Image Registration Using Log Polar Transform

Divyang Patel[1] Vaibhav Gandhi[2]

[1,2]Department of Computer Science & Engineering

[1, 2] Parul Institute of Engineering & Technology.

Abstract— Image registration is the fundamental task used to match two or more partially overlapping images taken, for example, at different times, from different sensors, or from different viewpoints and stitch these images into one panoramic image comprising the whole scene. It is a fundamental image processing technique and is very useful in integrating information from different sensors, finding changes in images taken at different times, inferring three-dimensional information from stereo images, and recognizing model-based objects. Some techniques are proposed to find a geometrical transformation that relates the points of an image to their corresponding points of another image. To register two images, the coordinate transformation between a pair of images must be found. In this thesis comparison of various image registration algorithms is done by performance evolution among them.

Key words: Int Image Registration, Log-Polar Transform (LPT), Fast Fourier Transform (FFT).

I. INTRODUCTION

The estimation of the relative motions between two or more images is probably at the heart of any autonomous system which aims at the efficient processing of visual information. Motions in images are induced due to camera displacements or displacements of the individual objects composing the scene. Image registration techniques for global motion estimation address the problem of compensating for the camera ego-motion and finally aligning the images. Practical applications are numerous: from global scene representation and image mosaicking to object detection / tracking and video compression.

We propose a robust correlation-based scheme which operates in the Fourier domain for the estimation of translations, rotations and scaling in images. For the class of similarity transforms, a frequency domain approach has several advantages. First, through the use of correlation, it enables an exhaustive search for the unknown motion parameters. Second, the approach is global which equips the algorithm with robustness to noise [1]. Third, the method is computationally efficient. This comes from the *shift property* of the Fourier Transform (FT) and the use of Fast Fourier Transform (FFT) routines for the rapid computation of correlations.

The work in [2] introduces the basic principles for translation, rotation and scale-invariant image registration in the frequency domain. Given two images related by a similarity transform, the translational displacement does not affect the magnitudes of the FTs of the two images. Re-sampling the Fourier magnitudes on the log-polar grid reduces the problem of estimating the rotation and scaling to one of estimating a 2*D* translation. Thus, the method relies on correlation twice: once in the log-polar Fourier domain to estimate the rotation and scaling and once in the spatial domain to recover the residual translation. In the usual way, the authors use phase correlation (PC) [3] instead of standard correlation while they perform conversion from Cartesian to log-polar using standard interpolation schemes (e.g. bilinear interpolation).

In our scheme, we first replace image functions with complex gray-level edge maps and then compute the standard Cartesian FFT. Next, we simply resample the Cartesian FFT on the log-polar grid using bilinear interpolation. Neither sophisticated FFT nor over-sampling is employed to enhance accuracy. To perform robust correlation, we replace phase correlation with gradient-based correlation schemes.

II. LOG POLAR TRANSFORM (LPT)

The Log-Polar Transform is used for image registration for its rotation invariant and scale invariant properties. The log-polar image geometry is used because of the fact that scaling and rotation in Cartesian domain corresponds to pure translation in log-polar domain Taking logarithm of radial distance ρ, we get log-polar coordinates. The log-polar transformation is a conformal mapping from the points on the Cartesian plane (x, y) to points in the log-polar plane (log (ρ), θ). Considering a polar coordinate system, where ρ is the radial distance from the center of the image say (xc, yc) and θ denotes the angle. Any point (x, y) can be represented in polar coordinates and is given by

eu (1)

If the polar coordinate transformation is applied to an image in the Cartesian domain, then the radial lines in the Cartesian domain maps to horizontal lines in (ρ,θ) domain.

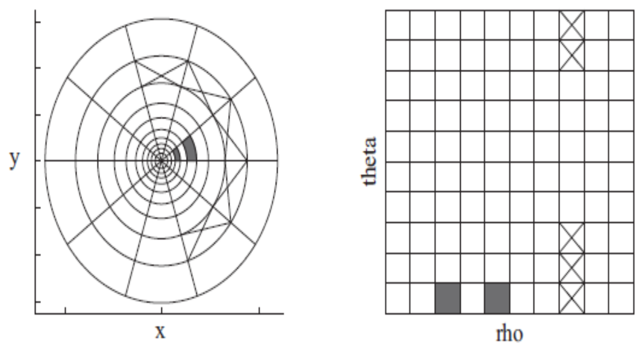

Fig. 1: Approximate mapping from Cartesian space to (ρ, θ) space. [4]

Fig.1 shows the approximate mapping from Cartesian space to polar space or (ρ, θ) space. The black box shows that the pixels are at a constant angle with respect to the center. Similarly, the boxes with cross marks are at a constant radial distance from the center. It is clear from Fig.1 that if there was a rotation in the image, the black box will shift its positions on the theta axis [4]. A similar situation can be discussed for the scale variation. In log-polar coordinates, logarithm of the radial axis is taken by

(ρ, θ) = (log (ρ), θ) (2)

Now if the image is scaled by a factor of say α, then the coordinates (x, y) in Cartesian domain will become (αx, αy). Introduction of logarithms will simplify the procedure, the coordinates in log domain will be reflected as

(log ((αx), log ((αy) = ((log α + log x), (log α + log y)) (3)

The effects of distortions are expressed by log-polar image translation on ρ axis and θ axis, respectively in the log-polar coordinates. However, when the original image is translated by (∆x, ∆y), the corresponding log polar coordinates is represented by

$$\rho' = \log \sqrt{(e^{\rho} \cos\theta - \Delta x)^2 + (e^{\rho} \sin\theta - \Delta y)^2} \quad (4)$$

$$\theta' = \tan^{-1} \frac{e^{\rho} \sin\theta - \Delta y}{e^{\rho} \cos\theta - \Delta x} \quad (5)$$

According to above two Equations (4) and (5), the slight translation produces a modification of the log-polar image. Therefore, the log-polar image is not suitable for faithfully extracting translation parameters of images [5, 6, and 7].

A. Image Registration Techniques: An overview [1]

The vital problem in medical imaging process of aligning two images into a common coordinate system thus aligning them in order to monitor subtle changes between the two. Registration algorithms compute transformations to set correspondence between the two images the purpose of this paper is to provide a comprehensive review of the existing literature available on Image registration methods.

B. Image registration methods: a survey [2]

Present a review of recent as well as classic image registration methods. Image registration is the process of overlaying images (two or more) of the same scene taken at different times, from different viewpoints, and/or by different sensors. The registration geometrically aligns two images (the reference and sensed images). The reviewed approaches are classified according to their nature (are abased and feature-based) and according to four basic steps of image registration procedure: feature detection, feature matching, mapping function design, and image transformation and resampling. Main contributions, advantages, and drawbacks of the methods are mentioned in the paper. Problematic issues of image registration and outlook for the future research are discussed too. The major goal of the paper is to provide a comprehensive reference source for the researchers involved in image registration, regardless of particular application areas. And also give the information about the various registering methods

For able to recognize the type of given task and to decide by itself about the most appropriate solution, can motivate the development of expert systems. They will be based on the combination of various approaches, looking for consensus of particular results.

C. Second order optimization of mutual information for real-time image registration. [3]

A direct image registration approach that uses Mutual information (MI) for metric alignment. Also describe the robust, real-time and gives an accurate estimation of a set of 2D motion parameters. And this method MI cost function and gives a practical solution for real time tracking. We show that by refining the computation of the Hessian matrix and using a specific optimization approach, the registration results are far more robust and accurate than the existing solutions while the computation is cheaper.

D. Symmetric image registration with directly calculated inverse deformation field [4]

Symmetric deformable image registration based on a new method for fast and accurate direct inversion of a large motion model deformation field. The proposed image registration algorithm maintains a one-to-one mapping between registered images by symmetrically warping them to each other, and by ensuring the inverse consistency criterion at each iteration. This makes the final estimation of forward and backward deformation fields anatomically plausible. The quantitative validation of the method has been performed on magnetic resonance data obtained for a pelvis area demonstrating applicability of the method to adaptive prostate radiotherapy. The experiments demonstrate the improved robustness in terms of inverse consistency error when compared to previously proposed methods for symmetric image registration.

In this method can replace the small-step multiple pass approach in each iteration step and offer the advantage of higher accuracy by removing the magnitude limiting procedure. The quantitative validation performed on real MRI and synthetic data shows that the proposed modifications results in the reduction of the inverse consistency and transitivity error measures when compared with the small-step multiple pass algorithm.

E. Image Mosaics Algorithm Based on SIFT Feature Point Matching and Transformation Parameters Automatically Recognizing [5]

Researchers solve the problem of image mosaic of images that are in different scales in the traditional image mosaic method. The match and mosaic of different scale and rotated images is achieved through feature point matching and automatically recognizing of transform geometric parameters between images. First, using SIFT extraction algorithm to extract the feature points of the image to be mosaic. Second, achieving feature points matching according to the principal of mutual information maximum. Third, automatically recognize the relationship of transformation parameters between two images according to the geometric information of the matching pairs. Finally, the projective transformation matrix that reflected the image translation, rotation and scaling information can be obtained and the image stable mosaic can be achieved.

The SIFT algorithm was used to extract image feature points, and then the circular area was adopted, and based on the principle of mutual information maximum the matching points in two images were founded. Proceed from the position information of matching points, to recognize the scale, rotation and translation parameters of images to be mosaic, calculated the transformation matrix, and eventually, achieved the image mosaic of two images stably and seamlessly. This is a better solution to the limitations that the traditional algorithm does not suitable for different scale images mosaic. The experiments show that the algorithm adopted in this thesis inherits the good robust of SIFT algorithm and as well as has higher parameter identification and mosaic accuracy, and good adaptability to image translation, rotation and scale transform.

III. CONCLUSION

Mostly image registration algorithm is presented using Log-Gabor filter, Log-Polar Transform and Phase Correlation. The rotation and scale invariant properties of the LPT, along with FT and phase correlation allow us to develop a robust algorithm that works faithfully under geometric distortions like rotation, scale and translation. Thus in our proposed work, is highly effective in registering aerial images. And anyone amount of scaling, rotation in Cartesian domain will be solid translation in log polar domain. The ability of the algorithm to recover registration parameters in presence of noise, partial data and with blurring is also verified.

REFRENCES

[1] Image Registration Techniques: An overview, Medha V. Wyawahare, Dr. Pradeep M. Patil, and Hemant K. Abhyankar, International Journal of Signal Processing, Image Processing and Pattern Recognition, Vol. 2, No.3, September 2009

[2] Image registration methods: a survey, Barbara Zitova´*, Jan Flusser, Image and Vision Computing 21 (2003) 977–1000

[3] Second order optimization of mutual information for real-time image registration, Amaury Dame, Eric Marchand, IEEE TRANS ON IMAGE PROCESSING, 2012

[4] Symmetric image registration with directly calculated invers deformation field, Bartlomiej W. Papie˙z1 and Bogdan J. Matuszewski, PAPIE˙Z AND MATUSZEWSKI: SYMMETRIC IMAGE REGISTRATION, Annals of the BMVA Vol. 2012, No. 6, pp 1–14 (2012)

[5] Image Mosaics Algorithm Based on SIFT Feature Point Matching and Transformation Parameters Automatically Recognizing**,** Pengrui Qiu,Ying Liang and Hui Rong, Proceedings of the 2nd International Conference on Computer Science and Electronics Engineering (ICCSEE 2013)

[6] ROBUST FFT BASED SCALE INVARIANT IMAGE REGISTRATION USING IMAGE GRADIENTS, MR. TEJAS D. DARJI , [2] PROF. S. D. JOSHI , [3] PROF. M. V. SHAH,

[7] "Asurvey of image registration." n.d. <https://docs.google.com/viewer?a=v&q=cache:665Vy2VgbCsJ:www.cscjournals.org/csc/manuscript/Journals/IJIP/volume5/Issue3/IJIP-364.pdf+image+registration+a+survey&hl=en&gl=in&pid=bl&srcid=ADGEESiqTC8-dOUFL6x0BbdOQRsb7kVNSwosXpeZBbkV6qSUNPmcHOLywka6vmHD9ldZ2. >

[8] Somaraju.Boda. "Feature-based image registration." 2009.

