

RegLSM Manual

1 Introduction

1.1 Outline

RegLSM is an interface in Windows OS that supports registration of CT and MR (DWI and FLAIR/T2) brain images to MNI space. The lesion masks together with their source images are input of this interface, and the output transformed lesion masks can be used for VLSM analysis (by NPM in [MRIcron](#)). The user can check the registration results of the final step or intermediate steps. Although manual correction is needed for about some of the results, it is not yet available in current version of this UI. The major functions of this UI are based on [Elastix](#) and [SPM12](#), so the installation of these two software is essential before you run RegLSM.

1.2 Installation

It is required that the user has installed Matlab and SPM before using this UI.

SPM is a package of functions that can be called in Matlab. To enable SPM in Matlab, the user should add the address of SPM folder in Matlab PATH. We recommend the user install SPM12 (the latest version of SPM) in Matlab. Although previous versions of SPM might also be sufficient, we have not tested for them.

For elastix, its version 4.8 has been embedded in the UI code, so you do not need to install it independently. However, you still have to prepare some basic tools (e.g. Microsoft Visual C++ Redistributable Package) to enable elastix, where you can find help in FAQ of Elastix (<http://elastix.isi.uu.nl/FAQ.php>).

1.3 Quick start

To open this UI in Matlab environment, you should change the current folder to that of RegLSM, and then type “RegLSM” in the command window. You will see a “Brief Guide” in the major panel that introduces the basic operation of the main functions. In the menu bar, you can realize the functions supported by this UI.

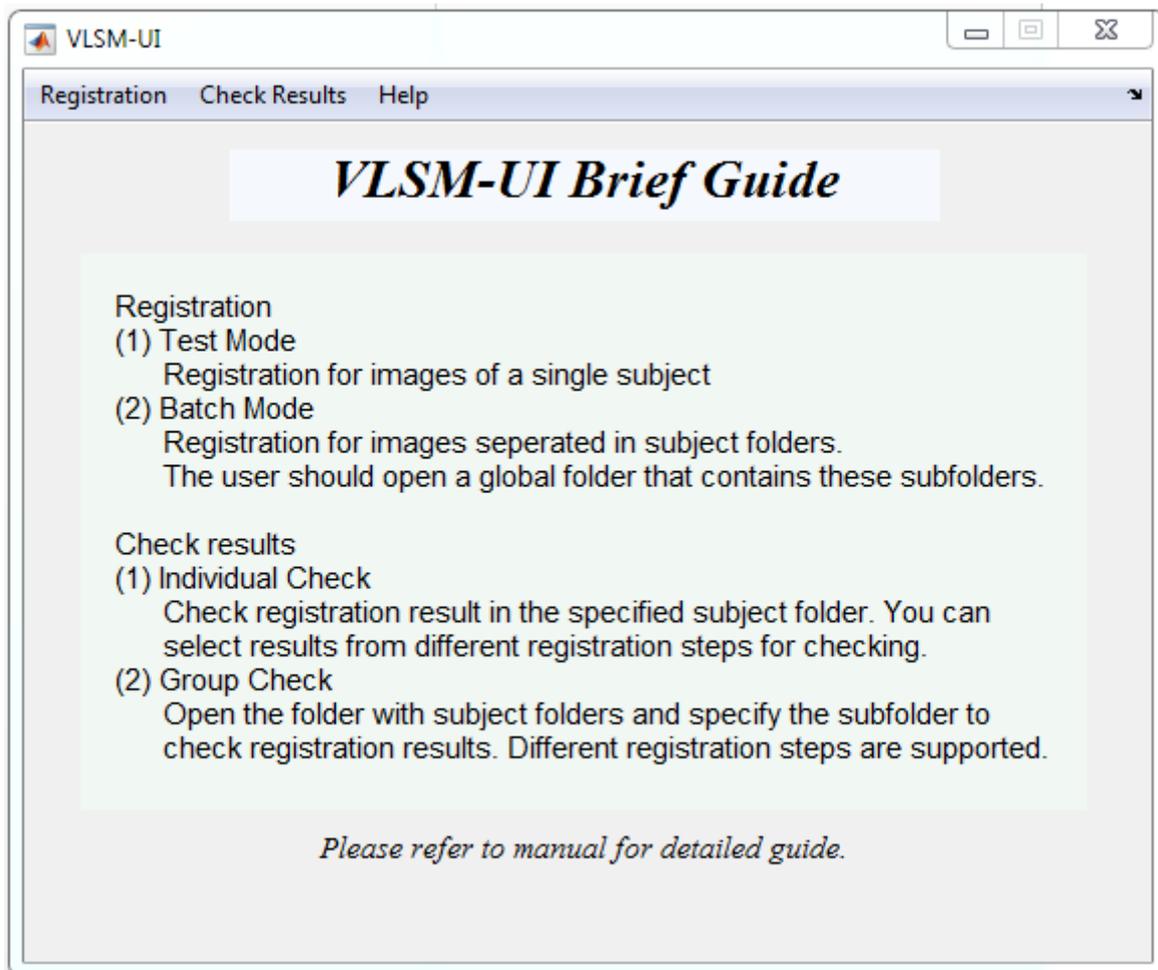


Figure 1 Main panel of RegLSM

2 Image registration

2.1 Test mode

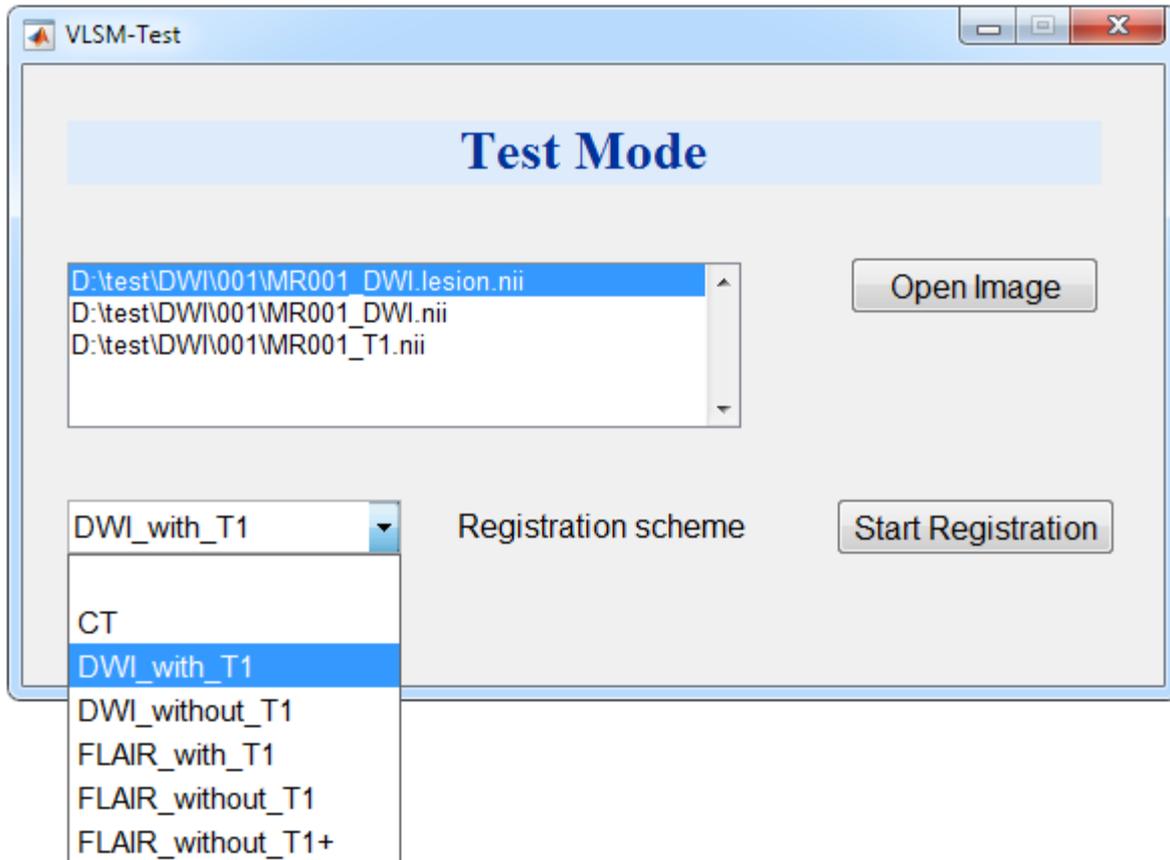


Figure 2.1 Panel of Test Mode

By clicking “Test Mode” in the item of Registration in the menu, you will see a panel like **Figure 2.1**.

- Open Image

The user can select nii files in the same folder and the directories of these files will be displayed in the listbox on the left. We recommend that you specify only the needed images for registration. If you select more than one lesion mask or source image, the registration cannot be started.

- Naming of images

Before selecting images for registration, the user should rename the images like the inputs shown in **Figure 2.1**. For example, if the lesion are delineated on DWI/FLAIR/T2, the source image should bare a string “DWI”/“FLAIR”/“T2” respectively. To name the lesion, you should copy the name of the source image and add “.lesion” to it. For T1 image, make sure to include “T1” in the name.

- Presence of 4D images

If some of the required input images are 4D nii, they will be converted to 3D nii automatically and the first layer will be taken as the input for registration.

- Registration Scheme

The user need to specify a registration scheme for selected images: CT, DWI_with_T1, DWI_without_T1, FLAIR_with_T1, FLAIR_without_T1, and FLAIR_without_T1+ (better than FLAIR_without_T1 to deal with large ventricles).

To specify an appropriate registration scheme for your images, there are some tips to follow. If the lesion is delineated on CT, select “CT” as the registration scheme. For MR images, there are different scheme according to the modality of the source image.

- (1) **DWI_with_T1**: If the lesion is delineated on DWI and you have a T1-weighted image of the same patient, please try this scheme first. However, if the lesion locates near skull, brainstem or cerebellum, and the mapping of the lesion is not good, you need to turn to “*DWI_without_T1*”.
 - (2) **DWI_without_T1**: If the lesion is delineated on DWI and you do not have a T1-weighted image of the same patient, please select this scheme.
 - (3) **FLAIR_with_T1**: If the lesion is delineated on FLAIR or T2 and you have a T1-weighted image of the same patient, please try this scheme first. However, if the the mapping of the lesion is not good, you can to turn to “*FLAIR_without_T1*” (or “*FLAIR_without_T1+*”, which is better to deal with large ventricles).
 - (4) **FLAIR_without_T1**: If the lesion is delineated on FLAIR or T2 and you do not have a T1-weighted image of the same patient, please try this scheme. If the lesion mapping is not good with this scheme due to large ventricles, please turn to “*FLAIR_without_T1+*”.
 - (5) **FLAIR_without_T1+**: This is the last option for FLAIR or T2 images and is better to deal with large ventricles to some degree. There might be bugs for some computers when running “*FLAIR_without_T1*” or “*FLAIR_without_T1+*” in elastix.
- ❖ Please note that the previous registered source image and lesion mask will be covered with the newly generated results. If you want to compare the results from different registration schemes, please save the previous result (in folder “to_MNI”) to another place.
 - ❖ There might be bugs for some computers when running MR registration schemes without T1. When you encounter a disruption error dialog of elastix, close it and contact the developers.

■ Start Registration

For now, this interface only accept registration if lesion mask is acceptable. If the specified images are not sufficient to match corresponding registration scheme, an error dialog will appear once the user click on “Start Registration”. Otherwise, the registration will start immediately with the specified images and registration scheme.

2.2 Batch Mode

By clicking “Batch Mode” in the item of Registration in the menu, you will see a panel as **Figure 2.2**. In batch mode, most functions are similar to those in the test mode. However, there are several differences.

■ Open Folder

The user need to select a folder with subfolders that contain images of specific patients. For example, as is shown in **Figure 2.2**, we have 3 subfolders (named 001, 002, and 003) in the global directory “D:\test\DWI”. Each subfolder has source DWI, lesion mask, and T1 image of the subject. Here we do not support image selection for every subject, so the user should rename the images according to the tips mentioned in “Naming of images” of the previous section.

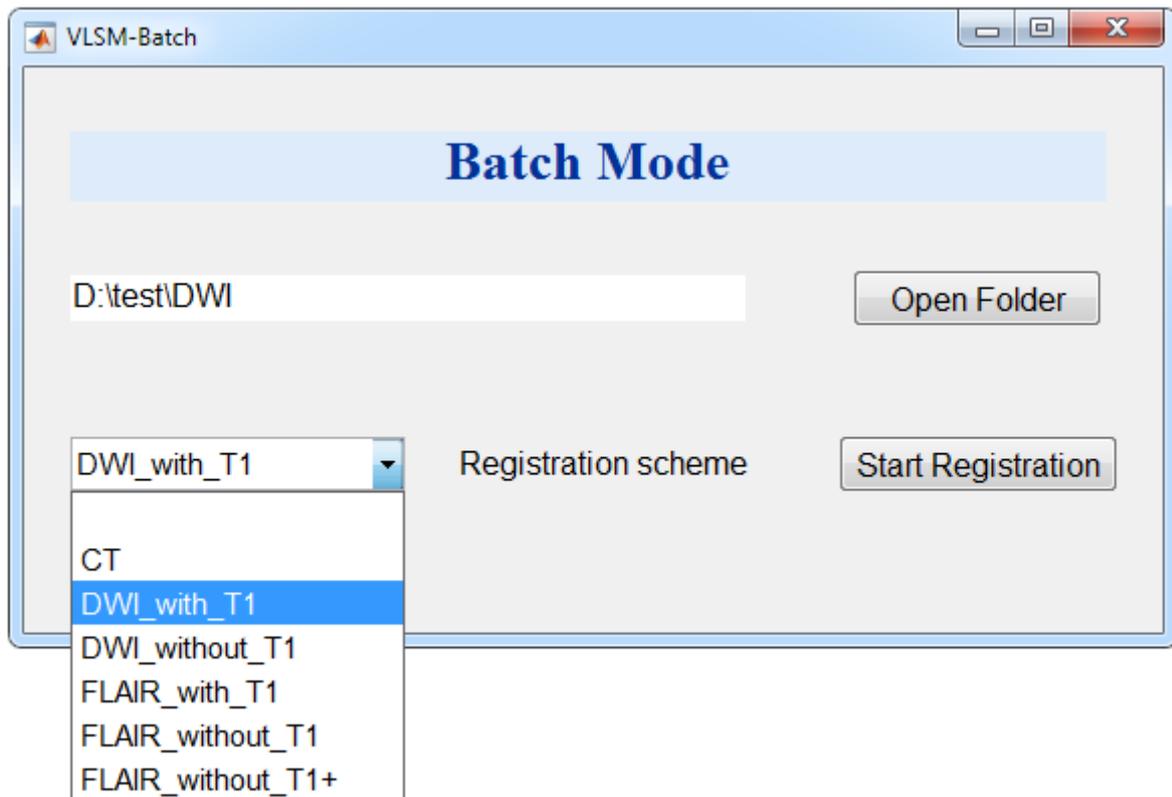


Figure 2.2 Panel of Batch Mode

■ Lack of images for registration

If some subfolders do not have complete images required for specific registration scheme, they will be ignored and the program will run for the following subfolders. Unlike test mode, here no error dialog will appear due to lack of images in a folder, and the incomplete subfolders will be recorded in an excel file after registration for all subfolders. This record file is named with “batch_record” which locates in the input root folder. **Table 1** is an example of batch record, with image directories of the inputs for registration. If any of the required images is empty or more than expected, the number of the image(s) will be displayed instead of its directory. For example, in **Table 1**, subject 003 does not have T1 image in specified scheme “DWI_with_T1”, so “0” is displayed in the directory of T1 image. If more than one required image is missing, the corresponding value of the image may be empty instead of “0” in the record.

Table 1 Example of batch record

Subject folder name	Lesion mask	Source image	T1 image
001	D:\test\DWI\001\MR001_DWI.lesion.nii	D:\test\DWI\001\MR001_DWI.nii	D:\test\DWI\001\MR001_T1.nii
002	D:\test\DWI\002\MR002_DWI.lesion.nii	D:\test\DWI\002\MR002_DWI.nii	D:\test\DWI\002\MR002_T1.nii
003	D:\test\DWI\003\MR003_DWI.lesion.nii	D:\test\DWI\003\MR003_DWI.nii	0

3 Check Registration

3.1 Individual Check

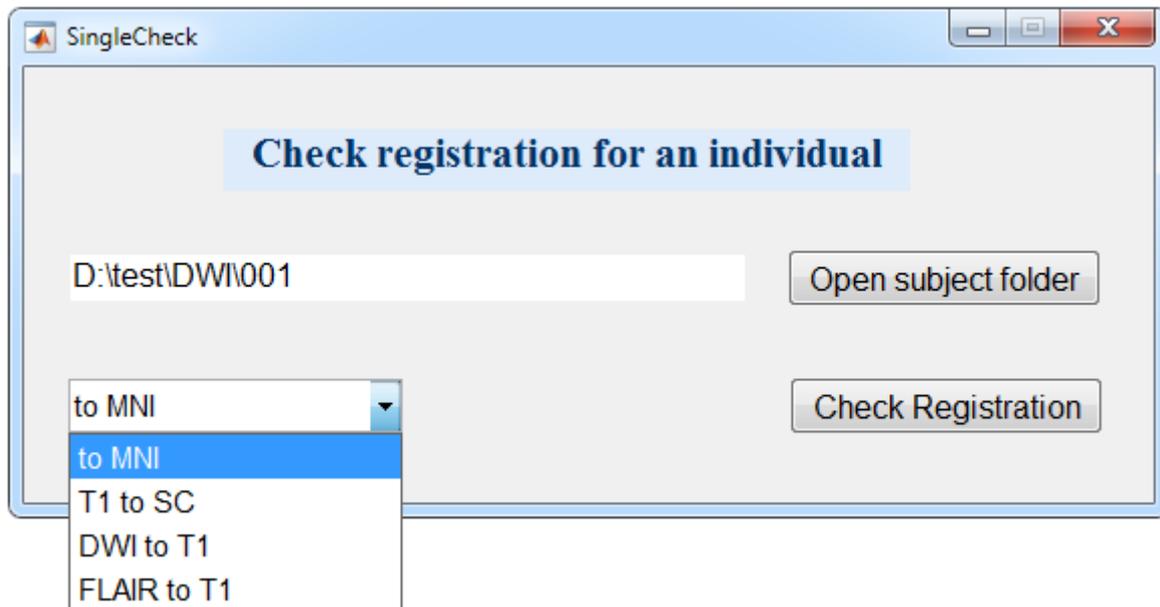


Figure 3.1 Panel of Individual Check

After registration for a single subject, you can check the results from different registration steps (**Figure 3.1**). The default target is the final registration result to MNI space. In addition, for example, if you have lesion delineated on DWI and the selected registration scheme is “*DWI_with_T1*”, you can also check the results from *DWI to T1* and from *T1 to SC*, where *SC* is an intermediate template in MNI space.

3.2 Group Check

In “Group Check”, you can specify a folder with subjects and check the results of different steps. This mode enables selection of subject folder to check (see **Figure 3.2**) compared to “Individual Check”.

Taking the example we’ve mentioned in Section 2.2, where there is a folder named “DWI” with 3 subjects whose lesions are delineated on DWI. If you want to check subject 001, you need to select folder “DWI” instead of “DWI\001”. Then input the number “1” in the bottom right frame (*Subfolder ID*), or just click “**Check Registration**”, which will start from the first subject by default. And if you want to check subject 002, you have 2 options. The first option is to type “2” in *Subfolder ID*, and click “**Check Registration**”. The second is to click on “Next” before clicking “**Check Registration**”. Also, you can change the registration step to check for each subject.

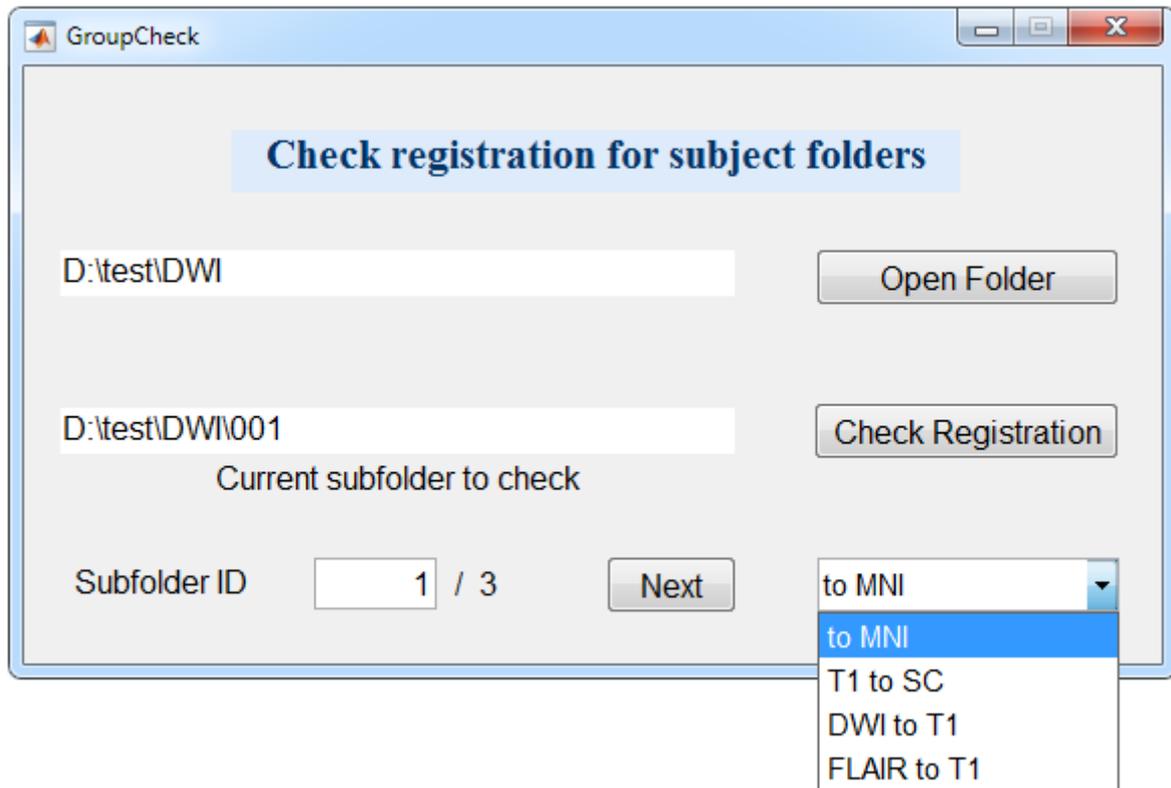


Figure 3.2 Panel of Group Check