Image registration and segmentation of brain tumors in mr images

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Abstract:

-Registration and Segmentation is an important aspects of medical image processing.This paper proposes an efficient image registration technique for medical imaging diagnosis application. After the image registration, it will be decomposed into multi sub region to detect the abnormal part efficiently. The recently proposed correlation and affine transformation based registering approach has already revealed to be a powerful tool for the obtention of tie points in general image processing tasks, but it has a limited performance when directly applied to medical images. Image registration is based on Combination of affine transform and correlation features, complemented by a robust procedure of outlier removal. This combination allows for an accurate obtention of tie points for a pair of medical images, being a powerful scheme for AIR. A set of measures which allow for an objective evaluation of the geometric correction process quality has been used. The proposed methodology allows for a fully automatic registration of pairs of medical images, leading to subpixel accuracy for the whole considered data set. The result from registration will be used to diagnose the tumor from registered image by clustering algorithm. Furthermore, it is able to account for differences in spectral content, rotation, scaling, translation, different viewpoint, and change in illumination. Finally the morphological process is applied to extract the tumor part separately.

1. INTRODUCTION

Image registration is the process of matching two images so that corresponding coordinate points in the two images cor-respond to the same physical region of the scene being imaged. It is a classical problem in several image processing applications where it is necessary to match two or more images of the same scene. Some examples of its applications are: Integration of information taken from different sensors. The previously used registration methods are feature detection, feature matching,spatial transformation image resampling and transformation.In feature detection the set of relevant features in the two images are identified.In feature matching each feature in the sensed image is must be matched to its corresponding feature in the reference image,and each feature is identified with the pixel location in the image,and these corresponding points are usually referred to as control points.In spatial transformation the mapping functions are determined that can match the rest of the points in the image using information about the control points obtained [6].The feature based registration have two drawbacks, the first one is the detected feature sets in the reference & scanned images must not have enough common elements, even in situations when the images do not cover exactly the entire information about diseases or when there are object occlusions or other unexpected changes, and the second one is problems caused by incorrect feature detection or by image degradations, then physically corresponding features can be dissimilar due to the different imaging conditions and/or due to the different spectral sensitivity of the scanners.

Correlation based image registration is a linear association in context between two images, therefore in its simplest form, this method aims to geometrically align two images at the pixel level, since with correlation we are not able to achieve the subpixel level. The drawback of correlation method is the computation of correlation is performed at pixel level, so time complexity is very high.

Affine Transformation is used in image registration, in this method features of the two images are computed separately, then each keypoint in the original image is compared to every keypoints in the transformed image, and using these keypoints set the transformation functions.

Image Segmentation plays a important role in the field of medical applications.This segmentation technique is used to segment the image in to regions.The specific application of this technique is to detect the tumor region by segmenting the MR input image.clustering model is widely used in segmentation process.This clustering model is used to classify patterns in that way the samples of the same group are more similar to one another than samples belonging to different groups.More clustering

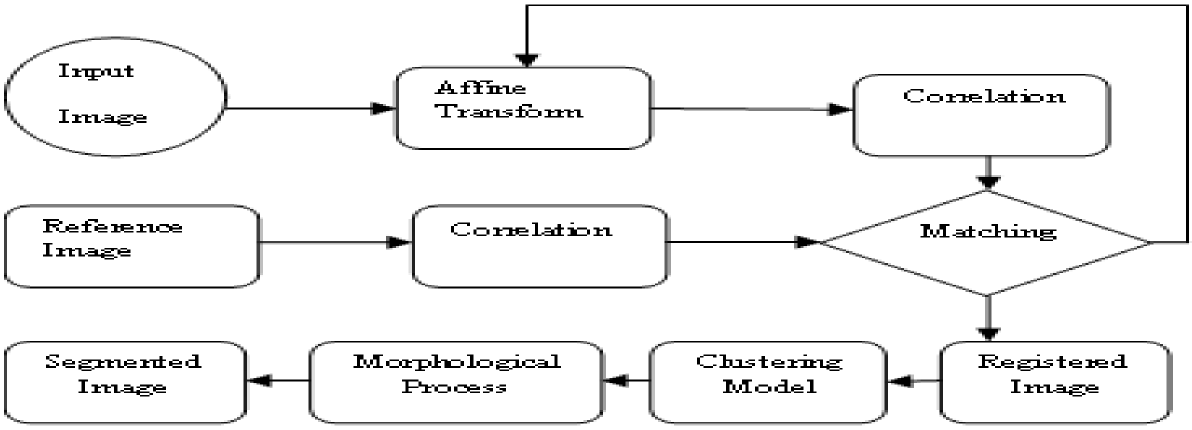


Fig 1: Block Diagram

methods are used but fuzzy clustering methods retains more information from the original images,than hard clustering methods.Fuzzy C Means algorithm is widely preferred for its additional flexibility which allows pixels to belong to more classes with varying degrees of membership but the major drawback of the fcm is more time consuming.The drawback of this FCM is overcome by the proposed improved FCM algorithm.

2. RELATED WORK

A method for Automatic Image Registration through Histogram Image Segmentation(HAIRIS) is used [1], for combining several segmentations of the pair of the images to be registered. HAIRIS allows for the registration of pair of images with differences in translation and rotation and also small differences in spectral content, leading to subpixel accuracy. In this method for segmentation large variety of histogram shapes are found and the registration is suitable for satellite images not for medical images.

The Correlation and Hough Transformation based Automatic Image Registration is used [2].In this the correlation is performed on two images and hough transform computation is used for convert the filtered correlation images to binary images. Hough transform also used for geometric correction at the subpixel level. This combination used for satellite images not for medical images because the image is divided into tiles and taking the center of each tile as a point, a geometric correction at the subpixel level may be achieved.

Affine Transformation is mostly used for registration of two images. It is only linear,it models a combination of several transformations: translating,rotating,scaling and shearing.It correcets the displacement of the coordinate systems.It is described in [3,4,5].

The Robust Affine Invariant Feature Extraction for Image Matching is used [6].In this approach a hierarchical filtering strategy is used for affine invariant feature detection,which is based on information entropy spatial dispersion quality constraints.The concept of spatial dispersion quality is introduced to quantify the spatial distribution of features.It is remove features with low information entropy and bad spatial dispersion.This approach is based on affine invariant transform, so rotation is not performed.

Image Registration Based on Corner Detection And Affine Transformation is used [7],In this method first corner feature was extracted by the improved multi-scale Harris operator, then image edge detection was conducted by canny operator, corner's coarse matching is based on correlation coefficient between the corner neighborhood on the edge image, and then fine matching can be achieved, two pairs of optimal matching corner were selected from matched corners as control points of affine transformation,thus affine transformation model could be obtained and the registered image was performed affine transformation in order to realizing image registration. The disadvantage of this method is the correlation coefficient calculation is performed only on the edges.

3. MATERIALS AND METHODS

The Block Diagram is shown in figure.1 this chapter explains four process namely Affine Transformation, correlation, clustering methods, morphological process.

A. Affine Transformation

Affine Transformation is one of the most commonly used methods in registering two images. Although only linear, it combines the effect of four simple transformations:translation, rotation and scaling. An Affine Transformation corrects some global distortions in the image to be registered.

The features of the two images are computed separately. Then each keypoint in the original image (Reference image) is compared to every keypoints in the transformed image using the descriptors computed in the previous stage. For each comparison, one feature is picked in each image. F1 is the descriptor array for one key point in the original image and F2 is the descriptor array for a key point in the transformed image. The most likely value for each pair of the keypoints is computed by:

Error = sum(sum(F1 – F2)) (1)

All these data are sorted in ascending order of matching error. Then the first two qualified pairs of the keypoints are chosen to set the transformation.

To apply the transform, the following functions are introduced into register the input image on reference image.

The transform gives the mapping of a model image point (x, y) to a transformed image point (u, v) in terms of an image scaling, s, an image rotation, θ, and an image translation:[tx , ty]

$$\begin{bmatrix} u \\ v \end{bmatrix} = \begin{bmatrix} s\cos\theta - s\sin\theta \\ s\sin\theta s\cos\theta \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} + \begin{bmatrix} t_x \\ t_y \end{bmatrix} \quad (2)$$

B. Correlation

It gives similarity in the small structures between the Reference and Unregistered images. Higher value of correlation means that more information is preserved. Coefficient correlation in the space domain is defined by

Correlation = sum (sum (B.*A))/Sqrt (sum (sum (B.*A))*sum (sum (A.*A)));

Where, B is difference between unregistered image and its overall mean value.

A is difference between Reference image and its overall mean value.

C. Image segmentation using Improved fuzzy c means

1. *Fuzzy C Means Algorithm*

Fuzzy C Means Algorithm is a method of clustering which allows one pixel to belong to one or more clusters.The FCM algorithm attempts to partition a finite collection of pixels in to a collection "c" fuzzy clusters with respect to some criteria.Fuzzy C Means Algorithm is based on minimization of the following objective function.

$$J(U, c_1, c_2 ... c_c) = \sum_{i=1}^{c} J_i = \sum_{i=1}^{c}\sum_{j=1}^{n} u_{ij}^m d_{ij} \quad (3)$$

u_{ij} is between 0 and 1, c_i is the centroids of cluster I, d_{ij} is the Euclidean distance between i^{th} centroids & j^{th} data point ,m€[1, ∞] is a weighting function.

Fuzzy partitioning of known data sample is carried out through an iterative optimization of the objective function.

$$u_{ij} = \frac{1}{\sum_{k=1}^{c}\left(\frac{d_{ij}}{d_{kj}}\right)^{\frac{2}{(m-1)}}} \quad (4)$$

$$c_{ij} = \frac{\sum_{j=1}^{n} u_{ij}^m x_j}{\sum_{j=1}^{n} u_{ij}^m} \quad (5)$$

This iteration will stop when $\max_{ij}\{| u_{ij}^{(k+1)} - u_{ij}^{(k)} |\} < \in$ where $\in$ is a termination criterian between 0 & 1,whereas k are the iteration steps.This procedure converges to a local minimum or a saddle point of j_m

The algorithm is composed of the following steps:

1.Initialize U=$[u_{ij}]$ matrix, $U^{(0)}$

2.At k-step:calculate the centers vectors $c^{(k)} = [c_j]$ with $U^{(k)}$

$$c_{ij} = \frac{\sum_{i=1}^{N} u_{ij}^m x_j}{\sum_{i=1}^{N} u_{ij}^m} \quad (6)$$

1. Update $U^{(k)}, U^{(k+1)}$

$$U_{ij} = \frac{1}{\sum_{i=1}^{c}\left(\frac{\| x_i - c_j \|}{\| x_i - c_k \|}\right)^{\frac{2}{m-1}}} \quad (7)$$

2.If $\| U^{(k+1)} - U^{(k)} \| < \in$ then STOP;otherwise return to step2.

2. Improved Fuzzy C Means Algorithm

The improved fuzzy c means algorithm is based on the concept of data compression where the dimensionality of the input is highly reduced.the data compression includes two types quantization and aggregation.

The quantization of the feature space is performed by masking the lower 'm' order bits of the feature value.the quantization output will result in the common intensity values for more than one feature vector for the process of aggregation,feature vectors which share common intensity values are grouped together.A representative feature vector is chosen from each group and they are given as input for the convetional FCM algorithm.once the clustering is complete,the representative feature vector membership values are distributed identically to all members of the quantization level.since the modified FCM algorithm uses a reduced dataset,the convergence rate is highly improved when compared with the conventional FCM.

The improved FCM algorithm uses the same steps of conventional FCM except for the change in cluster updation and membership value updation criterions.The modified criterians are shown below

$$C_i = \frac{\sum_{j=1}^{n} u_{ij}^{m} y_j}{\sum_{j=1}^{n} u_{ij}^{m}} \quad (8)$$

$$u_{ij} = \frac{1}{\sum_{k=1}^{c} \left(\frac{d_{ij}}{d_{ij}} \right)^{\frac{2}{m-1}}} \quad (9)$$

$$d_{ij} = y_j - c_i \quad (10)$$

Y=Reduced Dataset

D. Morphological Process

The term morphology refers to the description of the properties of the shape and structure of any objects. In the context of computer vision,this term refers to the description of the properties of shapes of ares on the image.This technique used for the analysis and processing of geometrical structures, based on set theory, lattice theory, topology, and random functions. Morphology is most commonly applied to digital images, but it can be employed as well on graphs, surface meshes, solids, and many other spatial structures.Operations of mathematical morphology were originally defined as operations on sets,but it soon became clear that they are also useful in the processing tasks of set of points in the two dimensional space. MM is also the foundation of morphological image processing, which consists of a set of operators that transform images according to the above characterizations.

1. Binary morphology

In binary morphology, an image is viewed as a subset of an Euclidean space R^d or the integer grid Z^d, for some dimension d.

2. Structuring element

The basic idea in binary morphology is to probe an image with a simple, pre-defined shape, drawing conclusions on how this shape fits or misses the shapes in the image. This simple "probe" is called structuring element, and is itself a binary image (i.e., a subset of the space or grid).
Here are some examples of widely used structuring elements (denoted by B):

i. Let $E = Z^2$; B is an open disk of radius r, centered at the origin.
ii. Let $E = Z^2$; B is a 3x3 square, that is, B={(-1,-1), (-1,0), (-1,1), (0,-1), (0,0), (0,1), (1,-1), (1,0), (1,1)}.
iii. Let $E = Z^2$; B is the "cross" given by: B={(-1,0), (0,-1), (0,0), (0,1), (1,0)}.

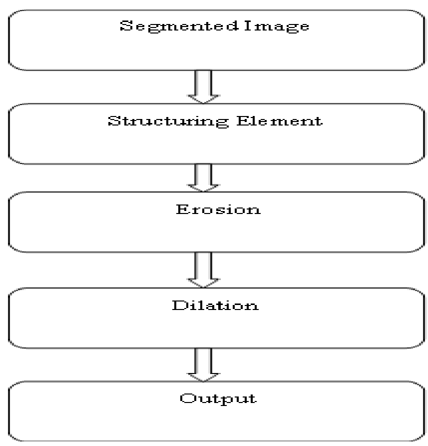


Fig 2.Flow chart for Morphological Process

3 Basic operators

The basic operations are shift-invariant (translation invariant) operators strongly related to Minkowski addition.

Let E be a Euclidean space or an integer grid, and A -a binary image in E.

4. Erosion

Erosion is the set of all points in the image, where the structuring element "fits into". Consider each foreground pixel in the input image, If the structuring element fits in, write a "1" at the origin of the structuring element.

Erosion is the morphological dual to dilation. It combines two sets using the vector subtraction of set elements. Let $A\Theta B$ denotes the erosion of A by B.

$$A\Theta B = \{x \in Z^2 \mid x + b \in A, \forall b \in B\} \quad (11)$$

Erosion can also be defined in terms of translation.

$$A\Theta B = \{x \in Z^2 \mid (B)_x \subseteq A\} \quad (12)$$

In terms of intersection

$$A\Theta B = \bigcap_{b \in B} (A)_{-b} \quad (13)$$

5. Dilation

The dilation is the set of all points in the image, where the structuring element "touches" the foreground. Consider each pixel in the input image, If the structuring element touches the foreground image, write a "1" at the origin of the structuring element.

Dilation is the operation that combines two sets using vector addition of set elements. Let A and B are subsets in 2-D space. A: image undergoing analysis, B: structuring element, Θ denotes dilation.

$$A\Theta B = \{c \in Z^2 \mid c = a + b, a \in A, b \in B\} \quad (14)$$

Let A be a Subset of z^2 and $x \in Z^2$.The translation of A by x is defined as

$$(A)_x = \{c \in Z^2 \mid c = a + x, a \in A\} \quad (15)$$

The dilation of A by B can be computed as the union of translation of A by the elements of B.

$$A\Theta B = \bigcup_{b \in B} (A)_b = \bigcup_{a \in A} (B)_a \quad (16)$$

4. RESULTS AND DISCUSSION

The input images are shown in the figure 3.and the reference images are shown in the figure 4.These two images are compared and the correlation coefficient was calculated.if correlation was matched the reference image is registered with input original image.if it is not matched then affine transformation was applied.In affine transformation rotation,scaling are performed.In these reference image rotation was performed,after rotating the image with 20 degree, the rotated images is shown in figure 5.Now it is compared with the input images,then correlation coefficient was calculated,it is matched then reference images is registered with input images, it is not matched then further rotation is performed.Each rotation the correlation coefficient is calculated,in one rotation the correlation coefficient is matched then that image is registered with input images, the registered images is shown in figure 5.And the registered is image is applied to clustering using improved FCM algorithm. then four regions are generated using these algorithm, then select one region that contain tumor part shown in figure ,and then apply morphological operations for extracting the tumor part, the Eroded images are shown in figure 8,the segmented tumor part is shown in figure 9.

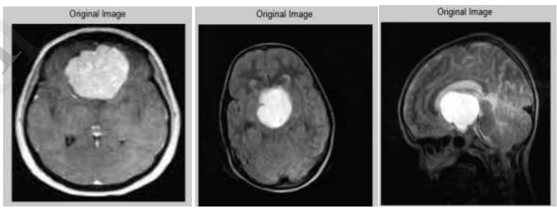


Fig.3 Input Original Images

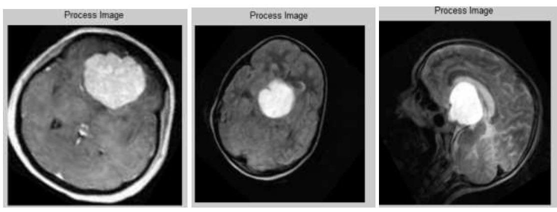


Fig.4 Reference Images

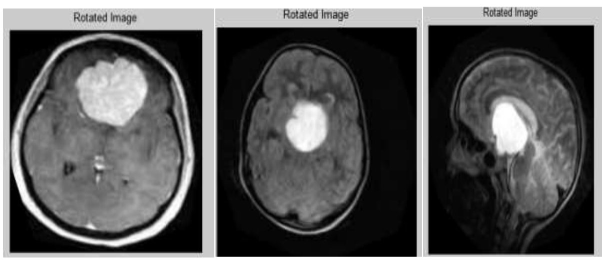


Fig.5 Rotated Images(after 20^o)

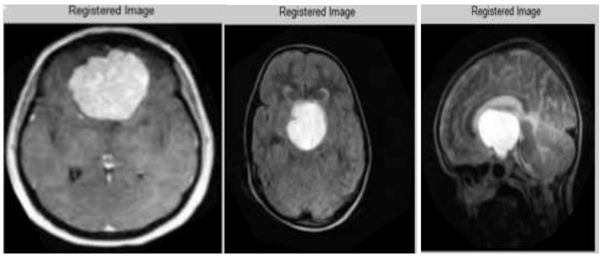


Fig.6 Registered Image After Rotation

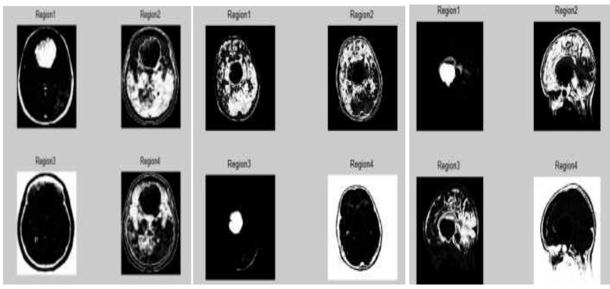


Fig.7 Regions of clustering model

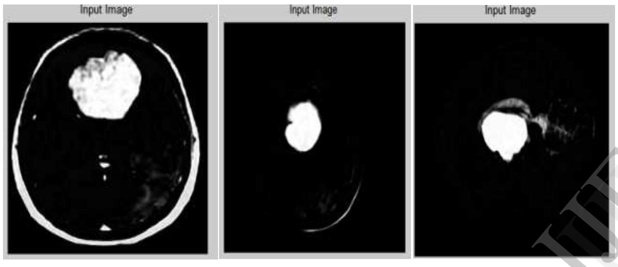


Fig.8 Input image for Morphological process after selecting the region

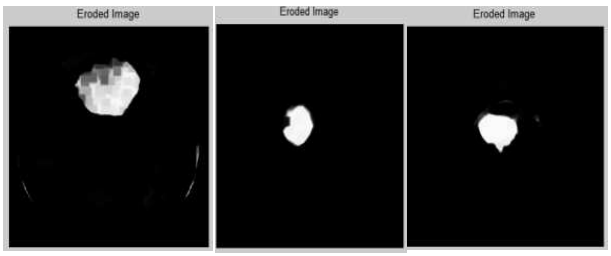


Fig.9 Eroded Images

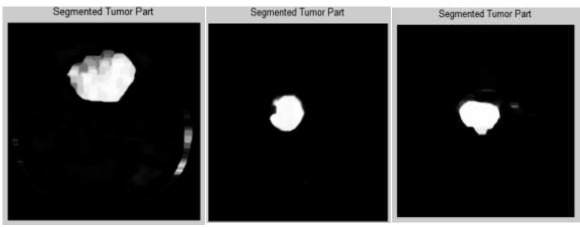
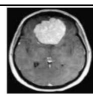
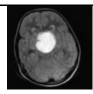
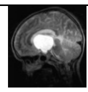


Fig.10 Final Segmented tumor part after applying Morphological Process

Table I .Comparison Results

Images	Entropy measurement for proposed method	Entropy Measurement for Fuzzy C Means	Entropy Measurement for K Means
	0.7416	0.7623	0.7657
	0.2362	0.2473	0.2485
	0.4202	0.4321	0.4355

The above table-I shows that the proposed method produces low entropy compared to existing, which indicates better clustering results.

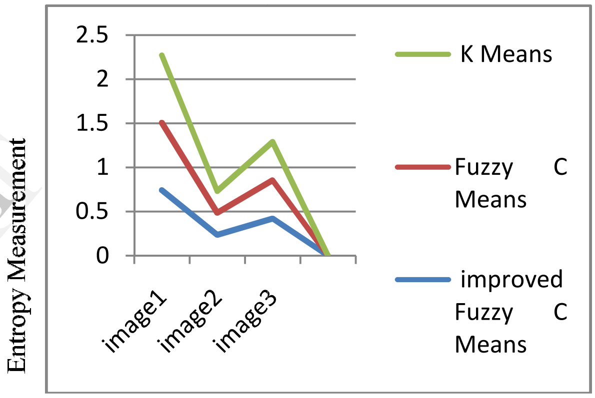


Fig 10.Entropy Comparison with Existing and Proposed Method

5. CONCLUSION AND FUTURE WORK

The results show that the registration and segmentation then the morphological operations extract the tumor region successfully. The Improved FCM algorithm yields superior convergence rate from table-I.Our Future Work will concentrate on segmentation using genetic algorithm with improved Fuzzy C Means And also improving the computational speed of the registration algorithm.It should deal with 3D volume segmentation instead of using 2D slice by slice segmentation.

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7. REFERENCES

[1] H. Gonçalves, J. A. Gonçalves, and L. Corte-Real, "HAIRIS: A method for automatic image registration through histogram-based image segmentation," *IEEE Trans. Image Process.*, vol. 20, no. 3, pp. 776–789,2011.

[2] H. Gonçalves,Jose A. Gonçalves and L. Corte-Real,"Automatic Image Registration Based on Correlation and Hough Transform," *IEEE Trans. Image Process.*, vol. 20, no. 3, Dec 20,2012.

[3] Noppodal Chumchob,Ke Chen,"A robust affine image registration method"International journal of numerical analysis and modeling.,vol. 6,no. 2,pages 311-334.

[4] Zhengwei Yang,Fernand S.Cohen,"Image Registration and Object Recognition Using Affine Invariants and Convex Hulls" *IEEE Trans. Image Process.*, vol. 8, no. 7, July 1999.

[5] Colin Studholme,John A.Little,Graeme P.Pency,Derek L.G.Hill,David J.Hawkes,"Automated Multimodality Registration Using the Full Affine Transformation:Application to MR & CT Guided Skull Base Surgery,"Deviation of Radiological Surgery.

[6] L. Cheng, J. Gong, X. Yang, C. Fan, and P. Han, "Robust affine invariant feature extraction for image matching," *IEEE Geosci. Remote Sens. Lett.*, vol. 5, no. 2, pp. 246–250, Apr. 2008.

[7] Hui Lin, Peigun Du, Weichang Zhao, Lianpeng Zhang, Huasheng Sun," Image registration based on corner detection and affine transformation"3rd International congress on Image and Signal Processing (CISP2010).

[8] C. Li, C. Gatenby, L. Wang, and J. Gore, "A robust parametric method for bias field estimation and segmentation of MR images," in *Proc. IEEE Conf. Comput. Vision Pattern Recog.*, 2009, pageno. 218–223.

[9] Jude hemanth.D, D.Selvathi and J.Anitha,"Effective Fuzzy Clustering Algorithm for Abnormal MR Brain Image Segmentation",Page Number 609-614, International/Advance Computing Conference (IACC 2009),IEEE,2009.

[10] Steven Eschrich, Jingwei Ke, Lawrence O. Hall and Dmitry B. Goldgof Fast "Accurate Fuzzy Clustering through Data Reduction", Page Number 1-18,November 13 IEEE 2002.

[11] B. Caldairou, N. Passat, P. A. Habas, C. Studholme, and F.Rousseau, "A non-local fuzzy segmentation method: application to brain MRI," Pattern Recognition, vol. 44, no. 9, pp. 1916–1927, 2011.

[12] Barbara Zitova, Jan Flusser ,Image registration methods: a survey.Academy of Sciences of the Czech Republic, Image and vision computing 21(2003) 977-1000.

[13] E.D. Castro, C. Morandi, Registration of translated and rotated images using finite Fourier transform, IEEE Transactions on Pattern Analysis and Machine Intelligence 9 (1987) 700–703.

[14] J. B. Antoine Maintz_ and Max A. Viergever, A Survey of Medical Image Registration. Image Sciences Institute, Utrecht University Hospital, Utrecht, the Netherlands.

[15] E. Spedicato, and M.T. Vespucci, "Numerical experiments with variations of the Gauss-Newton algorithm for nonlinear least squares", J. Opt. Theory Appl., Vol 57 No.2 (1988), pp.323-339.

[16] P. Zhilkin, and M.E. Alexander, "Affine registration: a comparison of several programs", J. Magn. Reson. Imaging, Vol.22 (2004), pp.55-66.

[17] A. Collignon, F. Maes, D. Delaere, D. andermeulen, P. Suetens, and G. Marchal.Automated multimodality image registration using information theory. In Bizais Y., Barillot C, and Di Paola R., editors, Proceedings of Information Processing in Medical Imaging, pages 263–274, 1995. Brest, France.

[18] H. Chang and J.M. Fitzpatrick. A technique for accurate MR imaging in the presence of field inhomogeneities. IEEE Trans. Med. Imaging, 11:319–329, 1992.

[19] G. Stockman, S. Kopstein, and S. Benett, "Matching images to models for registration and object detection via clustering," IEEE Trans. Pattern Analysis and Machine Intelligence, 4, 3, pp. 229–241, 1982.

[20] F. L. Bookstein, "Principal warps: thin-plate splines and the decomposition of deformations," IEEE Trans. Pattern Analysis and Machine Intelligence, 11, 6, pp. 567–585,1989.

BIOGRAPHY

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