行政院國家科學委員會專題研究計畫　成果報告

應用影像特徵幾何關係圖設計影像對應系統

計畫類別：個別型計畫
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（計畫名稱：應用影像特徵幾何關係圖設計影像對應系統）

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一、中英文摘要

近來，遙測影像的對應、醫學影像接合、衛星空照地形影像建立、物體運動偵測和物件的辨識越漸重要，而發展在這些應用的影像對應技術也越顯重要。一般而言，所謂的影像對應技術是指求的兩張部分重疊的影像對應的關係，而這些關係包含了兩張部分重疊影像大小變化、影像的旋轉和影像的移位幾何的參數。在影像對應系統之技術研發上，有兩個非常重要的問題，分別是影像特徵的萃取及如何應用萃取到之影像特徵做對應關係的估算。傳統之影像接合系統受限於計算複雜度，通常只考量使用特定之影像特徵(如邊緣或是影像的顯著點、輪廓、紋理)來發展影像接合系統。但是影像的種類與屬性非常廣泛，其特徵的屬性與量皆大不相同，換言之，也就是說部分影像使用某種影像特徵能夠使用在影像對應技術，然而使用另一種影像特徵卻會造成無法估計出正確的幾何參數。因此在發展一個健全之影像對應系統，影像特徵的種類應該盡可能被考慮納入系統中。所以在我們的論文中所發展之影像對應系統時是同時抽取多種特徵，如邊緣點、輪廓、紋理，再建立各個特徵的位置幾何關係及特徵的屬性，接著，利用特徵的位置幾何關係和特徵的屬性當作比對的依據，找出每種特徵在重疊區域的特徵配對、粗估的對應參數及每種特徵在可靠度和數量，最後選取最為可靠的特徵及除去假的配對，並使用基因演算法或奇異值分解法求取正確的影像對應幾何關係。

關鍵詞：關鍵字：影像對應，邊緣點，輪廓，紋理，特徵關係圖

Generally, the geometrical parameters in the conventional image registration system are estimated by applying only one specific image feature, *e.g.* salient points, contours, or textures, such that the computation complexity may be reduced. However, applying only one specific image feature may be fail for some images because the image characteristics are widely spread among the various kinds of images. Hence, how to select the image feature to estimate the correspondences between two images is an important issue in developing the image registration system. In this project, a feature-based relational graph for the image features is generated to roughly estimate the correspondence between two images and then the most reliable image feature is determined to calculate the precise geometrical correspondence parameters.

Keyword: image registration, salient point, contour, texture, feature-based relational graph

二、緣由與目的

Recently, with the great demand for the intelligent surveillance [1], medical image processing [2], telemeter image processing [3-4], motion detection and object recognition [5], the researches of image registration become increasingly imperative. In the conventional image registration systems, the correspondence parameters are estimated by applying only one specific image feature, *e.g.* salient points, contours, or textures, such that the computational complexity may be reduced.

There are two important issues in developing the image registration system. The first one is how to select the most reliable image feature to estimate the correspondences between two images; while the second one is the calculation of the precise correspondence parameters. The image features may be the salient points, contours, or texture regions. In [3], Hsieh *et al*. propose an edge-based method to extract the salient points and then solve the geometrical transformation parameters between two images. However, this method will be failed when the registration process is performed on the image pairs with dense texture regions. Hence, Averbuch *et al*. [6] proposed a region-based image registration method in which the regions are matched by using the FFT features. However, this method is sensitive to the rotation process. Furthermore, the contour-based methods in [4] are proposed to estimate the correspondence parameters between two images. In [2], Davatzikos *et al.* apply the region boundary as the image feature to estimate the image correspondence. However, the above methods will be unable to register the images with little contour information.

Therefore, applying only one specific image feature may be failed for some images because the image characteristics are widely spread among various kinds of images. In this project, a feature-based geometrical relational graph is generated to select the most reliable image feature and roughly estimate the correspondence between two images. Then, the most reliable image feature is applied to calculate the precise correspondence parameters. The block diagram of the image registration system using the feature-based relational graph is shown in Fig. 1.

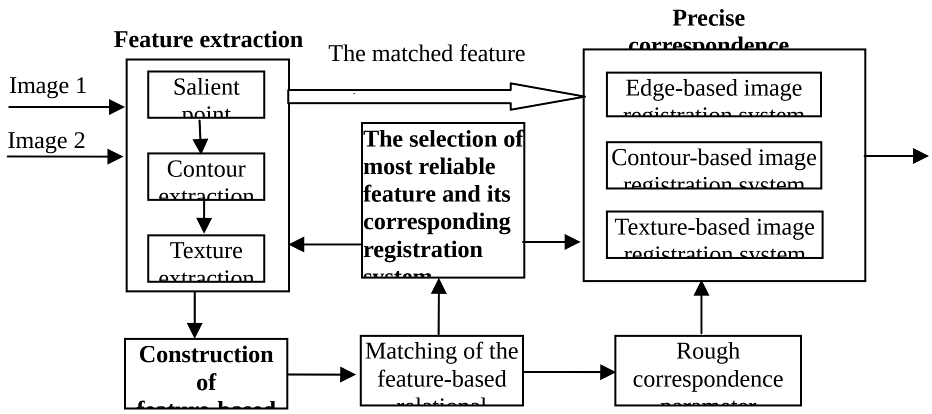


Fig. 1. The block diagram of the image registration system using the feature-based relational graph.

三、結果與討論

In this project, a two-stage image matching method is proposed to develop the new image registration system. Firstly, the geometrical relational graph is applied to estimate the rough corresponding parameters and then the most reliable image feature is determined. Secondly, the precise corresponding parameters are determined by measuring the similarity with the most reliable feature. Here, we will illustrate the experimental results for the two-stage image matching method.

(a) The image registration using the salient points

Given the image pair shown in Fig. 2-(a), the most reliable feature selected by the matching process for the two feature-based relational graphs is the salient points shown in Fig. 2-(b). The similarity measure between the two relational graphs for the image pairs (see Table 1) shows that the most reliable feature is the salient point. By applying the matched feature pairs shown in Fig. 2-(c) and the matched relational graphs, the rough correspondent parameters may be estimated (see Table 1). Then, the SVD method is applied to derive the precise image correspondent parameters s, R and T (see Table 2).

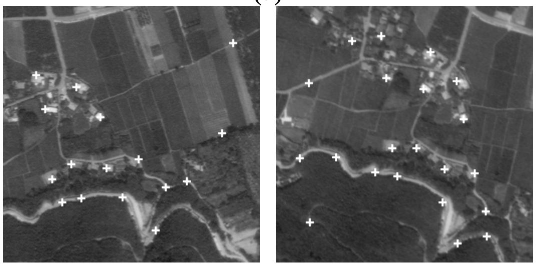
(b) The image registration using the contour feature

Fig. 3-(a) shows a binary aerial image pairs. Firstly, the similarity measure of the feature-based relational graphs for the image pairs is applied to select the most reliable feature. Table 3 illustrates that the most reliable feature is the contours (see Fig. 3-(b)). By applying the matched feature pairs shown in Fig. 3-(c) and the matched relational graphs, the rough correspondent parameters may be estimated (see Table 4). Secondly, based on the contour-based image registration method mentioned in section 3 and the genetic algorithm, we may calculate the precise correspondent parameters s, R and T (see Table 4).

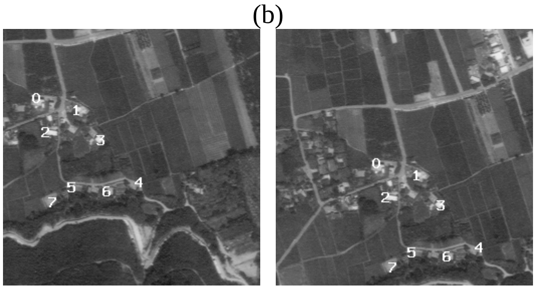
(c) The image registration using the reference points of the texture region.

Fig. 4-(a) shows the aerial image pairs. Firstly, the similarity measures of the feature-based relational graphs for these image pairs are applied to select the most reliable feature. Tables 5 illustrates that the most reliable feature is the texture feature shown in Fig. 4-(b). By matching the feature-based relational graphs the most reliable feature is determined shown in Fig. 4-(c), and then the rough correspondent parameters may be estimated (see Table 6). Secondly, based on the texture-based image registration method and the genetic optimization process, we may calculate the precise correspondent parameters s, R and T (see Table 6).

(a)



(b)



(c)

Fig. 2. (a) An aerial image pair. (b) The detected salient points. (c) The matched feature pairs (salient points).

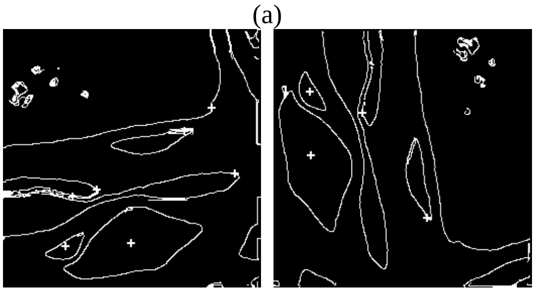
Table 1. The similarity measure for the feature-based relational graphs.

Image feature	Salient point	Contour	Texture
The number of matching pairs	8	4	7

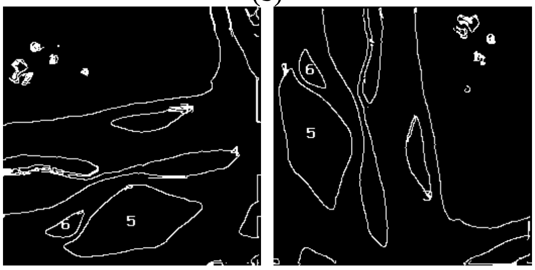
Table 2. The rough and precise correspondent parameters

	True correspondent parameters	Rough correspondent parameters	Precise correspondent parameters
Scale	1.0	1	0.9975
Dx	-65.0	-63	-62.0000
Dy	-68.0	-63	-65.0000
Angle	0.0	0.0	0.4770

(a)



(b)



(c)

Fig. 3. (a) Binary aerial image pair. (b) The detected corner points on the contours. (c) The matched feature pairs (corner points).

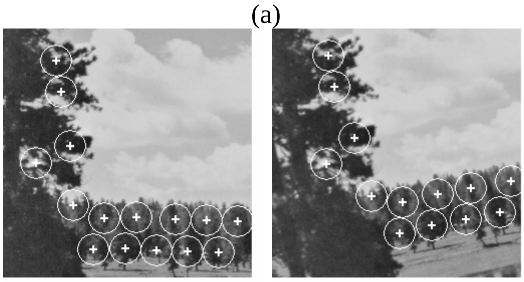
Table 3. The similarity measure for the feature-based relational graphs.

Image feature	Salient point	Contour	Texture
The number of matching pairs	6	7	0

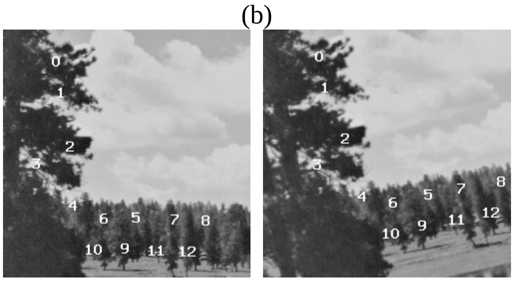
Table 4. The rough and precise correspondent parameters.

	True correspondent parameters	Rough correspondent parameters	Precise Correspondent parameters
Scale	0.97	1	0.9794
Dx	0	2	-1.3360
Dy	0	2	0.7824
Angle	90	90	90.3513

(a)



(b)



(c)

Fig. 4. (a) An scene image pair. (b) The location of the reference points in the detected texture regions. (c) The matched texture feature pairs.

Table 5. The similarity measure for the feature-based relational graphs.

Image feature	Salient point	Contour	Texture
The number of matching pairs	3	0	13

Table 6. The rough and precise correspondent parameters

	True Correspondent parameters	Rough Correspondent parameters	Precise Correspondent parameters
Scale	1	1	0.9856
Dx	21	17	22.7030
Dy	-16	-18	-17.7739
Angle	348	350	347.1019

四、計劃成果自評

By considering as many image features as possible a robust image registration system may be developed. In this project, multiple image features are acquired via the wavelet transformation and edge chaining processes and then a feature-based relational graph is constructed to describe their geometrical relationships. Applying the feature-based relational graph, the correspondence between two images may be estimated by a two stage matching method. Firstly, the feature-based relational graph is applied to estimate the rough corresponding parameters and then the precise corresponding parameters are determined by measuring the similarity for these image features. The experimental results show that the proposed registration system using the feature-based relational graph may register the various kinds of images efficiently.

五、參考文獻

[1] Y. Ren, C. S. Chua, and Y. K. Ho, "Motion detection with nonstationary background," *Machine Vision and Application*, Vol. 13, No. 5-6, pp. 332–343, Mar. 2003.

[2] C. Davatzikos, J. L. Prince, and R. N. Bryan, "Image registration based on boundary mapping," *IEEE Transactions on Medical Imaging*, vol. 15, pp. 212-215, Feb. 1996.

[3] J.-W Hsieh, H.-Y. Mark Liao, K.-C. Fa, M.-T. Ko, and Y.-P. Hung, "Image registration using a new edge-based approach," *Computer Vision and Image Understanding*, vol. 67, no. 2, pp. 112-130, Aug. 1997.

[4] H. Li, B. S. Manjunath, and S. K. Mitra, "A contour-based approach to multisensor image registration," *IEEE Transactions on Image Processing*, vol. 4, no. 3, pp. 320-334, Mar. 1995.

[5] Z. Yang and F. S. Cohen, "Image registration and object recognition using affine invariants and convex hulls," *IEEE Transactions on Processing*, vol. 8, no. 7, pp. 934-946, July 1999.

[6] A. Averbuch and Y. Keller, "FFT based image registration," *Acoustics, 2002 IEEE International Conference on Speech, and Signal Processing*, vol. 4, 2002.

[7] K. F. Shi, "Image compression by preserving the multiresolution edges," *Master dissertation,* Tsing Hua Univ., June 1993.

[8] I. Pitas, "*Digital image processing algorithms and applications*," Wiley-interscience, 2000.

[9] Z. Michalewicz, *Genetic algorithms+ Data structures = Evolution programs*, 3nd edition, Springer-Berlin Heidelberg, USA, 1996.

六、計畫成果發表

[1] **Cheng-Chang Lien** and Miao-Chen Chung, "Image registration using the feature-based relational graph," *Chung Hua Journal of Science and Engineering*, Vol. 3, No. 1, pp. 73~80, Jan. 2005.

[2] **Cheng-Chang Lien**, Chin-Chun Han, and Miao-Chen Chung, "Image registration using the feature-based relational graph," *IASTED Signal and Image Processing 2004*, pp. 407-472, Aug. 23-25 2004, Honolulu Hawaii, USA.