University of Burgundy

MsCV

MEDICAL IMAGE ANALYSIS

Lab 2 Image Registration

by

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1. Introduction

The aim of image registration is to find the transformation in the moving image to look similar to the Fixed Image. Image registration is very helpful in analyzing changes at different time intervals, information fusion from different modalities, minimize undesirable effects of patient movements etc. Image registration can be intensity based or feature based, rigid or non-rigid.

2. Components of Image Registration

Different components of image registration includes Interpolator, Metric , Optimizer and Transform.

Interpolator is used for determining pixel intensity given neighboring pixels.

Optimizer is used to optimize the cost function i.e., to find the best metric value with respect to transform parameters.

Metric is used to measure the similarity between moving and fixed images to ensure the optimization.

Transform is used to allow movement of moving image depending on certain parameters.

The Workflow:

In the image registration process two images : a fixed and a moving image are supplied to the registration process. As we are working with pixels of an image we need interpolator to interpolate the intensity values. Metric block measures the similarity measure and depending on this value the optimizer block optimizes the transform parameters required for the transformation and after reaching to the given tolerance level the optimization stops and the transform parameters obtained are used to transform the moving image very close to fixed image frame.

3. Registration Framework

3.1 Interpolator block can be found in image_interpolation.m file which is called in affine_transform_2d_double at line number 75.

Optimizer block can be found in affineReg2D file at line number 42.

Metric block can be found in affine_registration_function at line number 44.

Transform block can be found in affineReg2D file at line number 62.

3.2 The scale vector is used for parameter scaling for translation and rotation.

3.3 Gaussian smoothing is used as pre-processing to image registration to speedup the registration process by removing the noise.

3.4 The center of rotation of the transformation is at the centre of the image.

4. Affine Transformation

The code is modified to deal with full affine 2D transformations. There is a variable named *'ttype*' which can be changed accordingly in one program to run the rigid or affine transformations. There would be six affine parameters which are required to be initialized. We only initialize scaling and rotation parameters to a value of '1' (say) and others to '0'.

The below is the results of rigid transformation.

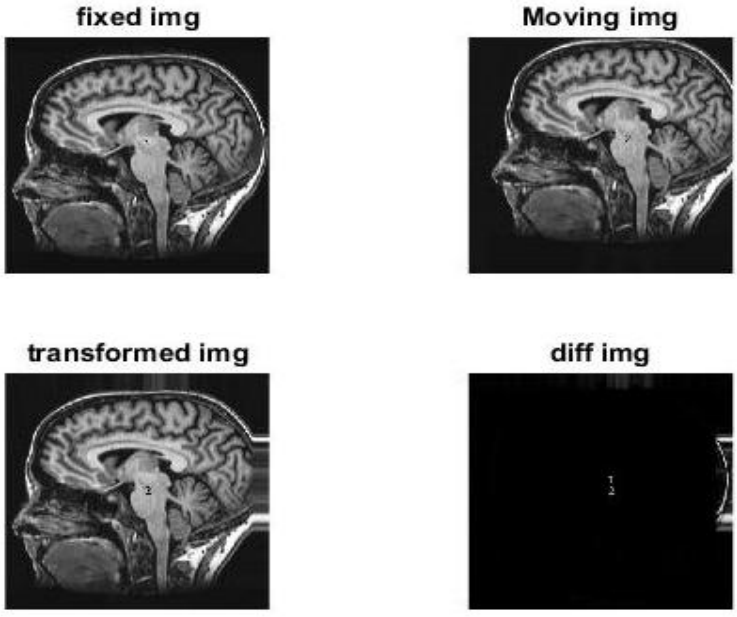

Figure 1 Rigid registration result

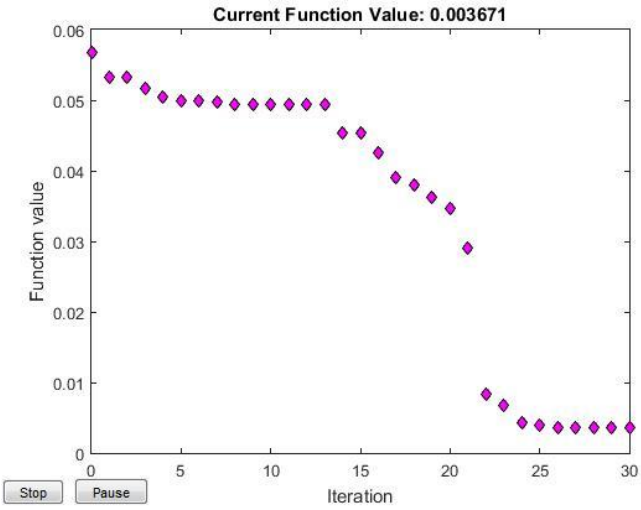

Figure 2 The error metric vs iterations for brain images (rigid transformation)

The results for affine transformation are as:

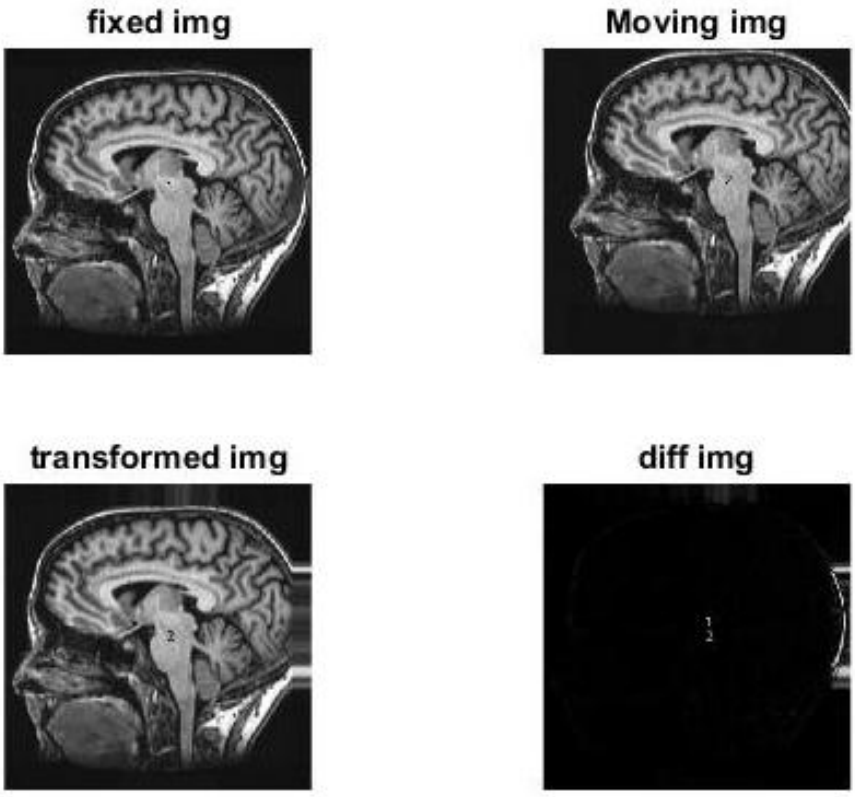

Figure 3 Affine registration result

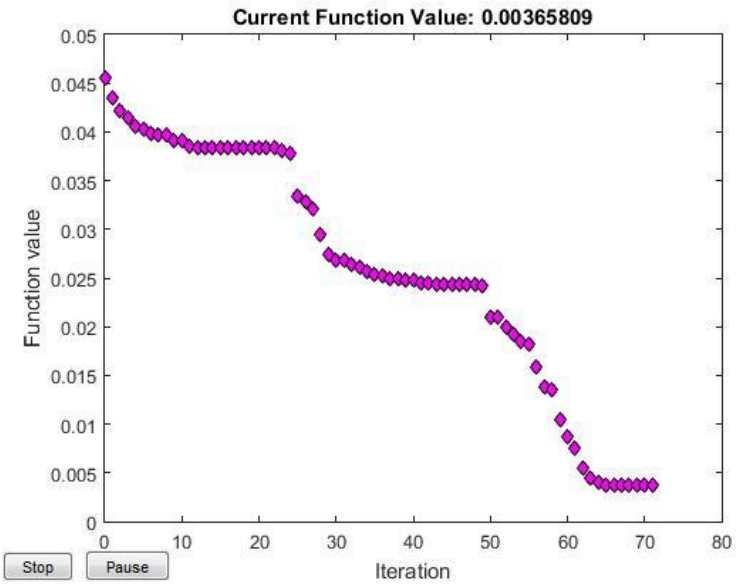

Figure 4 The error metric vs iterations for brain images (affine transformation)

5. Multi Resolution

The multi resolution framework is implemented and the code is given under 'affineReg2D_multi' and is implemented for 3 different resolutions. There is a variable named *'ttype*' which can be changed accordingly in one program to run the rigid or affine transformations.

The results are given as:

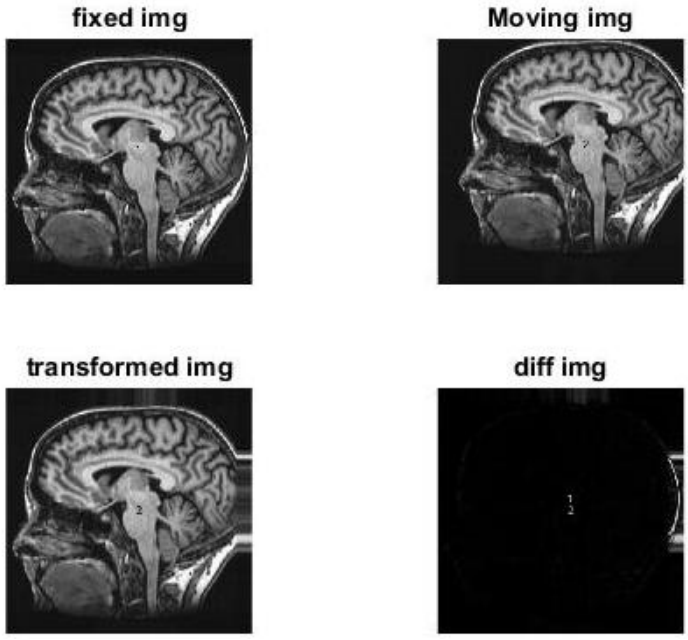

Figure 5 Multi Resolution result

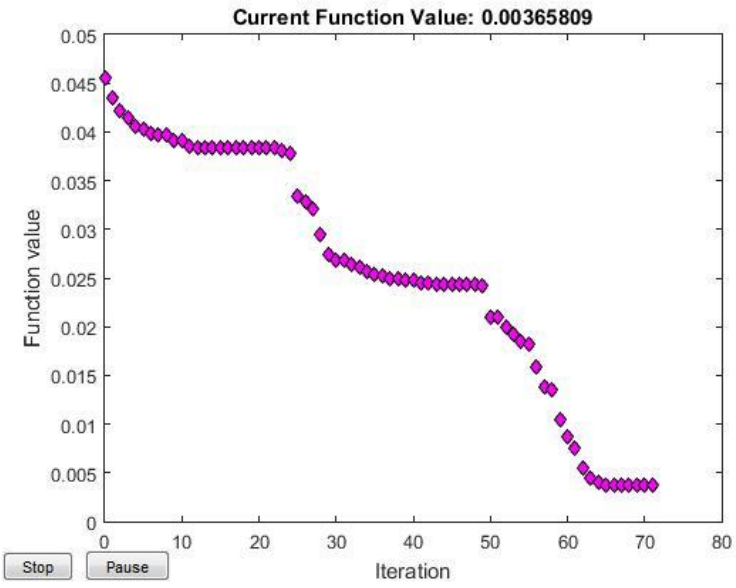

Figure 6 The error metric vs iterations for brain images (multi resolution transformation)

6. Mutual Information

The RMS, Normalized Cross Correlation (NCC) error metrics should have linear intensity relationship between two images. So we need to go to mutual information similarity to use as a metric in optimization process. *This is because the mutual information do not use exactly difference of intensity but its distribution of difference*. The mutual information metric code is tried under the affine_function under switch case statements. The problem faced with this is in its first iteration the solver is reaching the optimized value.

7. Results with Lena Image

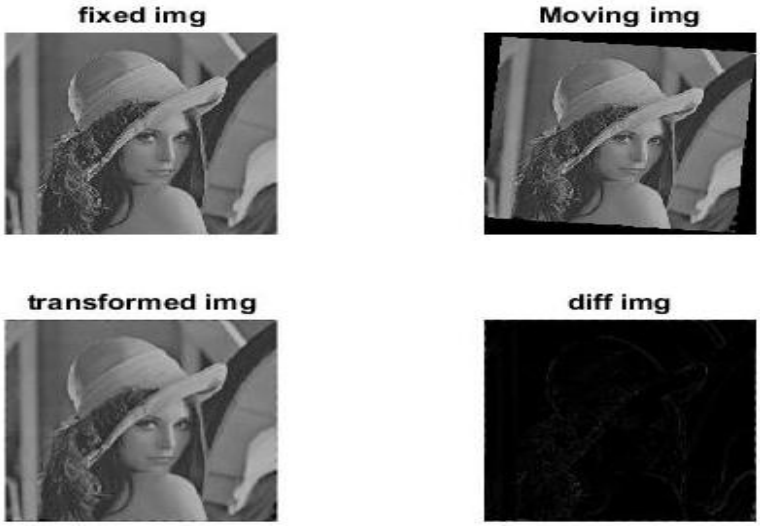

Figure 7 Affine Registration with lena images (2 and 3)

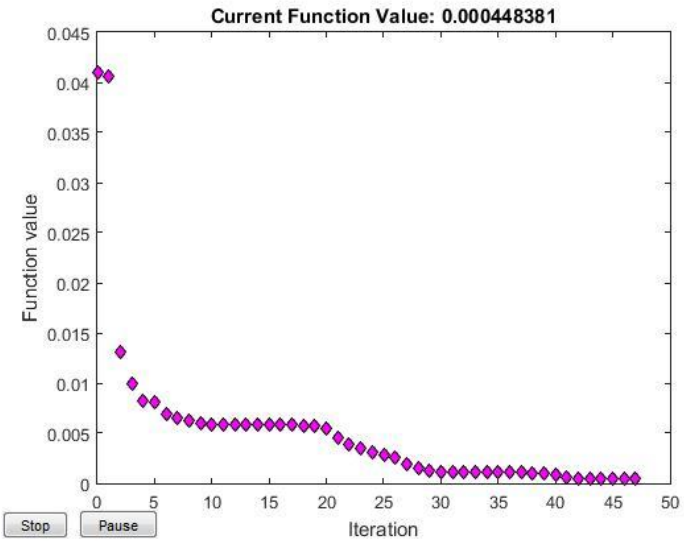

Figure 8 Error metric with lena images

With the same initialization but for different intensities of fixed image, we get different result as sum of squared error metrics should have linear intensity relationship between two images

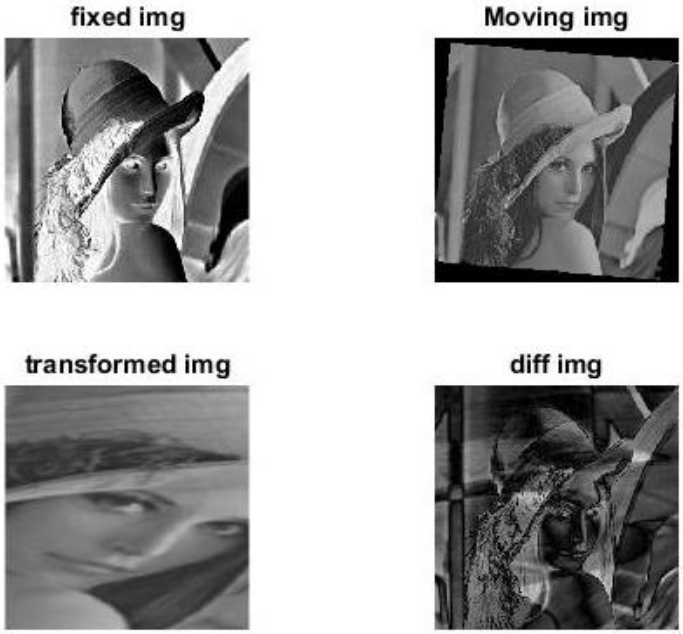

Figure 9 Lena image with different intensity fixed image

Table 1 Different parameters of optimization

Type	**Time (in s)**	**Final Error**
Rigid	32	0.003671
Affine	82	0.00365
Multi resolution rigid	30	0.003677
Multi resolution affine	122	0.0036

8. Conclusion

Image registration plays a significant role in medical image processing. the error metric plays a key role in optimizing the transform parameters. Some error metrics are sensitive to intensity value of images. So, we need to be careful in choosing the metrics.