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IMAGE REGISTRATION: EVALUATION AND COMPARISON OF NON-RIGID TRANSFORMATION ALGORITHMS

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ABSTRACT

Image registration is a technique, which helps in comparing and combining two images, which are taken at same or different times, with same or different cameras. The resultant image, which is obtained after the combination, is useful for the analysts as it gives complete information in one image, which is earlier in two different images. For doing image registration one can use feature-based methods or similarity measures can be used for the optimization purpose. In this paper feature based and intensity based registration methods are compared using various transformation functions. The results clearly showed that geometric based measures outperformed intensity based transformations in terms of execution time. In addition, Global transformations outperformed local transformations in terms of execution time.

Keywords: Image registration, feature based registration, intensity based registration, similarity metric, piecewise linear transformation.

I. INTRODUCTION

Image registration is a technique, which is used to combine two or more images (called as static and moving images) of same or different modalities, taken at same or different times, using same or different sensor [1] [2]. The whole image registration technique follows the steps shown in fig 1.

Firstly, static and moving images are input. On these images, pre-processing is applied. Image processing is a pre-requisite for image registration as in this phase noise reduction; image sharpening and contrast adjustment is done. This phase prepares the images for the feature extraction phase.

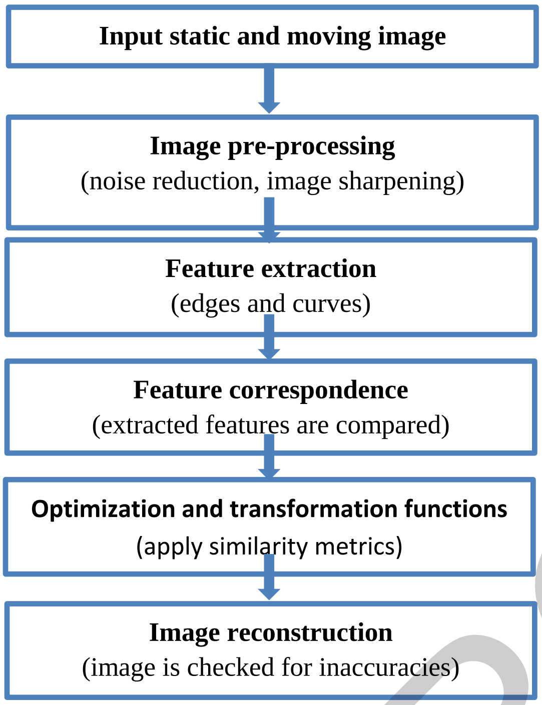

Fig. 1: Image registration process

In the feature extraction phase, the important features which are required are extracted using algorithms or by the user itself. In this paper, features are extracted manually so the accuracy of results totally depended on the accuracy with which features are extracted. The extracted features include closed regions, points, edges or curves. Then the features, which are extracted in the static image, are corresponded in the moving image so that mapping between both the images can be done using transformation functions. The transformations can be rigid (only translation and rotational differences are considered) and non-rigid (translation, rotation, scaling and shearing are considered) [4] [5] depending upon the type of the image selected for the purpose of registration. Lastly, the image is reconstructed using the transformation function obtained. To ensure the accuracy of the results three parameters are proposed which are root mean square error (RMSE) The root mean square error computes the mean squared pixel-wise difference in intensity between image *A* and *B* of size (M x N) [6], correlation index (CI), mutual information (MI). In addition, execution time is taken into consideration for both the rigid and non-rigid images.

II. METHODOLOGY

A. Medical image dataset

The datasets are taken from the subset of the datasets in the "University of North Carolina Volume Rendering Test Data Set" archive. There are 99 slicers of 256 X 256 pixels CT brain images.The dataset was acquired on a general electric CT scanner and performed at North Carolina Memorial Hospital. In this paper four set of slice of CT images are used for the registration as shown in fig 2.

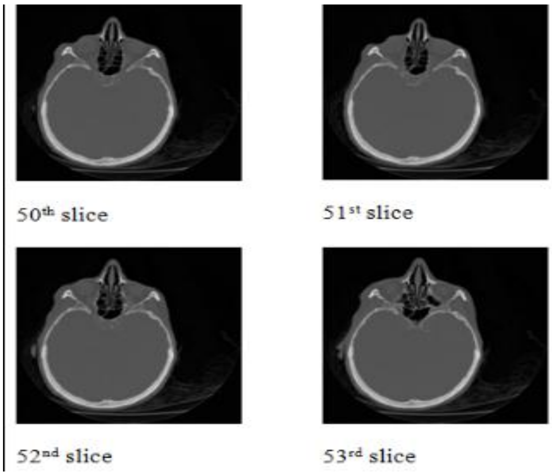

Fig. 2: CT brain image (50th,51st,52nd,53rd)

B. Registration procedure

In this paper, the features are extracted manually from both the static and moving images, although, automatic algorithms can be used for the feature extraction purpose. Then the transformation function is estimated, which is followed by interpolation (bilinear) and calculation of similarity measure (mutual information). The results are optimized using nelder mead optimization technique. At last, comparison is done between various algorithms to find the best efficient algorithm. The various registration steps are explained below:

1. Information is acquired from two images
2. Control points are selected from the static and moving images to establish the correspondence between the two images.
3. Transformation function is used to register the images and then reconstruction of the image.
4. Other evaluation methods are applied and error parameters are applied.
5.

C. Evaluation methods

The quality of the images can be inspected by two ways subjective and objective. In the subjective way, the experts do visual inspection but this method is very time consuming and inconvenient [7]. In the objective method, algorithms are applied to find the quality of the image. In this paper, the error parameter used is Root Mean Square Error (RMSE) to find the registration accuracy. Correlation index is used to find the positioning of the pixels in the resultant image. Mutual information is used to find the degree of matching.

III. EXPERIMENTAL RESULTS

A. **Execution time**

The result shown below in the fig 3 is displaying the execution time required by running the transformation algorithm with 15 control points. The diagram clearly shows that Mutual Information (MI) is more computationally expensive than other algorithms. It require more computation time as it considers all the pixel intensities of both the images. LWM is more reliable than Piecewise Linear (PL) computation wise. In addition, Polynomial 2nd order is more computationally reliable than Polynomial 3rd order. Clearly, geometric based measures outperformed intensity based transformations in terms of execution time. In addition, Global transformations outperformed Local transformations in terms of execution time.

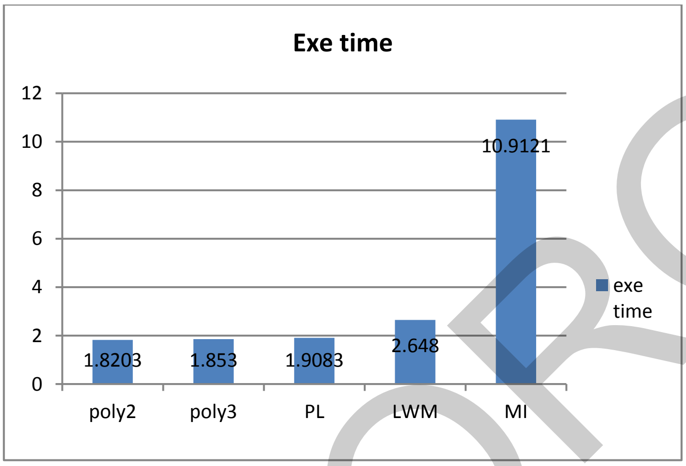

Fig. 3: Comparison of execution time result for different algorithms

B. Registration error

Results of Root Mean Square (RMS) error are presented in the figure below. The registration error is compared to observe the overall trend with 10, 15 and 20 control points. Fig 4 shows that 3rd order polynomial produces the highest registration error. However, the registration error is decreasing when more control points are included. The reason is mainly that polynomial is a global registration function. As the control points increases, the errors are average out. Above 3rd order polynomial MI produced the highest error.

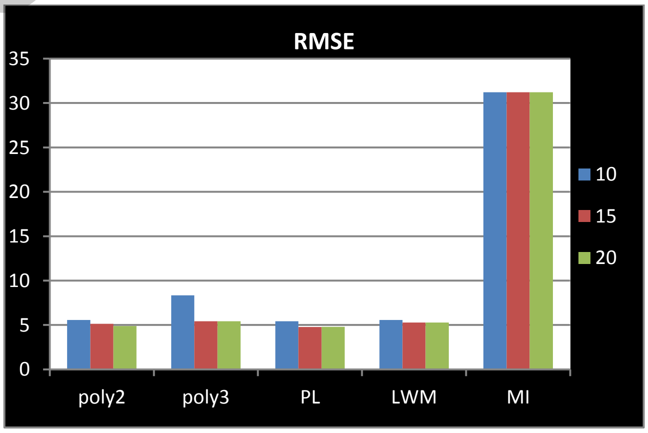

Fig. 4: Comparison of RMSE values for different algorithms

C. Correlation index

In general, most of the algorithms produced the optimum result to 1 except polynomial 3rd order. One possible reason is that the selected CT slices are quite similar with slightly differences. Polynomial 3rd order presents low correlation index due to the high registration error.

Optimum result in terms of correlation coefficient is also obtained at 15 control points. LWM produces optimum results not only at 15 control points but at all 10, 15 and 20 control points as compared to polynomials and PL in terms of correlation coefficient also. The fig 5 MI registers the images most efficiently.

IV. CONCLUSION AND DISCUSSION

It has been clearly seen from the results, that the resultant images are clearly aligned with the static image. Hence, it can be said that the transformations, which are applied, are accurate for non-rigid image registration.

For the polynomial transformation, as the order increases it results in undesired results with less control points. Hence while implementing; image set is to be considered.

REFERENCES

[1] *M. V. Wyawahare, P. M. Patil and H. K. Abhyankar*, "Image Registration Techniques: An overview," in *International Journal of Signal Processing, Image Processing and Pattern Recognition*, vol. 2, pp. 11-28, 2009.

[2] B. Zitova, J. Flusser, " Image Registration methods: a survey," *Image and Vision Computing*, vol. 21, pp. 977-1000, 2003.

[3] H. Kaur, S. Gupta, A. Girdhar, A. Gupta, "Deformable-Based Algorithm for Non-Rigid Registration of Images," *in 3rd International Conference on Biomedical Engineering & Assistive Technologies*, vol. 3, pp. 185-189, 2014.

[4] J. M. Fitzpatrick, D. L. G. Hill, C. R. Jr. Maurer, *Image Registration*, Handbook of Medical Imaging, SPIE PRESS, Bellingham, Washington, 2000, ch. 8, pp. 449-506.

[5] M. Holden, "A review of geometric transformations for non-rigid body registration," in *IEEE Transactions on Medical Imaging*, vol. 27, pp. 111-128, 2008.

[6] N. M. Nichat and V. Shandilya, "Image Registration for Area Matching by Using Transform Based Methods," in *International Journal of Advanced Research in Computer Science and Software Engineering*, vol. 3, pp. 839-845, 2013.

[7] R. Sakuldee, and S. Udomhunsakul, "Objective Performance of Compressed Image Quality Assessments," *International Journal of Computer Science*, vol. 2, pp. 258-267, 2007.