User Manual

Python Recording Aid

Contents

1 Introduction

Imaging guided access to the brain has become a routine procedure for various research and clinical applications, including drug administration, neurophysiological recording, and sampling tissue. Python Recording Aid (PyRecAid) is an open-source tool designed to automate accessing the area of interest in brain.

The software supports both Dicom and Nifti image format as input and provides processing procedures including reslicing, flipping, adding chamber, and co-registration in an automated manner.

2 Installation

Simply download or clone the directory to a desired location on your local system (extract the .zip file in case of downloading). Then redirect to this folder on your system to find the following files and folders:

main directory → here you will see the program scripts including the main method [...]. Files → here you will see the manual.pdf containing user guide and the yml file for conda environment.

Prior to the installation you should have a distribution of Python3 interpreter installed on your system (we recommend the anaconda distribution). Instructions on how to run the software on Windows and Linux machines are described below. In the case you don not want to install the packages manually, after installing anaconda, jump to the yml installation part.

2.1 Installing anaconda

Download the anaconda from here for your operating system. Then install then application and follow bellow procedure to install software requirements.

2.2 For Windows users:

After installation of Python3, open command prompt or the anaconda prompt (depending on your Python3 distribution and path settings) and type the following commands at the prompt (case sensitive):

```
$ pip install scipy dicom PyQt5 matplotlib OpenCV−Python scikit−image
transforms3d dill nibabel torch torchvision torchaudio
```

If you have python2 in your environment then you should type pip3 instead of pip in the above command since in that case pip defaults to Python2. It takes some time so be patient and wait for the transactions to finish and then enter:

```
$ conda install −c clinicalgraphics gdcm
```

In case you do not want to install anaconda, you can download the GDCM library at here.

2.3 For Linux users:

Linux machines contain a system Python3. It is highly recommended that you don't install the program using the system Python3. You are better to install a virtual environment by venv or conda (in case you have anaconda or miniconda) and then follow the instructions below. Open a terminal with your desired python3 environment activated and type in the following line:

```
$ pip install scipy==1.2.0 dicom PyQt5 matplotlib OpenCV−Python scikit−image
transforms3d dill nibabel torch==1.10.2+cpu torchvision==0.11.3+cpu
torchaudio==0.10.2+cpu −f
https://download.pytorch.org/whl/cpu/torch_stable.html
```

If you have python2 in your environment then you should type pip3 instead of pip in the above command since in that case pip defaults to Python2. It takes some time so be patient and wait for the transactions to finish and then enter:

```
$ conda install −c clinicalgraphics gdcm
```

In case you do not want to install anaconda, you can download the GDCM library at here.

2.4 yml file installation:

Installing from yml file is the easiest way to execute the software. After installing the anaconda open a terminal (Linux/Mac) or anaconda command prompt (Windows) and create a new environment by running:

```
$ conda env create −f environment.yml
```

By running this command a new environment will be created under the name "pyRecAid". By executing the bellow command you can see the existing environments in your device.

```
$ conda env list
```

If the installation process runs successfully, you should be able to see the "pyRecAid" environment under the exported list. After installing successfully, you have to activate the environment by running:

```
$ conda activate pyRecAid
```

After activating the environment, go to the cloned code directory on your system and run:

```
$ python3 Main.py
```

Thereafter, the software starts and ready to be used.

3 Main Menu

This menu contain tools to show the 3d images, reslice it, add chamber, and flip it if required. In the following sections we express each part by details:

3.1 Loading Image Folder

Using **Load Folder** button, the series directory is selected. If there exist image series inside the selected directory, the list of existing series will be showed as shown in figure 1.

3.2 Load Series

After loading all images inside directory, you need to select the desired series and then press **Load Series** button. Then the loaded series is showed in the main form as figure 2. As it is observable, images contain the the slice distances in milimeters. Three slices including Horizontal, Sagittal, and Coronal are showed. By moving the mouse scroll on each slice, the whole brain could be covered.

3.3 Enabling Extra Options

To enable reslice, add chamber, and flip the tools menu should be opened from the upper bar of frame. Then, by pressing each option the related window will be shown on the side bar of the main form (figure 3)
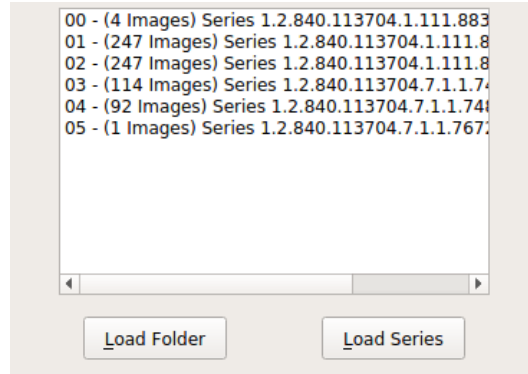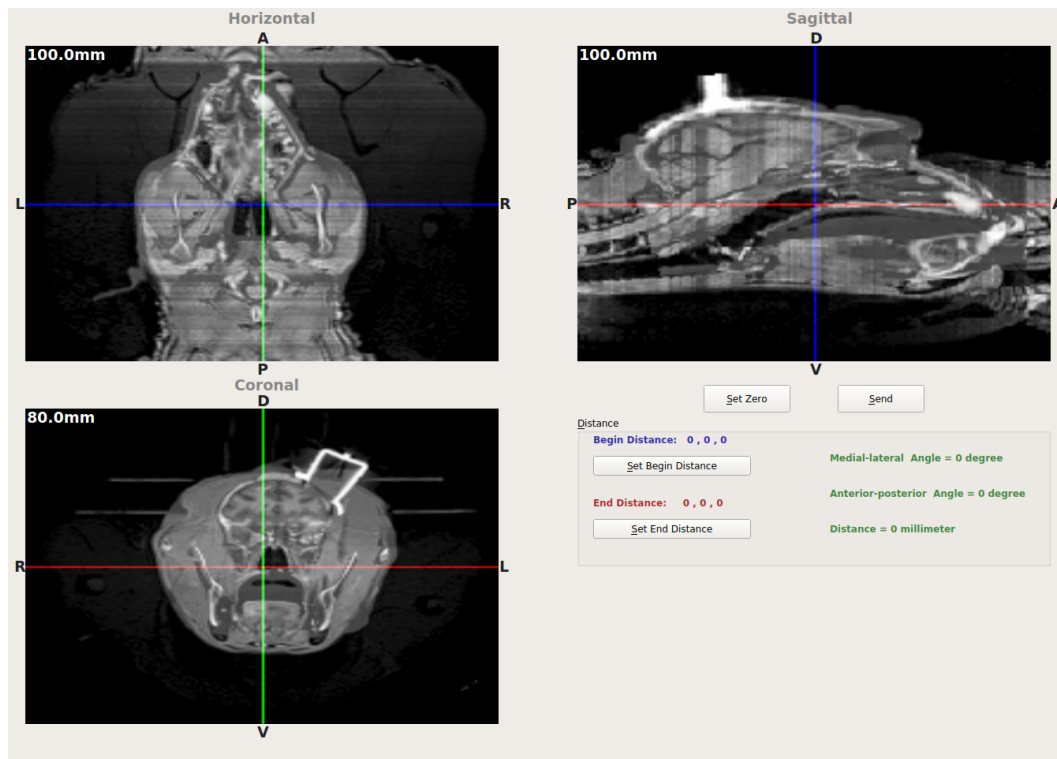
Figure 1: Series List

Figure 2: Loaded Series

3.4 Reslice

This tool is used to reslice the brain by specifying angles alongside each axis. All angles ranges are from -180 to 180 degrees. To reslice the brain in desired directions, related angles should be determined first, then by pressing **Reslice** button a new form with resliced series is shown as figure 4.

3.5 Add Electrode(Chamber)

Adding an electrode to the brain is one of the options that is provided in both resliced and main menu. As shown in figure 5, an electrode is added in the reslice form by setting required parameters. These parameters could be
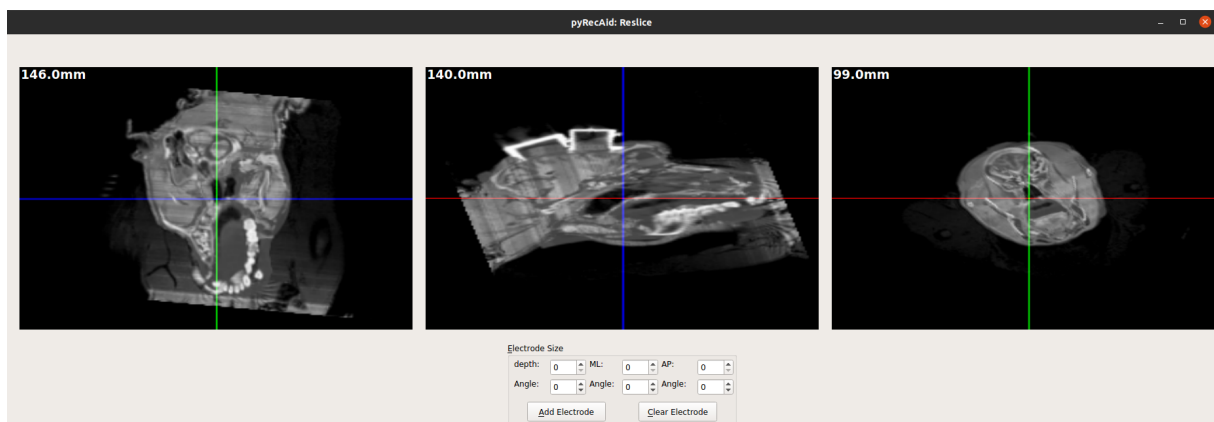
Figure 3: Extra Options

Figure 4: Reslice form

defined in the **Electrode Size (Chamber Size)** window (figure 6).

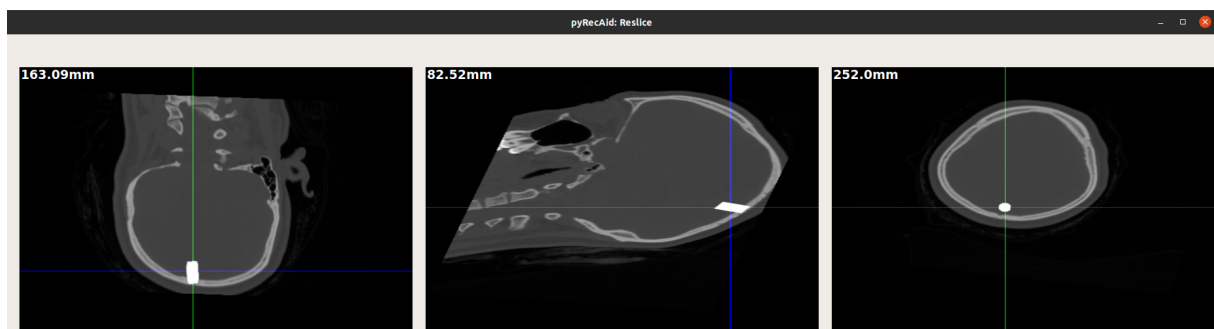Figure 5: Adding Electrode

5

Figure 6: Electrode Size

3.6 Flip Menu

This menu is very handy when the slices are not shown in right Directions. If the directions of head in series are not as desired, then by flipping them they could be put in right directions. As a case in point, Sagittal view is flipped as shown in figure 7.

3.7 Saving and Loading series

When an image series is loaded and manipulated, it may be needed to be saved for future experiments. As a case in point, you may want to use it in co-registration menu for after surgery assessments. In this case, the series could be saved by using **save** button under the **File** menu. It is also available by pressing **Ctrl+s**. It is worth mentioning that the last reslice will be saved by too, and the software will automatically detect the last reslice if it exists. The saved format is under dcmf format which is easily readable and writable in python.

To load a previously saved image series, the user should select the **open** option under the **File** menu or simply press **Ctrl+o** to open the desired dcmf file. After loading it, it will be shown in the main form and if a reslice is saved, then the last reslice button will be enabled in the reslice option.

4 Co-registration Menu

This menu is accessible from both main from by pressing **Co-registration** button, or opening from tools bar. The co-registration form is shown in figure 8. As it is observable, there are three rows for three series. The first and second series are the two series we intend to register. Consequently, the third row is for result series, which is the combination both first and second series. Loading the series is quite similar to the main form. After loading both series, some options are available for users. There are two types of co-registration available in this form: manual and automatic. Each option could be activated from the **tools** menu.

- **Manual co-registration:** This type of series co-registration is done by applying shift and rotation on the both series. The user could use both options provided in the related window to reach a proper result. Rotation is available on three different axes, and the shift is also provided in six directions. The **rotation preview** button is used to show the rotated images, but it will not be applied to other slices until the **rotation** button is pressed. In the case, the rotation is not as desired in the preview, the user could move the mouse scroll on one of images to eliminate the results as it is not finalized. Shift and rotate window is designed for this purpose as shown in figure 9.

- **Affine co-registration:** This co-registration is done by utilizing 3D affine transformation. To achieve a proper result, the user has to determine four match points on the both series and then press co-registration button to see the result. It is significant to choose these points precisely with at least one point on a different slice with others (not all of four points on a same plane). Point selection window is designed for this purpose as shown in figure 10. Points could be selected by setting the coordinates on both images by mouse scroll and the pressing **Select Point** button. By selecting each point, a check mark will appear in each box related to the point. If the user wants to clear points, it could be done by pressing **Clear Points** button. If a single point is to be cleared, then the user should clear the check mark of corresponding point.
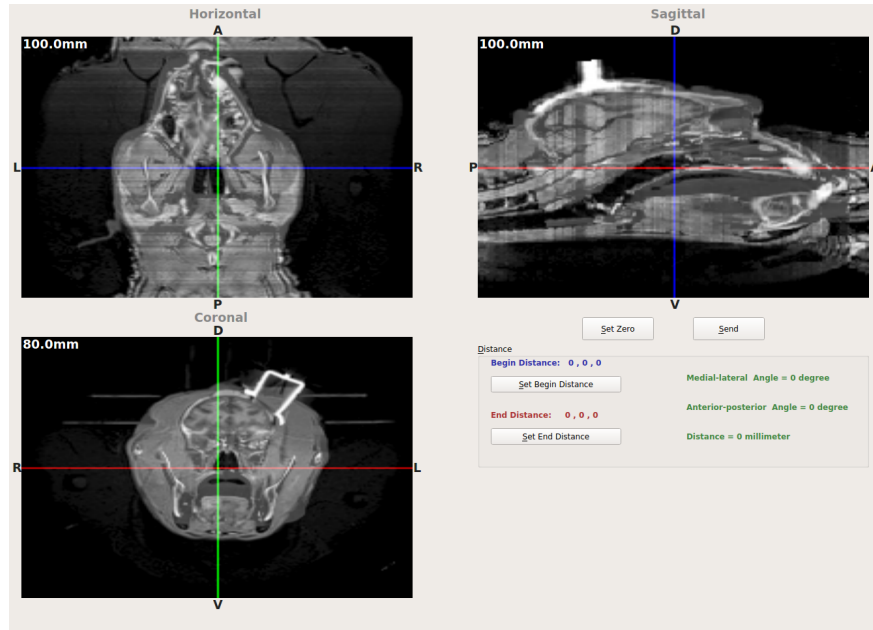
(a)
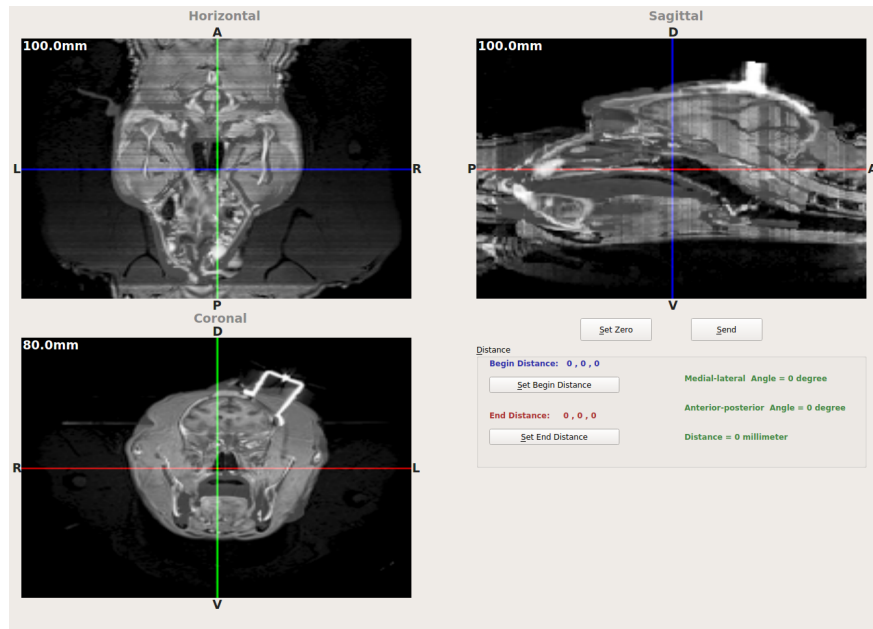
(b)

Figure 7: Flipped images

4.1 Flip and Swap options

If the series are not in the same directions and they do not match, then the user could change it to the right order by using **Flip** or **Swap** buttons. Before using this tools, the related series should be chosen and then the transformation could be applied (figure 11). These option could be enabled or disabled from tools bar. Two series should be in a same direction in order to reach a suitable co-registration.
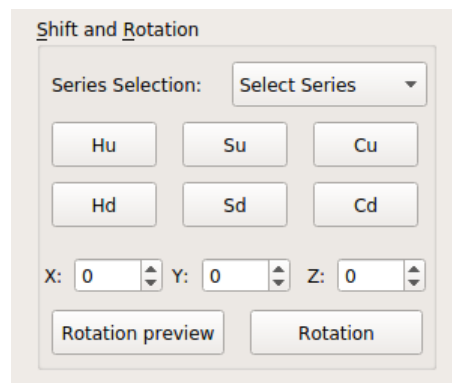
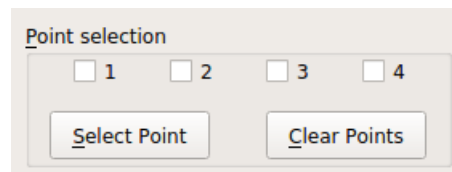Figure 8: Co-registration Menu

Figure 9: Shift and Rotation

Figure 10: Point Selection

4.2 Crop

In the manual co-registration, the series may have noise or undesired parts which are good to be removed. Hence, the **crop** option under the **tools** menu could be used in such cases. Cropping could be done from six different
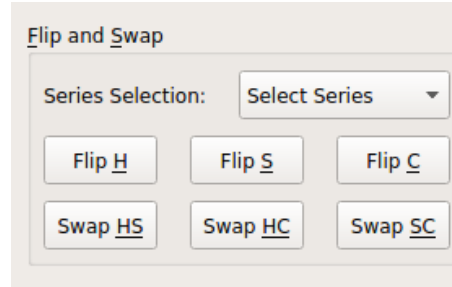
Figure 11: Flip and Swap window

directions and the maximum cropping pixels in each time is 50 pixels per direction. **Crop preview** is used to see the cropped image series and if it is as desired, it could be finalized by pressing **crop** button or discarded by scrolling on the series. This menu is shown in figure 12
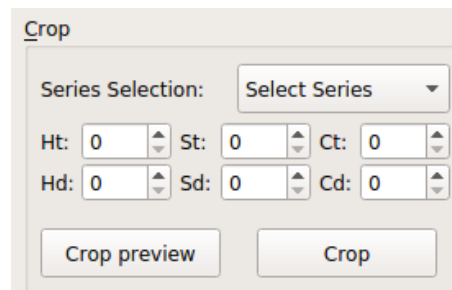

Figure 12: Crop window

4.3   Send to Main Form

After applying co-registration on series, the result could be sent to the main form by pressing **Send To Main Form** button. In the main form, the series are available for reslicing or adding chamber.

5   Some usable notes

- Each slice could be maximized by double clicking on it.

- Manual co-registration window and affine co-registration window could not be shown at the same time, but it is possible to first apply the manual registration and then do affine registration on the manipulated series.

- Crop and swap/flip menu are not usable at the same time in the co-registration menu, but they could be enabled and disabled from tools menu. By, enabling one of them, the other one will be automatically disabled.