Reconstruction Torn Image Pieces

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Abstract

In this work apply a polygonal approximation to in order to reduce the complexity of the boundaries and then extracts relevant features of the polygon to carry out the local reconstruct Thereafter, these features are used to feed the LCS dynamic programming algorithm, In this way, the overall complexity can be dramatically reduced because few features are used to perform the matching. The preliminary result is resolved and the pieces are match together as search for a global solution.

The results, which take into account a limited amount of torn pieces, demonstrate through comprehensive experiments that this feature-matching based procedure produces interesting results for the problem of image reconstruction.

longest common string dynamic programming algorithm and Douglas–Peucker algorithm the scores is a valid technique for solving this problem .

Keyword: - Torn Image Pieces, Longest String Dynamic algorithm, Douglas Peucker algorithm

إعادة بناء قطع الصور الممزقة

(صبا عزيز ساهي مدرس مساعد)

الخلاصة

في هذا العمل ، الطريقة المقترحة هي اولا تقترح شكل متعدد الاضلاع لكي يقلل من تعقيد الحدود للقطع الممزقة ، بعد ذلك سوف تنتزع ميزات من الشكل المضلع لكي تنفذ عملية البناء المحلي.

فيما بعد ،هذه الميزات سوف تستخدم لكي تغذي خوارزمية برمجيه وهي (LCS) .

التعقيد عموما يمكن ان يخفض بشكل كبير لانه يتم استخدام بعض الميزات لاداء التطابق ، حيث يتم حل النتيجة الاولية والقطع تصبح متطابقة معا في البحث عن حل عام .

النتائج التي تؤخذ بنظر الاعتبار هي كمية محددة من القطع الممزقة حيث يثبت من التجارب الواسعة التطابق ان هذا الاجراء يستند الى نتائج مثيرة للاهتمام لمشكلة بناء الصورة .

كل من خوارزمية (LCS , DP) من التقنيات الصحيحة لحل مثل هذه المشكله .

الكلمات المفتاحية: قطع ممزقه ، خوارزمية أطول سلسله ديناميكية برمجيه ، خوارزمية دوكلاس وبويكر .

Introduction

The reconstruct of pieces of an object using computer software has significant usages in the real world. Applications include reconstruction of torn images or pieces pottery and artifacts while excavating ruins of ancient civilizations. It can be a challenging and formidable task reconstructing an entire object [1].The re-reconstruct of pieces can be viewed as puzzle-solving which has mostly been attempted on jigsaw puzzles as a classic exercise in computer vision or robotics [2].

The amount of time necessary to reconstruct an image depends on the size and the number of pieces, and it can be measured in days or even weeks. Sometimes some pieces of the image can be missing, and for this reason, the image can be only partially reconstruct, the manual effort of human, which is tedious and laborious, Can be alleviated by means of computer usage. [3].

Wolfson[4] describes two curve matching algorithms where the boundaries are represented by shape feature strings, which are obtained by polygonal approximation, the matching stage finds the longest common sub-string and it is solved by geometric hashing, the algorithms described by Wolfson are pretty fast, and for this reason are used by most puzzle solving methods. According toKong and Kimia [5], these algorithms fail when the number of puzzle pieces becomes larger; Kong and Kimia [5]propose re-sampling the boundaries by using a polygonal approximation in order to reduce the complexity of the curve matching. They make a coarse alignment using dynamic programming on the reduced version of the boundaries [3].

To reconstructed pieces have invariably involves two distinct stages: (1)local matching of pieces for pair wise affinity, and (2)searching for a global solution to the puzzle. Previous work in computing pair wise affinity measure has often relied on curve matching, or more specifically, partial curve-matching, because for adjacent pieces, only a portion of their boundaries are adjacent and thus similar. For a given pair of pieces, one must determine which portions of the piece boundaries to compare, and how similar these two segments are [2].

Related works

Most of these methods were developed for solving problems such as the jigsaw puzzles [3]. In general, they are based on specific shape and color features as well as the relationships that may exist between several jigsaw puzzle pieces, Willis and Cooper[6] address the problem of artifact reconstruction discussing2D and 3D approaches. Leit˜ao and Stolfi[7] propose an algorithm based on incremental dynamic programming to reconstruct ceramic tiles. Interesting results also have been reported by Papaod ysseus et al [8] where the focus is in the reconstruction of archaeological wall-paintings. Regarding the reconstruction of documents for forensics purposes, DeSmet[9] discuss a formal analysis of the problem of reconstructing ripped-up documents when the remnants can be recovered as an ordered stack of fragments.

Justino et al [10] propose a local reconstruction of shredded documents based on polygonal approximation and feature matching [11].

The Proposed Methodology

The Methodology is composed of three major steps as depicted in (Fig3.1) initially; each piece of the image is pre-processed through polygonal approximation in order to reduce complexity of the boundaries. Then, a set of features are extracted from each polygon in order to carry out the matching busing the LCS (longest common string) dynamic programming algorithm and Douglas–Peucker algorithm((Douglas and Peucker, the authors describe two methods for reducing the number of points required to represent a digitized line. The second method has been most widely implemented; hence we shall now describe this in some detail. The first point on the line is defined as the 'anchor' and the last point as a 'floater'. These two points are connected by a straight line segment and perpendicular distances from this segment to all intervening points are calculated. If none of these perpendicular distances exceed a user specified tolerance (distance value), then the straight line segment is deemed suitable to represent the whole line in simplified form. finally the scores yielded by the LCS algorithm are then used into a modified Prim's algorithm to find the best match among all pieces. (**Prim's algorithm** or sometimes even more inappropriately called 'the Prim/Dijkstra algorithm' the basic idea of the algorithm is very simple: find A's safe edge and keep it.

Pieces image

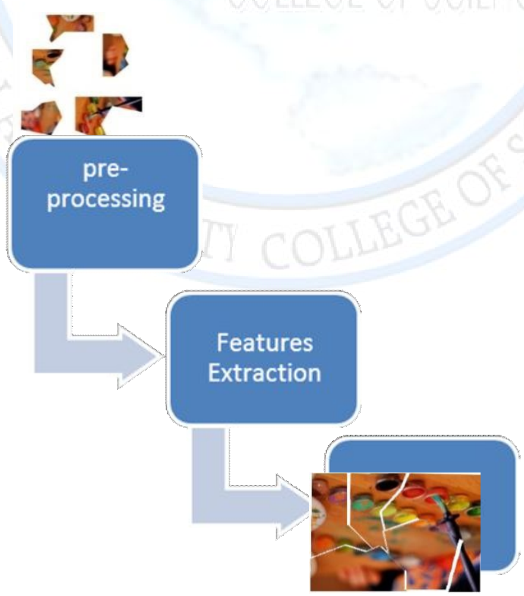


Image Totally or

Partially **econstruction**

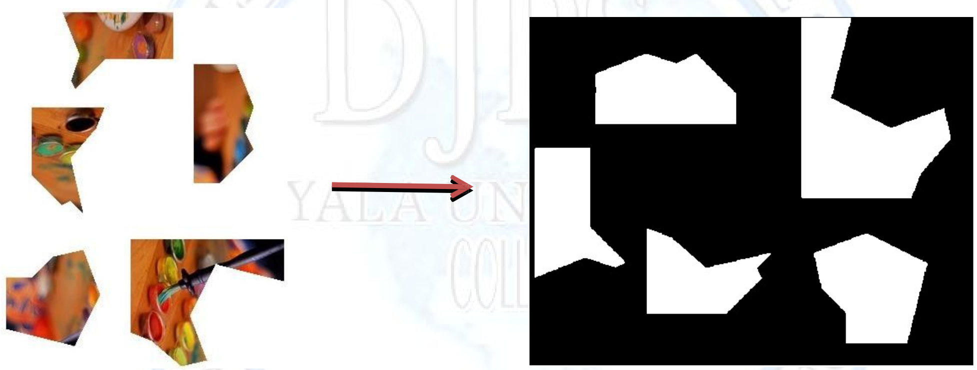
Figure (3.1.)The proposed method

Reconstruction goals

The goal is reconstruction to assemble number of pieces that have been broken or torn into a large number of irregular pieces.

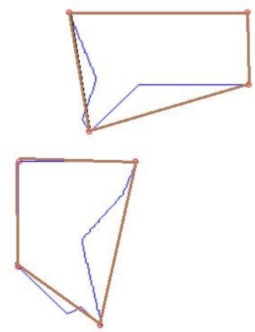
Pre-processing

The aim Pre-processing of the preprocessing phase is to estimate outline/piece of the torn image. Then each piece of the image is pre-processed through polygonal approximation in order to reduce complexity of the boundaries. A set of features is extracted from each polygon in order to carry out the matching as shown in the figure (5.1). [12]



Figures (5.1) shows image pieces pre-processing

To overcome this kind of problem, different algorithms were tested, and the one that brought the best results was the well-known Douglas-Peucker(DP) algorithm [13]. This algorithm implements a poly line simplification and it is used extensively for both computer graphics and geographic information systems. (Figure 5.2) shows an example of this process using different levels of approximation.



(Figure 5.2). Show Inner and Outer Boundaries Produced by Torn Image

Extracting The Pieces

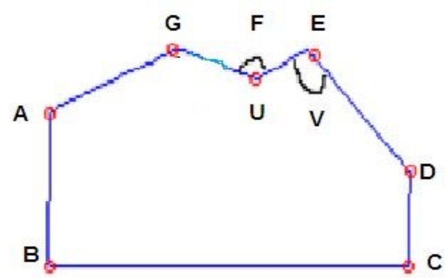
Initial analysis of the issue of extracting the pieces of image from a scanned image suggests there are several stages to this: determining the difference between the background of the image and the pieces to be extracted, picking out the rectangular shape of the piece and disregarding any noise, then extracting the relevant pixels and rotating or resizing as necessary to produce a piece of the same size and shape. These pieces can then be combined to form a new image for the next stage of analysis [2]

- **Feature Extraction**

After the complexity reduction through polygonal approximation, the next step consists in extracting features to carry out the local matching. The feature extractions can be seen also as a complexity reduction process, since it converts the polygon in a sequence of features. Here, we propose simple feature set that can be used to carry out the local matching is used. The first feature is the angle of each vertex with respects its two neighbors. Consider for example the vertices G and F in the polygon depicted in (Figure 6.1) the angle α is given by the equation [3].

$cos(\alpha) = uv$Eqe -----(1)

Verification is needed to see whether such an angle is convex or concave. For example, in (Figure 6.1) vertex E has a convex angle while vertex F has a concave one. To complete the feature set, we compute the distances between the vertex and its neighbors (next and previous in a clockwise sense) is computed Such distances are achieved by means of the well-known Euclidean distance. Table 1 describes the feature vector extracted from the polygon depicted in (Figure 6.1) [3].



(Figure 6.1) Show Angle features extracted from the polygon

Table 1.Description of the feature vector

Vertex	Angle	Distance		X	Y
		Next	Previous		
A	140.657070706068	39.5600814819336	60.9261856079102	139	53
B	113.198590513648	60.9261856079102	58	83	77
C	90	58	164	83	135
D	91.5911402711946	164	36. 0138854980469	247	135
E	133.408859728805	36.0138854980469	62.2253952026367	248	99
F	116.565051177078	62.2253952026367	28.4604988098145	204	55
G	145.420712396795	28.4604988098145	39.5600814819336	177	64

This table shows the angle of the vertex F which is computed by using vertex G and E , is (116.565051177078) the Euclidean distances between F and neighbors G and E (28.4604988098145).

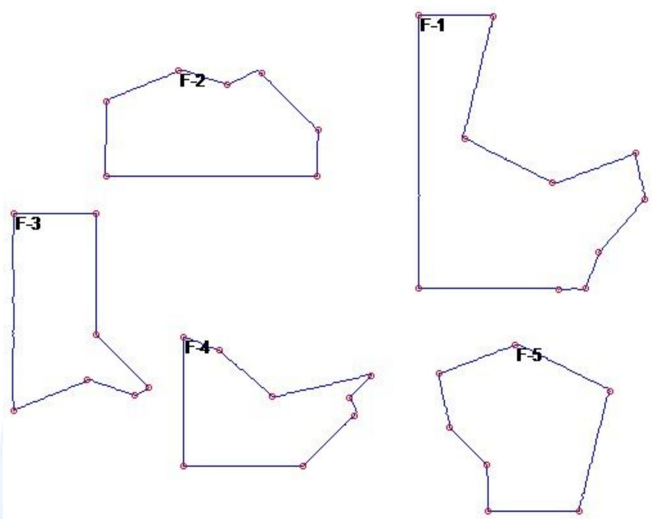
Where threshold value =200

Douglas-Peucker (DP) value= 3.5

Matching

- **Computing the Similarity between Polygons**

The feature vector described so far allows computing a degree of similarity, which is used to measure the quality of the matching between two pieces of the image [14].

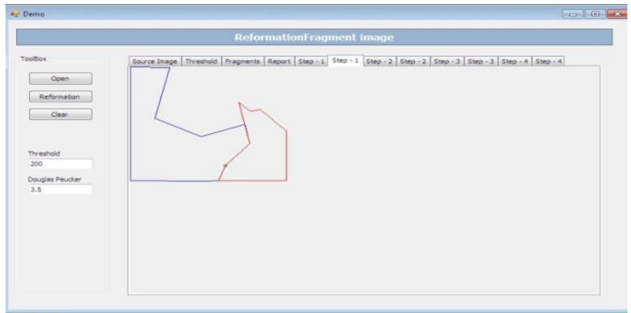


(Figure 7.1) Show pieces

Reconstructing

- **Global Search**

The method applied here is based on the algorithm proposed by Leitao and Stolfi[7] which tries to match two pieces at a time, consider a torn image D = {F1, F2,. . ., Fn} composed of n pieces. The algorithm compares the piece F1 with all the other pieces searching for the best matching, i.e., the match that maximizes the matching defined previously. Then, the pieces (Fi) and (Fj) that maximizes matching are merged forming a new piece (Fij).The feature vector of the new piece (Fij) is then modified by removing the vertices matched. (Fig.8.1) shows this merging and the vertices removed as well [14].



(Figure 8.1) shows merging pieces and the vertices removed .

Result

The application was developed using C# within the Microsoft Visual Studio platform. Image pieces were scanned in using a HP Scan Jet 5200C scanner, several pieces at a time. RGB format is transformed to grayscale and then the images are converted to a binary format, so all pixels are either black or white. Boundaries are extracted and corner points are detected, then regular matching is performed. (Step 4) shows a puzzle put together after regular matching is performed.

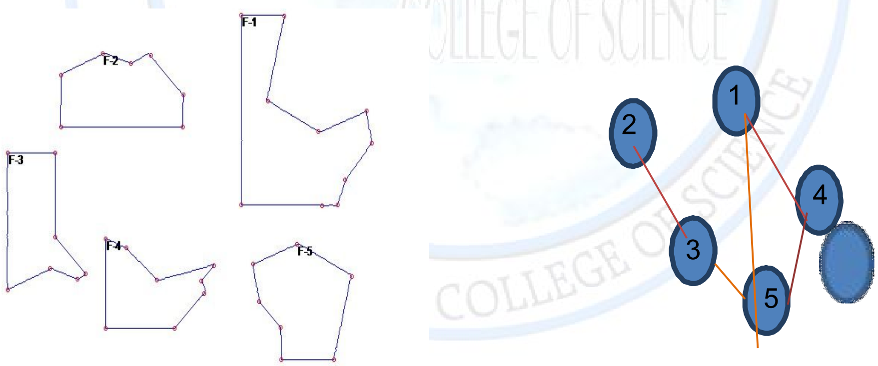
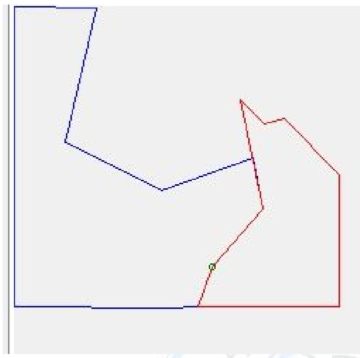


Figure (9.1) show fracture graph Fig. 9. (a) Results of the polygonal approximation, and (b)The graph representing the relationships among the fragments

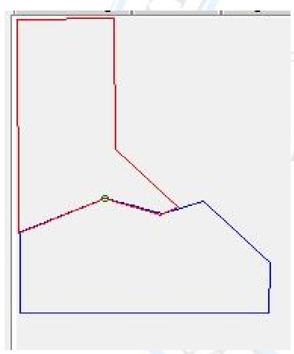
Steps of the image reconstruction

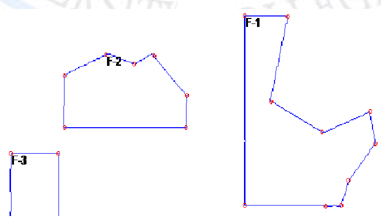
Step1: Best Matching between F1, F4

Then use longest common subsequence algorithm to compute a degree of similarity between of each fragment of the image. Torn image D {F1, F2, F3, F4, F5} composed of n fragment this algorithm compares the F1 with all the other fragments searching for the best matching as shown in figure

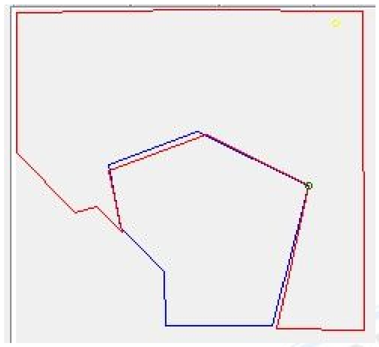


Step2: Matching between F2, F3



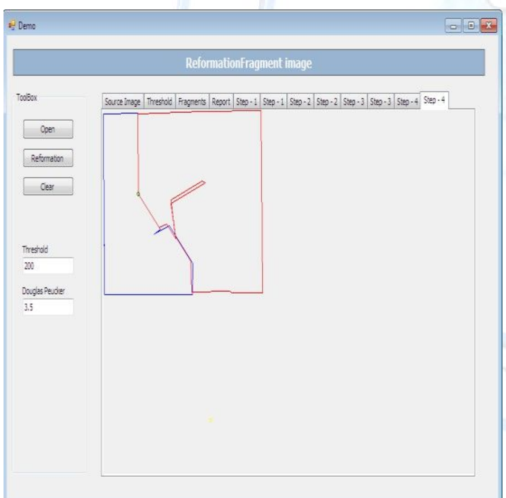


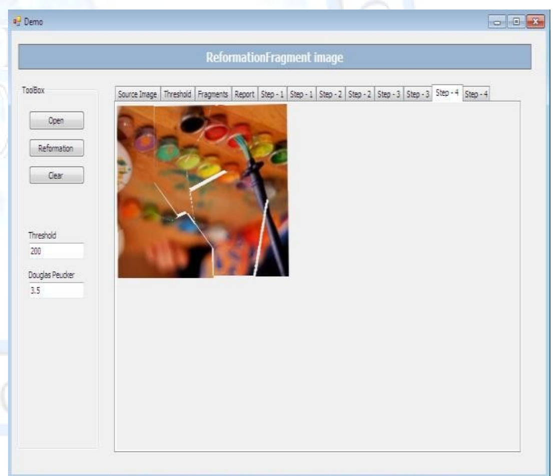
Step3: another matching piece



Step4: Final reconstructed Image

After matching, the process starts again but now the image has (n-1pieces. It ends when the number of pieces is (1) or none pieces have been match.





Conclusion and future works

Proposed algorithm for image reconstruction based on feature matching is presented. It takes two steps where the former makes an approximation in order to reduce the complexity of the boundaries and overcome specific problems faced in image reformation and the latter extracts relevant features of the polygon and uses them to make the local reformation.

The results demonstrate that the algorithm, in spite of the fact of using few features, is able to reformation images torn by hand. A less complex system, like the one presented here, could be applied initially and then a more complex one, hence more time consuming, could be applied to resolve final confusions. As future works, plan to make some experiments in this sense and also to analyze the performance of the system for other kinds of torn as well. Also investigating some optimization techniques such as genetic algorithms and particle swarm optimization so that larger amounts of torn pieces (up to 100) can be handled by the algorithm.

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