

INSTAR: Infant Joint Segmentation And Registration

Pei Dong, Li Wang, Weili Lin, Dinggang Shen, Guorong Wu

Image Display, Enhancement, and Analysis (IDEA) Laboratory

Department of Radiology and Biomedical Research Imaging Center (BRIC)

The University of North Carolina at Chapel Hill, Chapel Hill, NC 27599

1. Purpose

Accurate segmentation and registration of early brain MR images is an essential part of many clinical diagnosis and applications, such as early detection of neurological disease and early brain development studies. Different from registration/segmentation on adult brain images, infant brain image registration and segmentation encountered much more challenges due to the dynamic image appearance change and anatomical structure variation during the fast brain developmental stage from birth to 2-year-old.

Since the urgent demand of accurate segmentation and registration tools for the early brain images, and no software with user-friendly interface is available currently, we developed an easy to use and high-performance software (INSTAR) using our latest proposed infant joint segmentation and registration framework to facilitate the researches for neuro-science community.

The software is developed at IDEA lab of the University of North Carolina at Chapel Hill, and can be downloaded from NITRC. Our software is free to use for the academic research purpose. Please cite the paper [1] as references if your studies use this software.

This software is distributed WITHOUT ANY WARRANTY; without even the implied warranty of MERCHANTABILITY or FITNESS FOR A PARTICULAR PURPOSE.

2. System and Installation

The software GUI is developed using Qt (<https://www.qt.io/>), and has been tested on Linux (kernel version 2.6.32-573.26.1.el6.x86_64). For using the software, we recommend the computer has more than 8G memory and 10G free disk space.

2.1 Overview of INSTAR

INSTAR provides an easy-to-use interface for the registration of early infant MR brain images. In particular, we incorporate our latest joint segmentation and registration framework to this software. Compared to the existing registration method, our method has its merits in two-fold. (1) The image registration is assisted by the image segmentation, which avoids the challenge of direct register two infant brain images with large appearance change. (2) The refined registration can help to bring more useful information to achieve better segmentation images. (3) Our framework is scalable to various registration tasks in early brain development studies.

2.1 Installation on Linux environment

For Linux user, please download the software (Instar_v1.0.tar.gz) and extract (using command `tar -xvzf ./instar_v1.0.tar.gz`) to certain folder, for example, `/home/username/instar`. If you are using C-Shell, you can set up the path by typing `setenv PATH ${PATH}:/home/username/ instar/ instar_release/` and type `setenv LD_LIBRARY_PATH "/home/username/instar/instar_release/lib"` in your c-shell profile (`~username/.cshrc`). If you are using BASH, type `export PATH=${PATH}:/home/username/instar/instar_release` and type `export LD_LIBRARY_PATH=/home/username/instar/instar_release/lib` in your bash profile (`~username/.bashrc`). Then, use the "source" command to make the change take effect immediately (`source ~username/.cshrc` for C-Shell user and `source ~username/.bashrc` for BASH user). To test if you have successfully use the INSTAR software, you can type "instar" in the terminal command line. If you can see the GUI shown in **Fig. 1**, congratulations, you are ready to enjoy INSTAR.

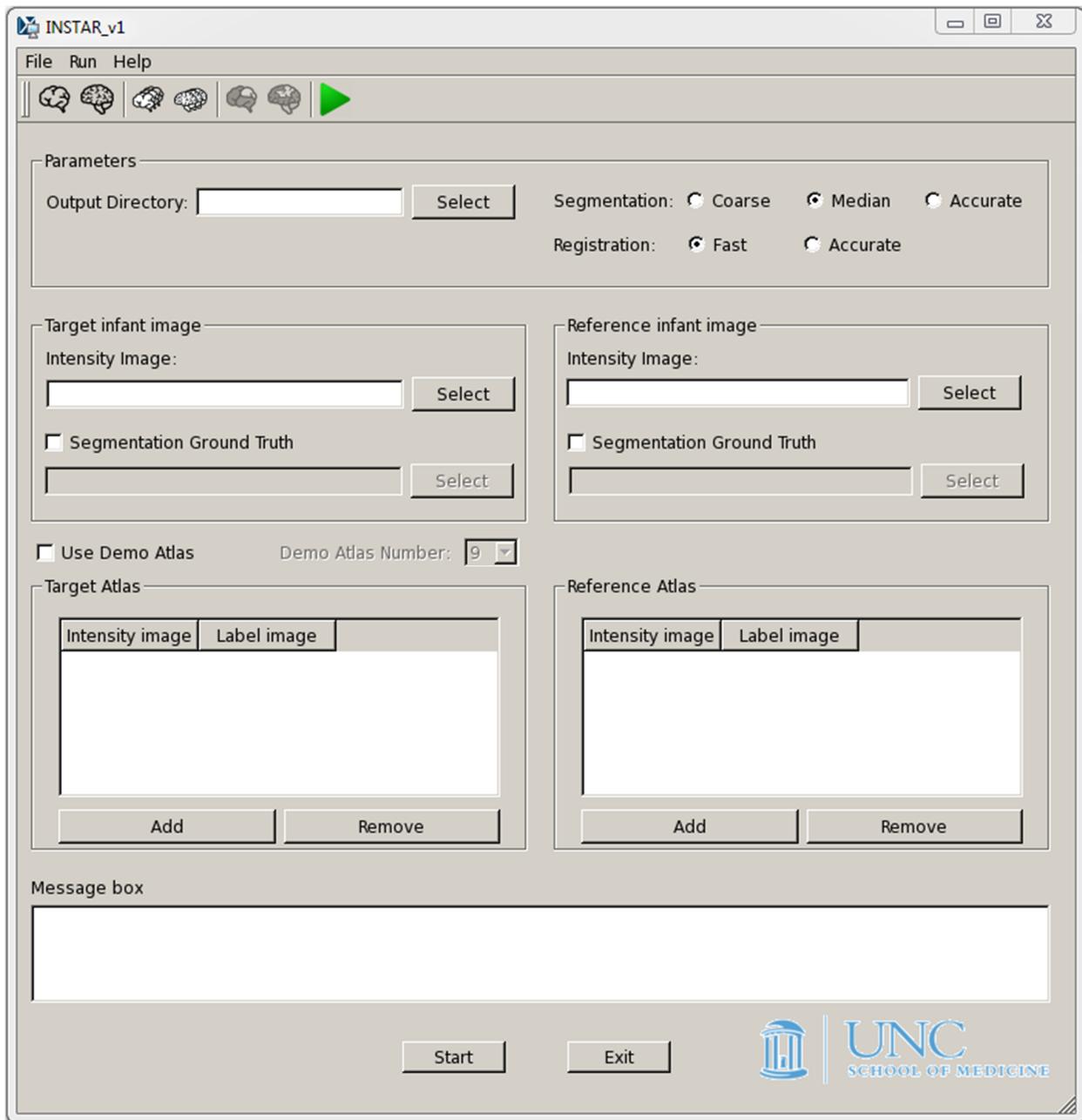


Fig. 1. Welcome screen of INSTAR in Linux.

3. The INSTAR GUI

The GUI of INSTAR is shown in Fig.1 (Linux). Next, we will go through the registration steps to illustrate how to align a target image with a reference image.

3.1 Load target image and reference image

To perform registration between two infant images, the user needs to load the target image (moving image) and the reference image (fixing image). To load the target image, the user can either chose "File -> Open Target Intensity Image" or chose the icon  on the tool bar, or click the "Select" button in the "Target infant image" section. To load the reference image, the user can either chose "File -> Open Reference Intensity Image" or chose the icon  on the tool bar, or click the "Select" button in the "Reference infant image" section.

If the user has the segmentation ground truth of the target image or the segmentation ground truth of the reference image, and want the software to run the analysis program for quantitative evaluation, please first check the "Segmentation Ground Truth" button. Then, to load the label image, you can either click the "Select" button in the "Target infant image" section and in the "Reference infant image" section. Or go to the menu and click "File-> Open Target Segmentation Ground Truth" or "File-> Open Reference Segmentation Ground Truth". Or simply click the icon  for "Open Target Segmentation Ground Truth", and the icon  for "Open Reference Segmentation Ground Truth".

It is noted that, in the current version, we only support 8-bit ANALYZE format. Please select the header file (with the extension of ".hdr").

3.2 Load atlas images

Our software uses multi-atlas segmentation method to extract brain tissue, including cerebrospinal fluid (CSF), white matter (WM), and gray matter (GM). Therefore, our software needs the user to provide atlas images and their corresponding label image for both target image and the reference image.

To load a pair of intensity image and label image at a time, the user can click the "Add" button in the "Target Atlas" section or "Reference Atlas" section. Then, you should see an open file dialog, as shown in **Fig. 2**. After selecting the corresponding image files (with the extension of ".hdr"), click "OK" button to add the selected files in the atlas table in the main GUI, as shown in **Fig. 3**. You may double click the element in the atlas table to check the file information. You need to repeat the above steps until you have loaded all the atlas images. To delete a pair of atlas images, you can first select the file in the atlas table, then click the "Remove" button below the table.

It should be noted that to successfully start the program, the software requires the same number of atlas images in both "Target Atlas" section and "Reference Atlas" section. Fig. 4 shows an example of after loading all the atlas images.

To test the software, the user can click the checkbox of "Use Demo Atlas" to automatically fill the test atlas images. The user can also choose the number atlas image by selecting "Demo Atlas Number". The test atlas images are under the "atlas" folder of the extracted INSTAR software.

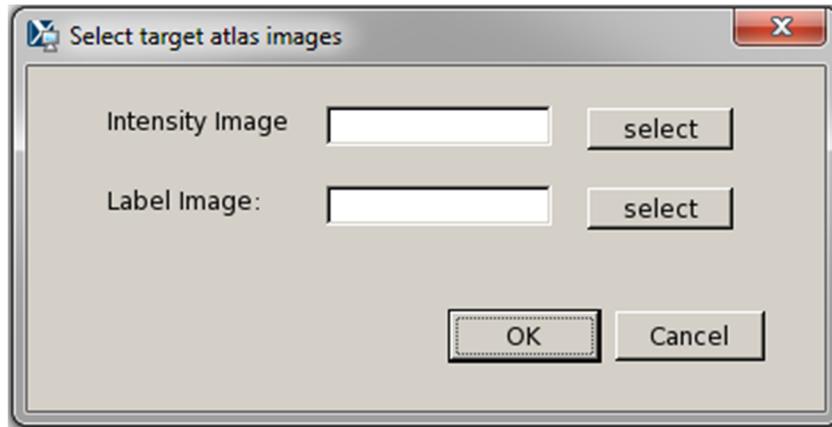


Fig. 2 Load atlas images, including an intensity image and a label image.

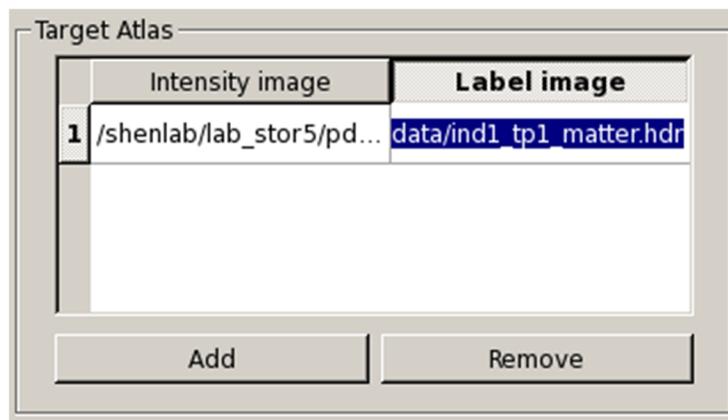


Fig. 3 Atlas table after loading a pair of intensity image and label image.

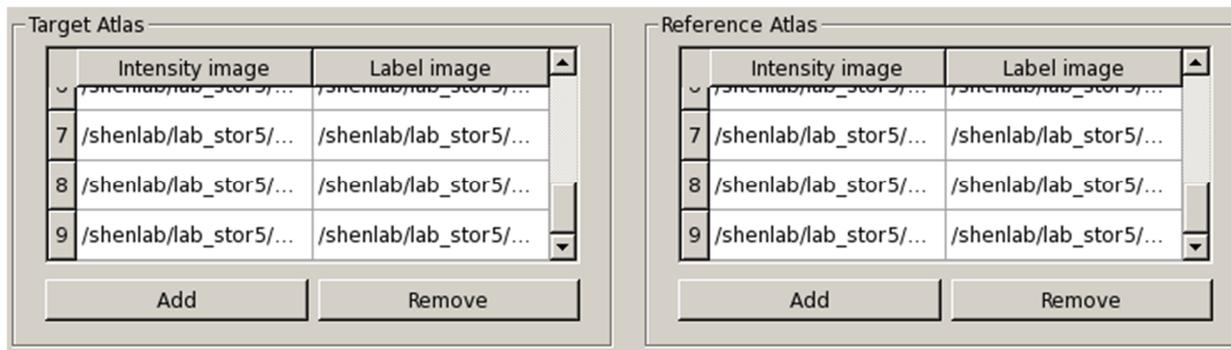


Fig. 4 Atlas table after loading all the atlas images for both target atlas and reference atlas. Note, the total number of atlas images need equal between target atlas and reference atlas.

3.3 Parameter settings:

In the parameter setting section, the user can select the output directory for the segmented target image, segmented reference image, registered target image and the evaluation result. The user is able to choose the quality of the segmentation and the registration process by choosing the corresponding

radio buttons, as shown in **Fig. 5**. Choosing the low quality of process will benefit from the fast processing speed.

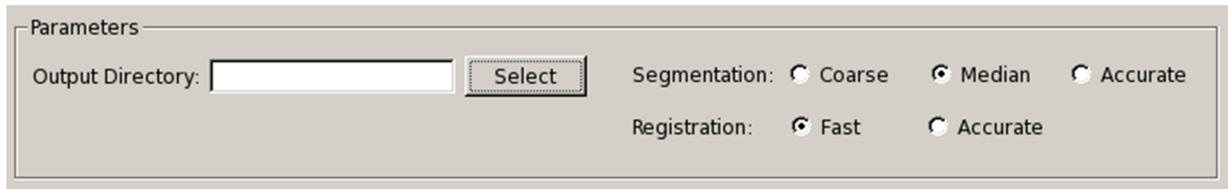


Fig. 5 Parameter settings

3.3 Check results:

After processing, the results will be saved in the output directory.

Output files are stored under the directory indicated in the "*Output Directory*", as shown in **Fig. 5**.

Segmented target label image	[output directory]/Seg_Target.hdr
Segmented reference label image	[output directory]/Seg_Reference.hdr
Registered target intensity image	[output directory]/Reg_Intensity_TargetToReference.hdr
Registered target label image	[output directory]/Reg_Label_TargetToReference.hdr
Evaluation result	[output directory]/report.txt

4. Contact us

For questions and bug reports, please email to pei.dong@med.unc.edu

5. Reference

[1] P. Dong, L. Wang, W. Lin, D. Shen, and G. Wu, "Scalable joint segmentation and registration framework for infant brain images," *Neurocomputing*, In Press, 2016