRML tree should now look as shown on the right. This assigns the new transform to be applied to the MRI image, so we can see our adjustments.
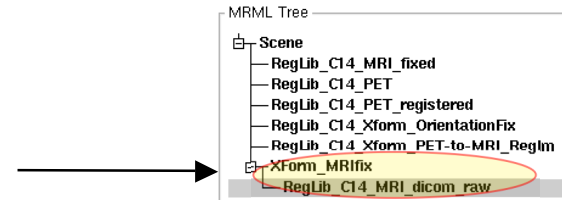
4. Go to the "Transforms"module.

5. Under "Transform Node", select the newly created "Xform_MRIfix"

6. Make sure you have the "MRI_dicom_raw" volume selected as background in the view panels and the view switched to show the background.

7. We now adjust the rotations of the volume until we get axial and coronal views to show up correctly.

8. Enter 90 in the "Rotation LR" field. Hit the "TAB" key to update.

9. Enter 180 in the "Rotation IS" field. Hit the "TAB" key.

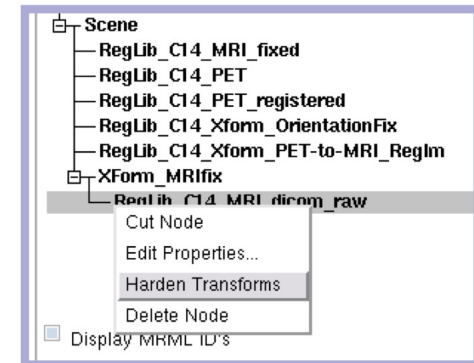10. You should now see the volume displayed correctly as shown on the right
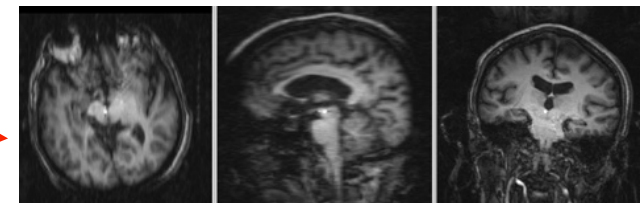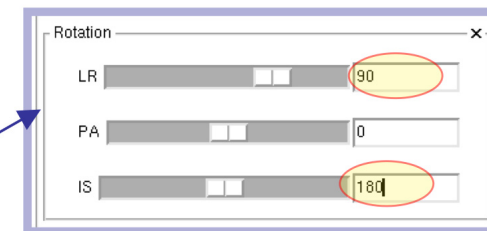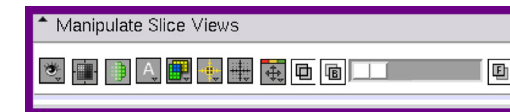
Resample

1. Go back to the "Data" module

2. Select the "MRI_dicom_raw" node. Right click and select "Harden Transforms". This will apply the transform and resample the volume into the new space. You should see the node for the image move back out to the root level.

Registration

1. Go to the "Expert Automated Registration" module

2. Input:
   fastest way is to select the presets already loaded with the scene, or load the separate presets file that comes with the tutorial, via "Import Scene…" or:

   Fixed Image: MRI (the one we just resampled, or the pre-loaded MRI_fixed)
   Moving Image: PET
   Save transform: create new, rename to "Xform_PET_affine"
   Resample Image: create new, rename to "PET_registered"

3. We leave all the default settings, as shown on the right, except for
   Expected Offset Magnitude: 20
   Affine Sampling Ratio: 0.05
   Click "Apply". Registration should take ~1 minutes

View Registration Result

1.   The result should look as shown on the right

2.   To inspect, place the MRI in the background and the registered PET in the foreground.
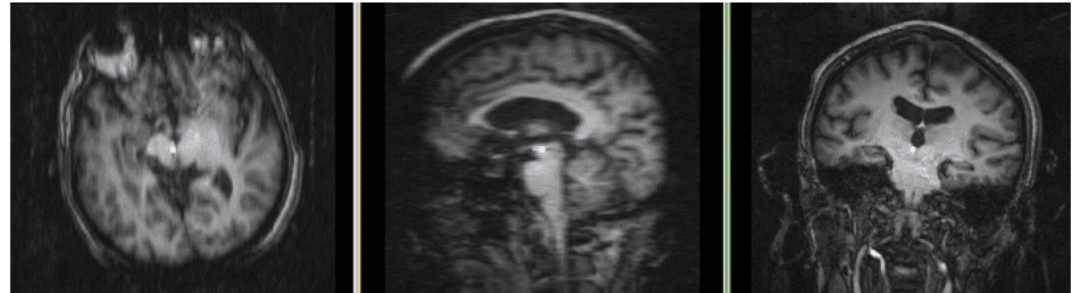
animated gif, view in presentation mode

3.   If you did not select to have a resampled volume generated by "Register Images", i.e. have only a transform as result, make sure to drag the PET image under the new transform in the "Data" module, as shown earlier.

4.   If you do have a new resampled volume: go to the "Volumes" module and ajust the display of the new "PET_registered" to a PET, as shown on slide 7.

5.   Switch between the views using the toggle button in the slice control tab.
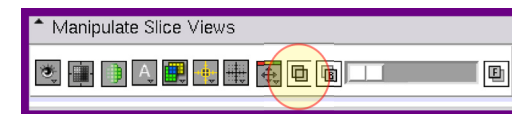
Save

- From the File menu, select "Save"
1. In the dialog box, check the boxes for the resampled PET, the fixed MRI and the transform. NRRD file format for images is recommended.

2. Ensure directories are as desired.
3. Click on "Save Selected".

Save Scene & Data Options

Select	Node Name	Node Type	Node Status	File Format	File Name	Data D
☑	(Scene Description)	(SCENE)	Modified	MRML (.mrml) ▾	RegLib_C14_SlicerScene1.mrml	📁/Net
☑	RegLib_C14_MRI_fixed	Volume	Not Modified	NRRD (.nrrd) ▾	RegLib_C14_MRI_fixed.nrrd	📁/Net
☑	RegLib_C14_PET	Volume	Not Modified	NRRD (.nrrd) ▾	RegLib_C14_PET.nrrd	📁/Net
☑	RegLib_C14_PET_registered	Volume	Not Modified	NRRD (.nrrd) ▾	RegLib_C14_PET_registered.nrrd	📁/Net
☑	RegLib_C14_Xform_OrientationFix	LinearTrans...	Not Modified	Transform (.tfm) ▾	RegLib_C14_Xform_OrientationFix.tfm	📁/Net
☑	RegLib_C14_Xform_PET-to-MRI_Reglm	LinearTrans...	Not Modified	Transform (.tfm) ▾	RegLib_C14_Xform_PET-to-MRI_Reglm.tfm	📁/Net
☑	RegLib_C14_MRI_dicom_raw	Volume	Modified	NRRD (.nrrd) ▾	RegLib_C14_s002_dicom_coronal.nrrd	📁/Net
☑	XForm_MRIfix	LinearTrans...	Modified	Transform (.tfm) ▾	XForm_MRIfix.tfm	📁/Net

What Next

- Try the Manual Registration Tutorial or one of the tutorials from the Registration Case Library.

    - http://www.slicer.org/slicerWiki/index.php/Slicer3.4:Training

    - http://na-mic.org/Wiki/index.php/Projects:RegistrationDocumentation:UseCaseInventory

    - http://www.slicer.org/slicerWiki/index.php/Slicer3:Registration#Registration_in_3D_Slicer|Main

- Feedback: anything amiss? If you have suggestions on how we can improve this and other documentation, please let us know: visit:

    - http://na-mic.org/Wiki/index.php/Projects:RegistrationDocumentation

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