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Image Registration for Dental X-Ray images using Hybrid Technique

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Abstract: Medical imaging is a vital component of large number of applications within current clinical settings. Image registration is a fundamental task in medical imaging. It is a process that overlays two or more medical images that are taken from different devices such as MRI, CT, PET and SPECT etc or taken at different angles. Integration of useful data obtained from different images is often required for medical diagnosis and procedure that brings spatial alignment among images is known as registration. We address the problem of image registration by adopting discrete cosine transformation (DCT) with a neural-network distance point learning approach. Instead of explicitly specifying the local regularization parameter values, they are regarded as network weights which are then modified through the supply of appropriate training points from the medical image taken. The desired response of the network is in the form of a gray level value estimate of the current pixel using contour distance vector (CDV). At last apply Fuzzy logic. Root mean square error (RMSE) and peak signal to noise ratio (PSNR) are used for accuracy evaluation.

Keywords: Magnetic resonance imaging (MRI), Computed Tomography (CT), Positron emission tomography (PET), Single positron emission computed tomography (SPECT), Discrete cosine transformation (DCT) and Contour distance vector (CDV).

I. INTRODUCTION

The image registration is to "compensate for" or "undo" defects which degrade an image or to make compatibility between two images. Degradation comes in many forms such as motion blur, noise, and camera mis-focus. In cases like motion blur, it is possible to come up with a very good estimate of the actual blurring function and "undo" the blur to restore the original image [1]. In cases where the image is corrupted by noise, the best we may hope to do is to compensate for the degradation it caused. Image Registration refers to a class of methods that aim to remove or reduce the degradations and registers the points of second image into the base image that have occurred while the digital image was being obtained [2]. All natural images when displayed have gone through some sort of degradation. Many different algorithms are found in literature for registering dental X-ray images. Some are based on maximization of combined mutual information and gradient information for rigid registration of three-dimensional clinical images [3]. Nagham E Mekky and F.E.Z Abou Chadi [4] registered images using wavelet based image registration techniques. In our approach, we will introduce and implement new method using DCT and fuzzy logic to register dental X-ray image. Neural network is used as the basis classifier which identifies the points where the image to be registered and contour distance classifier which is used to classify the distance vectors of the image. Two images to be registered are called as reference image and floating image. Differences between the reference and floating dental x-ray images can be considered as the effect of three mechanisms: a) local anatomical deformations due to progression or regression of a disease; b) geometric transformation due to projection errors (reversible and irreversible); and c) intensity transformation due to non- identical exposure or film processing parameters. Irreversible projection errors cannot be eliminated [5]. Intensity transformation may be due to the film development, film scanning etc [6]. Section II provides literature survey. Section III deals with methodology of proposed registration technique. Results showing registered images with accuracy evaluation are shown by section IV. Conclusion is given in section V.

II. LITERATURE SURVEY

According to N. M. Alpert, D. Berdichevsky, Z. Levin, E. D. Morris and A. J. Fischman [7], "Improved methods for image registration" "Neuroimage 3, 10-18(1996) Article no. 0002" presented a system for PET–MRI registration that is improved or optimized in several areas: (1) Automatic scalp/brain segmentation replaces manual drawing operations,

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(2) a new fast and accurate method of image registration, (3) visual assessment of registration quality is enhanced by composite imaging methods (i.e., fusion) and (4) the entire procedure is embedded in a commercially available scientific visualization package, thereby providing a consistent graphical user interface.

According to Morgan McGuire [8], "An image registration technique for recovering rotation, scale and translation parameters", "NEC Tech report, February 1998" presents a new method of obtaining a rotation and translation-invariant scale signature of an image, a scale and translation-invariant rotation signature and a technique for recovering the rotation, translation and scale transformation parameters that relate two images of similar scenes using these signatures. The transformation parameters can be used to coregister the subbands of a composite image. In finite discrete case where invariances donot hold completely, the technique is completely robust in presence of occlusion due to alignment, resampling, linear and constant luminance changes and noise. The robustness comes from use of filters that minimize transformation artifacts.

Rui Xu and Yen-Wei Chen [9] suggested that "Wavelet based multiresolution medical image registration strategy combining mutual information with spatial information" "international journal of innovative computing, information and control Volume 3 No. 2 April 2007" says that mutual information is a widely used metric in medical image registration that achieves good result but due to absence of spatial information it leads to misregistration. Calculation of two images with different resolutions and their corresponding gradient-like images are integrated under the wavelet transform. Mutual information (MI) and Spatial information (SI) are calculated from the low-frequency coefficients and high- frequency coefficients of wavelet transform on each resolution layer and a hybrid metric is adopted to combine MI and SI together. Registration strategy runs faster than when multiresolution scheme is used.

Bruce D. Lucas Takeo Kanade [10] presented "An Iterative Image Registration Technique with an Application to Stereo Vision" "Volume 5 2008" says that the system that we have implemented at present requires considerable hand-guidance. The following are the issues we intend to investigate toward the goal of automating the process.

- Providing initial depth estimates for objects: one should be able to use approximate depths obtained from low-resolution images to provide initial depth estimates for nearby objects visible only at higher resolutions.
- Constructing a death map: One could build a depth map from depth measurements by some interpolation method.
- Tracking sudden depth changes: the sudden depth changes found at the edges of objects require some set of higher-level heuristics to keep the matching algorithm on track at object boundaries.
- Compensating: For the different appearances of objects in the two views: the general form of matching algorithm that allows for arbitrary linear transformations should be useful here.

According to Stefan Kruger and Andrew Calway [11], "Image Registration using Multiresolution Frequency Domain Correlation", "British machine vision conference" presents a correlation based image registration method which is able to register images related by a single global affine transformation or by a transformation field which is approximately piecewise affine. The method has two key elements: an affine estimator, which derives estimates of the six affine parameters relating two image regions by aligning their Fourier spectra prior to correlating; and a multiresolution search process, which determines the global transformation field in terms of a set of local affine estimates at appropriate spatial resolutions. The method is computationally efficient and performs well for a range of different images and transformations.

According to A. Collignon, et al. [12], "Automated multi-modality image registration based on information theory", "Medical imaging research" presents an information theoretic approach to rigid body registration of 3D multi-modality medical image data. The mutual information of gray level pairs is proposed as a new matching critera. Accuracy can be obtained completely without pre-segmentation.

According to Sahil Suri, Peter Schwind, Peter Reinartz and Johannes Uhl [13], "Combining mutual information and scale invariant feature transform for fast and robust multisensory SAR image registration" "2009" says that Scale Invariant Feature Transform (SIFT) operator's success for computer vision applications makes it an attractive solution for the intricate feature based SAR image registration problem. For SAR images, SIFT feature matching results into lot of false alarms. To overcome this problem, use mutual information (MI) along with the SIFT operator for SAR image registration and matching applications. MI is an established multimodal registration similarity metric and has the capability to quickly estimate rough registration parameters from down-sampled images. The rough image registration parameters obtained using The matching consistency of the SIFT matches especially for SAR images with various acquisition differences might not be up to the desired levels. To tackle the observed phenomenon, MI can further be utilized to refine the SIFT matches and to bring the matching consistency within desirable limits. This analysis is based

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on multisensor, multitemporal and different view point SAR images acquired over plain and semi urban areas. The proposed registration methodology shows tremendous potential to become a fast and robust alternative for geometric SAR image registration as subpixel registration consistency has been achieved for diverse natured datasets.

P. Ramprasad, H.C. Nagaraj and M.K Parasuram [14]. "Wavelet based image registration for matching dental X-ray", "International journal of electrical and computer engineering 4: 2009" says that image registration is useful for diagnosis of dental problems such as root canal treatment (RCT). It presents a wavelet based algorithm for registering noisy and poor quality images. Affine transformation is applied to calculate wavelet coefficients. RMSE and Correlation coefficients are used for evaluation. This technique is useful for images that differ by rotation and translation but not for scaling.

III. METHODOLOGY

Two images considered here are IR and IF where IR is assumed to be reference image while IF is a floating image or target image which is to be matched to IR. These two images are assumed to be differed by rotation, translation as well as by scaling. Registration technique consists of following stages:

Preprocessing: Salient and distinctive objects from image are detected. These detected features are known as control points on basis of which registration technique is applied. The correspondence between the control points in reference and target image is established by using discrete cosine transformation.

Transformation: Discrete cosine transformation performs basic registration of the image. It is a transformation which is used to generate the waveform of the input file. DCT has two coefficients. One is called the central maxima and another is called central minima. The discrete cosine transform helps to separate the image into parts or spectral sub-bands of differing importance with respect to the image's visual quality. This provides coefficients of the image to be registered.

Processing: Coefficients are passed to neural networks. The response of the network is in the form of a gray level value estimate of the current pixel using contour distance vector (CDV). It helps to filter out noise in basic registration of image. This will calculate Peak signal noise ratio (PSNR) and Root Mean Square Error (RMSE) between two images as accuracy parameters. Fuzzy Logic optimizes similarity measure for image registration. It extracts concerned region at which particular points in reference image are corresponded with another target image. For the image registration to take place, it is necessary to plot points where exactly the registration has to take place. The fuzzy system creates a rule set based on the points selected on the basis of the contour registration points. The registration process of medical image starts if the selected point falls in the region of fuzzy rule set.

IV. RESULTS AND DISCUSSION

Table I depicts PSNR and RMSE values for dental X-ray image rotated at an angle of 20^o and with enlargement factor of .2 for accuracy evaluation of proposed registration technique. Table II shows PSNR and RMSE values for dental X-ray image by deploying previous method of registration. Fig. 1(a) shows reference image rotated at 20^o angle and Fig. 1(b) is target image rotated at 20^o. The registered image with rotation angle of 20^o is shown by Fig .1 (c). The reference image is shown by Fig. 2(a) and target image with enlargement factor of .2 is shown by Fig. 2(b). The registered image with scaling is shown by Fig. 2(c).

Registration of image with rotation and scaling Parameter	**PSNR**	**RMSE**
Rotation at angle of 20^o	60.3397	0.11643
Translated image	57.6521	0.1594
Scaling with .2 enlargement factor	50.2791	1.2216

Table I: Values of PSNR and RMSE by applying proposed technique.

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Registration of image with rotation and translation Parameter	**PSNR**	**RMSE**
Rotation at angle of 20^o	17.365	1.8937
Translated image	30.346	1.7912

Table II: Values of PSNR and RMSE by applying previous technique.

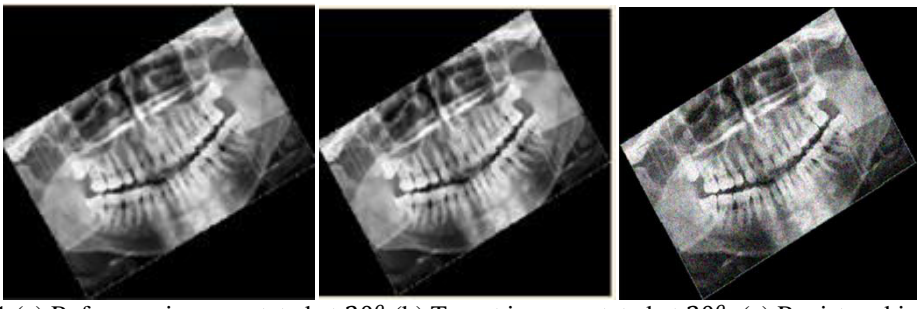

Fig. 1 (a) Reference image rotated at 20^o (b) Target image rotated at 20^o (c) Registered image.

Fig. 2 (a) Reference image (b) Target image with scaling factor of .2 (c) Registered image.

V. CONCLUSION

Appropriate and efficient hybrid technique of registering dental X-ray is presented here. The PSNR and RMSE computed by proposed technique is better than previous method of registration. Also previous technique does not handle dental image with scaling factor but our proposed technique works for scaling images too. Proposed technique results better when compared with previous technique of registration. The scheme in its present form works for images that differ from each other by scaling, translation and rotation. However it does not handle images with different translation factor and also PSNR, RMSE values can be improved further for scaling images. Future work will address this problem.

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