Software for MABMIS: Multi-Atlas-Based Multi-Image Segmentation

Hongjun Jia, Pew-Thian Yap, and Dinggang Shen

Image Display, Enhancement, and Analysis (IDEA) Laboratory
Department of Radiology and Biomedical Research Imaging Center (BRIC)
University of North Carolina at Chapel Hill, Chapel Hill, NC 27599

1. Purpose

This software package implements MABMIS: Multi-Atlas-Based Multi-Image Segmentation [1] – an algorithm for accurate and consistent multi-atlas based segmentation/labeling on a group of images.

Hongjun Jia, Pew-Thian and Dinggang Shen, "Iterative Multi-Atlas-Based Multi-Image Segmentation with Tree-Based Registration", NeuroImage, submitted.

The package is available free to the public for the academic research purpose at IDEA lab webpage http://bric.unc.edu/ideagroup/free-softwares/, and NITRC http://www.nitrc.org/projects/mabmis. Please cite the paper of MABMIS [1] as references if your studies use this software.

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2. System and Installation

This software is developed using ITK (http://www.itk.org/) and has been tested on Windows XP (32-bit) and Linux (64-bit, kernel version 2.6.18-194.el5). The required inputs are a set of atlases with 3D MR intensity images and the corresponding segmentation/label images, a set of images to be segmented with only intensity image, and a text file (.txt) listing all IDs of each image. All image files are in Analyze format with paired .hdr and .img files. The output is the set of labeled images. The following is the software packages required by MABMIS.

2.1. Diffeomorphic demons

MABMIS uses Diffeomorphic demons (*Vercauteren et al., Diffeomorphic demons: Efficient non-parametric image registration, Neuroimage, 45(1 Suppl):S61-72, 2009*) as the registration engine for estimating the dense deformation field between 3D MR intensity images. Please refer to the following websites for the code and the paper:

http://insight-journal.org/browse/publication/154

http://www.ncbi.nlm.nih.gov/pubmed/19041946

2.2. Tcl/Tk

MABMIS GUI version uses Tcl/Tk 8.5 version (http://www.tcl.tk/software/tcltk/) together with KWWidgets (http://www.kwwidgets.com/) and VTK (http://www.vtk.org/). Please have Tcl/Tk installed on your Linux 64-bit system, or copy the lib folder and the library files tcl85.dll, tk85.dll in the package to the same folder as other executable files on your Windows XP 32-bit system.

2.3. C runtime library in Windows

If the pop-up windows shows the error information as "This application has failed to start because the application configuration is incorrect ……", please download and install Microsoft Visual C++ 2005 Redistributable Package (x86) (http://www.microsoft.com/downloads) if you do not have Visual C++ 2005 installed on your machine with Windows. You can also use the file vcredist_x86.exe, which is included in this package, to install.

2.4. Download package

Package for Windows-32bit includes:
- MABMIS_GUI_main.exe, MABMIS_command.exe,
- MSVCP80.dll, MSVCR80.dll, MSVCM80.dll, Microsoft.VC80.CRT.manifest, vcredist_x86.exe,
- tcl85.dll, tk85.dll, and a tcl/tk library folder: lib.

Package for Linux-64bit includes:
- MABMIS_GUI_main, MABMIS_command.

2.5. Before starting MABMIS

All MR intensity images used as inputs to MABMIS should be pre-processed so that they are in the same situation (i.e., skull-stripped or not, cerebellum removed or not, etc.). And all input images should be in Analyze format with paired header (.hdr) and image (.img) files with same size and resolution.

- Please copy all program files, library files and lib folder (for windows) in the package to the same folder of data.
- Please create a text file (.txt) within the data folder, which includes all IDs. Each ID is in the form of "AA" with two letters. All IDs of images to be segmented are listed after the IDs of atlases in the file, with a space required after each ID. Please refer to Sec. 3.3 for details.
- Please make sure that there are NOT any spaces in the absolute path of the image list file. For example, do not copy data files to the desktop in windows, as its path, "Documents and Settings," includes spaces.

3. The MABMIS GUI
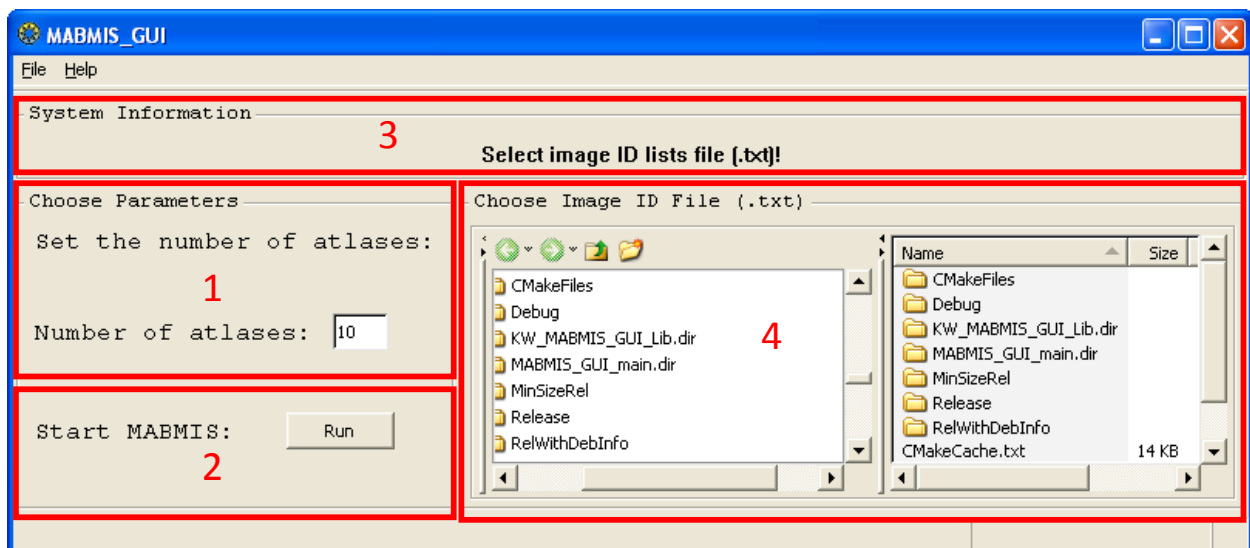
3.1. User interface

The GUI can be launched by calling:

```
MABMIS_GUI_main
```

The GUI is divided into several regions:

- Region 1: Parameters used by MABMIS
- Region 2: Button to start MABMIS
- Region 3: System information
- Region 4: Panel for selecting the list file

3.2. Required Parameters

Two parameters (in this version) are needed which are explained as follows.

Number of atlases: An integer showing the number of atlases whose file name is indicated by the first part of IDs file.

ID file name: The name of IDs files which includes all IDs of atlases and images to be segmented. User need to specify this file using the file explorer window (Region 4).

3.3. IDs file

All IDs of the atlases and images to be segmented are listed in one single text file (.txt), which is one of the inputs to MABMIS. For each ID, e.g., "AA", the corresponding intensity image file name is AA_cbq_000.hdr (and AA_cbq_000.img), and the corresponding label image file name, if this is an atlas, is AA_seg_000.hdr (and AA_seg_000.img).

For example, if there are four atlases (with IDs AA, AB, AC, AD) and five images to be segmented (with IDs BA, BB, BC, BD, BE), the IDs file is as follows (with a space after each ID and NO 'carriage return' at the end of the line):

AA AB AC AD BA BB BC BD BE

And please make sure you input the correct number of atlases (4 in this case) in the field of **Number of atlases**.

Please make sure that all .hdr files and their corresponding .img files exist in the same folder as well as the list file. Please notice that there should NOT be any space in the data folder name or any parent/ancestor folders' name. For example, do not copy data files to the desktop in windows as its path, "Documents and Settings," includes spaces.

3.4. Starting MABMIS

Before running MABMIS, copy all executable files and the library file in the package to the data folder.

For 32-bit windows, these files are:
- MABMIS_GUI_main.exe, MABMIS_command.exe, tcl85.dll, tk85.dll and the lib folder.

For 64-bit Linux, these files are:
- MABMIS_GUI_main, and MABMIS_command.

One can start to run MABMIS GUI version from the folder with all image files and image list file by calling `MABMIS_GUI_main`. If all parameters are properly set and the list file is selected, MABMIS can start by pressing the button "Run".

3.5. Result

The outcome of MABMIS is the segmentation result of each image to be segmented. For the case in Sec. 3.3, the output images are as follows:

BA_seg_001.hdr(.img), BB_seg_001.hdr(.img), BC_seg_001.hdr(.img), BD_seg_001.hdr(.img), BE_seg_001.hdr(.img),

BA_seg_002.hdr(.img), BB_seg_002.hdr(.img), BC_seg_002.hdr(.img), BD_seg_002.hdr(.img), BE_seg_002.hdr(.img),

…

The number within each file name indicates the iteration number.

3.6. System Information

<div style="text-align:center">Select the image header lists file (.txt)!</div>

Initial information.

<div style="text-align:center">Please select one file with image names!</div>

If zero or more than one files is selected in the file explorer window.

<div style="text-align:center">The number of Atlases is invalid.</div>

If the number of atlases specified in **Number of atlases** is not valid.

<div style="text-align:center">Please check all .hdr and .img files (ID_cbq_000)!</div>

If the image file sanity check is not successful. Possible causes include: 1) some file names do not have the extension hdr, 2) missing header (.hdr) files, 3) missing image (.img) files, and 4) missing the corresponding label image.

<div style="text-align:center">Missing executable file MABMIS_command.exe.</div>

If the required executable file is not found within the same folder as MABMIS_GUI_main.exe.

<div style="text-align:center">Spaces found in the data file path!</div>

If any space is found in the absolute path of data or image list files.

<div style="text-align:center">Missing image ID file.</div>

If the image list file is not found.

MABMIS is running …

If MABMIS starts normally.

MABMIS failed!

If MABMIS failed for some reason.

MABMIS is done successfully!

If MABMIS is successfully executed.

4. Command Line Version

The command line version of MABMIS, `MABMIS_command`, is similar to the GUI version. Please make sure that the executable file, MABMIS_command.exe for 32-bit windows or (MABMIS_command for 64-bit Linux) and the data files are in the same folder. Create a text file listing all IDs of atlases and images to be segmented in the data folder and start MABMIS with `MABMIS_command`.

A typical call is as follows.

`MABMIS_command ids_list.txt number_of_atlases`

Parameters are listed below (option -f is required).

   ids_list.txt - The list file with all IDs with atlases' ids listed in the front

   number_of_atlases – The number of atlases

5. Contact us

For any questions or bug reports, please email to jiahj@med.unc.edu.

6. References

[1] Hongjun Jia, Pew-Thian Yap and Dinggang Shen, "Iterative Multi-Atlas-Based Multi-Image Segmentation with Tree-Based Registration", NeuroImage, submitted.