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A Study on Assembling of Sub Pictures using Approximate Junctions

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Abstract: It is important to develop a method of assembling a set of sub pictures automatically into a mosaic picture, because a view through fiberscopes or microscopes with higher magnifying power is much larger than the field of view taken by a camera. This paper presents a method of assembling sub pictures, where roughly estimated junctions called approximate junctions are employed for matching triangles formed by selected junctions in sub pictures. To over come the difficulties in processing speed and noise corruption, fuzzy rules is applied to get fuzzy values for existence of approximate junctions and fuzzy similarity for congruent triangle matching. Some demonstration, exemplified by assembling microscopic metal matrix photographs, are given to show feasibility of this method.
Keywords: Fuzzy, Image, Mosaic

1. Introduction

Graphical images taken by fiber scopes, microscopes or ophthalmo scopes are viewed within so narrow space that the experts have to handle the scopes carefully to get wider images of the objects. The techniques to get wide images give some unified pictures of the whole objects to the experts, which make it easier to examine some delicate points in the pictures. Therefore, moving the scope automatically by visual servo mechanism with integrating a set of several pictures into a mosaic picture has been required to be developed in many fields. Assembling sub pictures by determination of overlapping area were studied in many papers[1],[2],[3],[4],[5]. Some methods, determining over lapping images and choosing best seam path in two sub pictures by using space vectors, has been proposed. But it is assumed that sub pictures are free from noises, distortions ,and rotations, so ideal signal processing are necessary to over come any difficulties in matching the area.

This paper propose a method which provides an efficient way to reduce a number of junction points by restricting area to some appropriate size, using an approximate junction points. The algorithm are tested by simulation and proved successfully in experiments.

2. Algorithm of Assembling and Approximate Junction Points

Basic idea of assembling of sub pictures are calculation of parameters necessary for assembling using information of positions of junctions included in the adjacent pictures[6]. The steps are as follows;

1. Three junction points are selected from Picture 1.
2. Search a similar triangle on the Picture 2.
3. Using geometric parameters of two triangles, estimate magnifying power, rotation and translation parameter.
4. Points on Picture 2 are transformed by the parameters.

In this method, quick finding a similar triangle on Picture 2 is a key point. So, we propose the idea of the approximate junction point, which are likely to be junctions with large probability. Searching approximate junction points are performed as follows;

a) A junction might exist in some segments of meshes in the binary images, partitioned into meshes.
b) Probability of existence of junction points are calculated for each mesh, and the meshes of high probability are marked and assembling into a larger one if adjacent meshes are high probability.

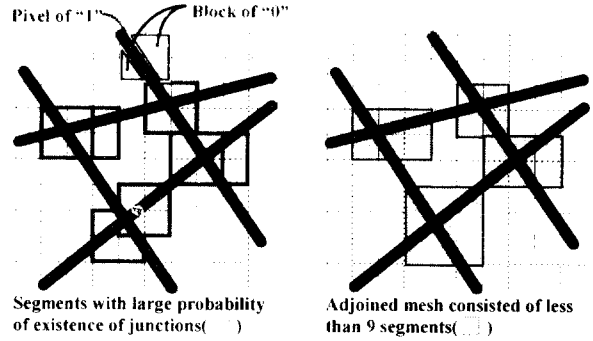


Fig. 1 :Searching Approximate Junctions

The probability of existence is estimated by Fuzzy Rule related to the meshed segments. The segments, which might have a junctions with large probability, are selected as the following fuzzy rules based on the number of black pixels and white blocks in the meshed segments. Assuming that a junction exists in a segment, it can be expected that black pixels exist more than the average as well as black pixels isolate white pixels into more than one blocks. Therefor the fuzzy probabilities in each segment of meshes are computed by the fuzzy

reasoning using the number of black pixels and white blocks in the segments as

IF x_1 is A_{1i} and x_2 is A_{2i} then y is B_i

where

x_1 is the number of black pixels in the mesh,

x_2 is the number of white blocks in the mesh,

A_{1i} is defined as fuzzy set belonging x_1,

A_{2i} is defined as fuzzy set belonging x_2,

y is the fuzzy probability of junction existence, and

B_i is defined as Fuzzy set belonging y.

By fuzzy reasoning and Max-Min composition center gravity method, the fuzzy probability output y is computed. The fuzzy rules and the member ship functions applied here are shown in Table 1 and Fig.2 respectively. Then the segment whose output y is larger than 0.7 is considered as having a junction.

Table 1. Fuzzy Rules

A_{2j} \ A_{1i}	VS	S	M	B	VB
VS	VS	VS	S	M	S
S	VS	S	M	B	S
M	S	M	B	VB	S
B	M	B	VB	VB	M
VB	B	VB	VB	VB	M

VB : Very Big
B : Big
M : Medium
S : Small
VS : Very Small

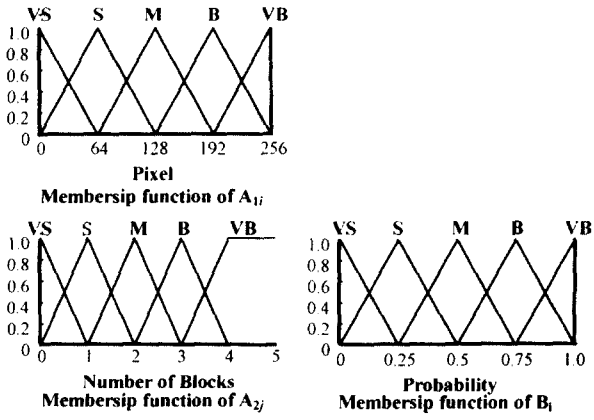


Fig. 2 Membership functions

3. Fuzzy Matching

3.1 Algorithm of Fuzzy Matching

The triangles formed by three selected approximate junctions are searched and the fuzzy similarity for congruent triangles is computed for selection of one triangles in a picture and another triangle in another picture.

The algorithm is performed as follows.

1. Select three approximate junctions to form a triangle in the standard picture.
2. In the object picture, search a congruent triangle.
3. Repeat 1 and 2 until the algorithm finds a pair of congruent triangles in two pictures
4. Choose the highest fuzzy similarity for a pair of triangles if two or more triangles are determined by selection.
5. After finishing selection of a pair of triangles, compute translation and rotation to determine overlapping area in the standard picture and the object picture.

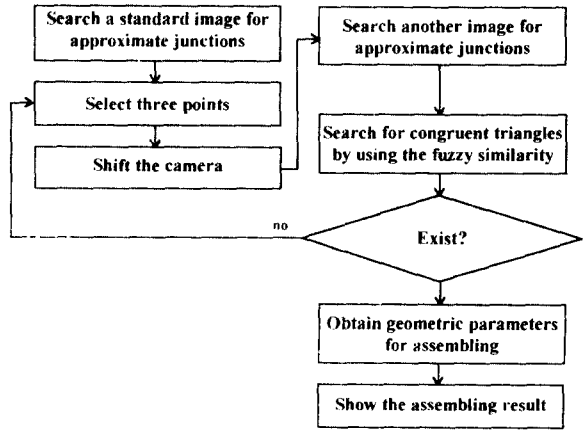


Fig. 3 :Fuzzy matching algorithm

3.2 Fuzzy Similarity of two triangles

When three side length of triangles match each other, the two triangles are congruent. So we define the characteristic lists of triangles to distinguish congruence between triangles as follows:

$$L_k: (l_1, l_2, l_3) \qquad (1)$$

Where l_1, l_2, l_3 are side length of a triangle formed with three points of center of gravity of approximate junctions.

Then the characteristic list of a triangle extracted from standard picture and the characteristic list of a triangle extracted from a input picture are compared to each other to distinguish congruence by using the fuzzy similarity degree[7] based on the fuzzy logic.

A. The degree of similarity between two numbers

In order to evaluate similarity between two characteristic lists, it is necessary to define the degree of similarity for each element of the lists. In this paper, it is assumed that each element of the characteristic lists is a fuzzy number having a triangular membership function $\mu(x)$, as shown in Fig 4, and the width of the

bottom side of the triangle is equal to the absolute value of the number. Assuming all the numbers are fuzzy numbers in this way

So, the similarity degree S_i between each element of two characteristic lists is defined as follows.

$$S_i = Max\{Min\{\mu_{ai}(x), \mu_{bi}(x)\}\} \quad (2)$$

Here μ_{ai} and μ_{bi} are the membership function of i-th elements of lists.

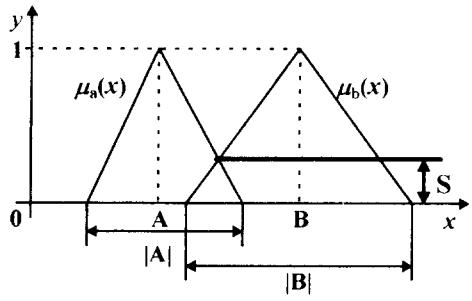


Fig. 4 The similarity degree of two fuzzy numbers

B. Similarity degree between the characteristic lists

Using the similarity degree between these fuzzy numbers, the similarity between characteristic lists is evaluated. Let l_{ai} and l_{bi} represent the i-th elements of the two characteristic lists, denoted as $L_A(l_{a1}, l_{a2}, l_{a3})$ and $L_B(l_{b1}, l_{b2}, l_{b3})$ respectively, as shown in Fig 5.

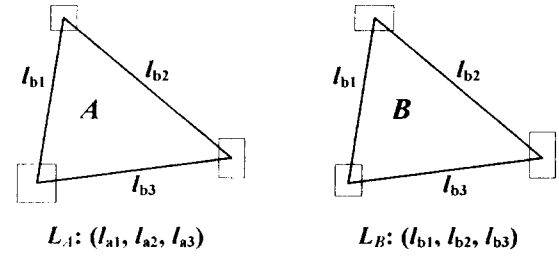
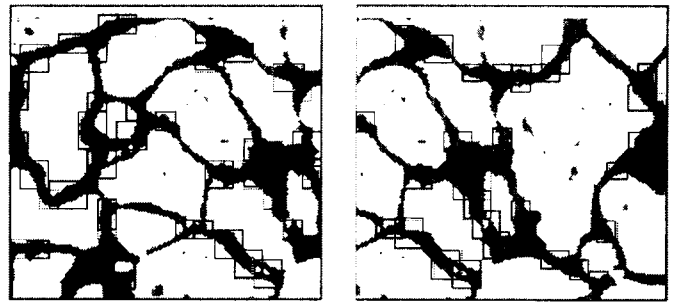


Fig. 5 The characteristic lists of triangles

Then the similarity degree between lists L_A and L_B is defined as follows.

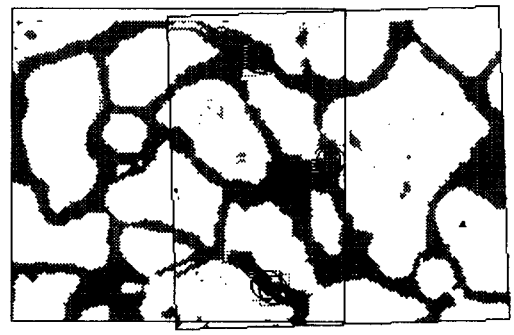
$$SL = \underset{1 \le i \le 3}{Min}\{S_i\} \quad (3)$$

Here S_i denotes the similarity degree between the i-th elements of the characteristic lists. The degree S_i can be calculated using Eq.(2).



standerd picture object picture

(a) Result of estimate approximate junctions (□: approximate junction)



(b) Result of fuzzy matching

Fig. 6 :matching result

When we compare a characteristic list L_A with the other list L_B, we must consider three lists concerning L_{A1} as follows.

L_{Ak}: $L_{A1}=(l_{a1}, l_{a2}, l_{a3})$,
$L_{A2}=(l_{a2}, l_{a3}, l_{a1})$,
$L_{A3}=(l_{a3}, l_{a1}, l_{a2})$

Then the list L_{Ak}(k = 1,2,3) and the list L_B are compared each other in order to obtain the similarity.

The degree of similarity between the list L_{Ak} and the list L_B is denoted as SL_k(k = 1,2,3), which is obtained by Eq.(3). The similarity degree between two characteristic lists, L_A and L_B, of triangles is defined as following equation,

$$SF = \underset{1\le k\le 3}{Min}\{SL_k\} \qquad (4)$$

Then the two triangles, whose similarity degree SF is larger than threshold value, then two triangles are congruent.

4.Applications Results

Some experiments for matching triangles and determining the over lapping area is performed in some pictures. The threshold value 0.95 or more is considered as matching successfully in congruent triangle similarity matching. In the method of using approximate junctions, the matching in binary pictures(pixels to pixels) are employed after triangle congruent matching is finished because wrong combination of triangles are considered as a pair of congruent triangles which has higher similarity.

The results are shown in Fig.6, (a) is the result of estimate approximate junctions and (b) is the result of fuzzy matching using approximate junctions. Fig.6(b) shows some inaccurate position estimation which results in some errors in deciding overlapping area. Though, the approximate junction method has some errors in estimation, the decided over lapping area coincide with real overlapping area in tolerable accuracy.

5.Conclusion

In this paper, a method for assembling sub pictures was reported, where approximate junctions were employed for assembling by matching triangles formed by junctions. To overcome the difficulties in processing speed and noise corruption, fuzzy reasoning was applied to get fuzzy values for existence of approximate junctions and fuzzy similarity for congruent triangle matching. Some examples were shown as demonstration of the proposed method.

The following are some conclusions.

(1) The approximate junctions can be employed as markers formed for triangles to match.

(2) Fuzzy similarity can be used for searching congruent triangles and the algorithm works successfully.

(3) The experiments on determination of overlapping area, show feasibility of the method, though some improvement will be required in the future.

References

[1] D.L.Milgram, "Adaptive Techniques for Photomosaicking", IEEE Trans. on Computer, Vol.C-26, no.11, 1977,pp1175-1180.

[2] R.Y.Wong and E.L.Hall, "Sequential Hierarchical Scene Matching", IEEE Trans. on Computer, Vol.C-27, no4, 1978, pp359-366.

[3] M.Tanaka, S.Tanaka and K.Tanaka, "Picture Assembly using a hierarchical Partial-Matching Techniques", IEEE Trans. on System, Man and Cybernetics, Vol.24, no3, 1995, pp253-262.

[4] D.T.Pham and M.Abdollahi, "Automatic Assembly of Ocular Fundus Images", Pattern Recognition(UK), Vol.SMC-8, no3, 1995, pp.253-262.

[5] P.Daniand S.Chaudhuri, "Automated assembling of images: image montage preparation", Pattern Recognition(UK), Vol28, no3, 1995, pp431-445.

[6] K.Kurosu, K Morita, M.Ohta, T.furuya and M.Soeda, "A Study on Assembling Subpictures with Visual Servo", Proceedings of the 1996 IEEE IECON, Vol.2, 1996,pp.864-869.

[7] M.Soeda, T.Furuya, W.Zhang and K.Kurosu,"Lip Reading using polygonal Approximation of Mouth-Shape and degree of Fuzzy Similarity", Japanese Journal of Fuzzy theory and Systems, Vol.6, no5, 1994, pp609-622.