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Automated Mosiacing of Torn Paper Documents

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ABSTRACT

The objective of proposed work is to deal with joining of torn pieces of a document. The project is aimed at automating the process for joining of the pieces which includes searching for the pieces in the memory, loading them into the program, matching the appropriate parameters and then joining them. After joining the image, presenting it to the user is the last part of the process. The whole project is aimed at reducing the amount of effort required to join back pieces and at the same time increasing the efficiency of the whole process. Humans are liable to commit mistakes but computers don't. So that is why we let the system perform the task by simply inputting the images to the system and executing it auto mode. As the jigsaw problem is similar we have to overcome the problem of global consistency in which pieces are joined together because they match. It's quite a possibility that they are not the correct pair. We aim at making sure that no portion of the system violates the rule of global consistency. Software's already available in the market are Andrea Mosaic for PC application and MacoSaix for the MAC application. The problem these software's have is that in these software's there is a lot of involvement of humans in the form of choosing the images to be matched. So, thus we are not saving on the human resources. The aim of this work is to reduce the human involvement while increasing the efficiency of the project.

Keywords: Mosiacing; MacoSaix; Texture, Jigsaw; Puzzle; Elucidates.

1. INTRODUCTION

Mosaicing

Combining multiple photographic images with overlapping fields to produce a high resolution image is known as Mosiacing. It is the art of joining many images to form on single image which depicts a Different meaning from its constituent images. Image mosaics are collections of overlapping images that are transformed in order to result in a complete image of a wide angle scene. The transformations can be viewed as simple relations between coordinate systems. By applying the appropriate transformations via a warping operation and merging the overlapping regions of a warped image, it is possible to construct a single image covering the entire visible area of the scene. Nevertheless, those coordinate transformations are not known beforehand, unless the camera parameters are tracked with precision. The central problem of image Mosiacing is thus to compute these parameters solely from the image data, a problem commonly called image registration.

Mosiacing is based on 3 phenomena's:

- Edge detection is a terminology in image processing and computer vision, particularly in the areas of feature detection and feature extraction, to refer to algorithms which aim at identifying points in a digital image at which the image brightness changes sharply or more formally has discontinuities.
- Image processing is any form of signal processing for which the input is an image, such as photographs or frames of video; the output of image processing can be either an image or a set of characteristics or parameters related to the image. Most image-processing techniques involve treating the image as a two-dimensional signal and applying standard signal-processing techniques to it. There is various form of Image processing such as Digital, Optical, Analog.
- During matching each pixel value is matched and the process continues till all the pixels are not matched. Because each pixel is similar to some other pixel with respect to some characteristics like Color, Intensity, Texture.

2. PROPOSED METHOD

A paper, when torn, creates uneven edges bearing undesired shears containing tiny paper fibers, which gives rise to ill-defined physical contours. Further, due to limitations in the imaging mechanism, a torn piece, after being scanned, may contain digital imperfections and unpredictable rigid transformations. As a result; there will be some non-ideal conditions which should be considered in the reconstruction procedure. Hence the following stipulations are incorporated in our algorithm.

a. A hand-torn piece of paper may have arbitrary shape and as many edges as possible, depending

on how many times the corresponding document has been torn apart. However, each torn piece is supposed to contain some sudden discontinuities (corners) in the overall contour direction.

b. A particular torn piece may or may not contain a straight edge (i.e. original machined edge). Further, for a given collection of torn pieces, it may happen that there is not even a single piece having straight edge(s).

c. There may be some shear while tearing off a piece of paper. The shear will occur due to twisting and skewing of the grip, and resultant tearing will proceed along the surface as well as the thickness of the paper. The torn apart counterparts, therefore, will have a partial overlap along their matching edges.

d. We don't have a priori knowledge about the content of the document is available.

e. The corners for a torn piece may be topologically different from those of its counterparts, depending on the nature of hand movements and the behavior of the corner detection process.

f. There can be small gaps between the images of correctly matching pieces.

g. There will be unpredictable rigid transformation (translation and rotation) of scanned images of the torn pieces during image acquisition.

h. Since no a priori information is there, for each torn piece, the corresponding scanned image can be of any one of its two surfaces. Hence, the problem of computer-aided reconstruction of hand-torn pages is not only different from that of a jigsaw puzzle, but also poses other challenges. This work elucidates a method to exploit the contour information's of the fragmented remnants for restoration of the initial object document/image, when no a priori information is available.

2.1. Register Image

To register the images, for each pair of overlapping images, find four or more corresponding points, get their coordinates, and compute the transformation from one image to the other.This project involves four basic steps as shown in fig.1. The proposed registration system loads multiple pictures (side-by-side or sequentially), permits the user to tap out four or more corresponding points for each pair, and solves the linear system of equations for the coefficients of the projective transform. To improve accuracy Place the digitization points as far apart as possible. If you digitize n points, you'll be solving a system of 2n equations in 8 unknowns. If n = 4 then you can turn it into an 8x8 linear system of equations. If n>4 then the system is over determined, and requires more work to solve. Overdetermined case, depending on whether you work with the rational or linearized versions of the equations, given in the above paper, you get either a nonlinear or linear overdetermined system of equations, which can be solved by least squares methods.

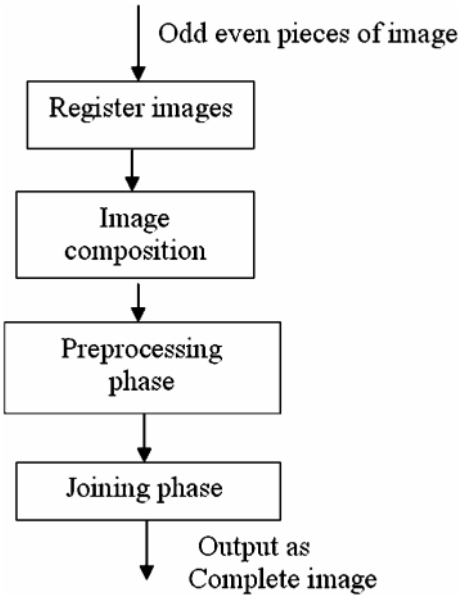

Fig. 1: Phases of Proposed System

2.2. Image Composting

After geometric corrections followed by registration process there are some discontinuities and distortions because of registration error, incompatible model and light conditions etc. Compositing process is required to remove these defects. The main objectives of compositing process are followings

- Visibility of overlapping pixels.
- It determines the border between over lapping images.
- To eliminate geometric distortion.

2.3. Preprocessing Phase

The scanned image of each torn piece P where t= 1,2,3,4 is passed through a contour extraction process, using the differential operators I(i,j) and I2(i,j), where I(i,j) represents the gray-value at the point. After that each contour C corresponding to the torn part P, is passed through the feature extraction stage. Since C is supposed to contain some corners (stipulation (i)), its corners are detected at first, using the bending values [14] of the discrete points constituting C. Now for each C, we prepare the corresponding feature list L Along with the set of feature lists; we also prepare a single height-

balanced (AVL) Tree, J, for the entire collection of torn papers, P where t varies from 1 to n. In tree J, the corner-to corner Euclidean distances for all edges in all the contours, are stored as primary keys. Each node of J, apart from storing the distance d corresponding to the edge e, also contains

1. The edge number;
2. The List name.

The primary keys and the auxiliary keys are required during the joining phase.

2.4. Joining Phase

In the first step (and the subsequent steps) of this phase, the possibility of a matching counterpart for each torn piece is explored in two stages, using the corresponding feature list and the AVL tree J. From the feature list L, for each edge distance d and search operation is performed in J for the distances. The variable V is used to take care of the topological variation of the corresponding corners of the correctly matching counterpart of P (stipulation (v)). The corresponding matching distances, obtained from the search operation, are now arranged in non-decreasing order of their differences. In the second stage (of first step) of the matching piece(s), a match is tried for the edge number in best matching distance in the list e. The second stage is an intricate part in the joining phase, which is performed as follows.

First, a Murkowski Sum is defined for the edge considering its union operation with a circular disc, having a suitable radius i. The resultant sum takes care of the shears and gaps (stipulations (iii) & (vi)) present in two correctly matching pieces. Next, the rigid transformation (stipulation (vii)), required to align the ordered pair of corners is determined.

Using translation operation the coordinates are obtained. If the resulting coordinates are entirely inside the said envelope, then the edge is said to be matching. Otherwise, the transformation matrix is redefined so as to align the ordered. If the match is not yet found, then the case of (wrongly) scanning the other side of the page should be considered (stipulation (viii)), and the chain code of the corresponding edge is transformed (twice, as the previous case) accordingly. If no match is found, then the next possibility is tried for. This is continued till a match is found or until the ordered set of distances, gets exhausted.

On the other hand, if no match is found then a match for the next edge (starting from the next distance between consecutive corners), listed in e, is tried for, with repetition of the above procedure (i.e. first step of joining Phase).The second step of the joining phase starts after the first step of joining is finished for all pieces. This joining step is repeated till the end of the original document. The joining procedure, described above, therefore, follows a bottom-up strategy and if there is any missing piece then proper modification in this procedure can finally produce some disconnected larger parts.

3. RESULTS

For our experiments, we have used torn papers from

1. Office documents (4 nos.)
2. Magazines on local dialects (4nos.),
3. Hand-written documents (4 nos.), and
4. Newspapers (4 nos.).

Each of these papers has been torn into 8 fragments to test our reconstruction procedure. It has been found that the joining method does not produce desired output when the shear is abnormally high. However, in case of reasonable shears, our method produces encouraging results. One such example is exhibited in Fig. 2, where, 4 sample fragmented pieces out of 8 pieces have been given, and the corresponding reconstructed fraction of the original document has been shown Fig 3 and Fig 5.

Table 1
Average Image Size & Average Execution Times for the Four Sets

Document set	1	2	3	4
Avg size	300*240	210*200	240*220	190*210
Preprocesses time	.635	.394	.448	.445
Joining time	.687	.511	.455	.336

Experiment 1

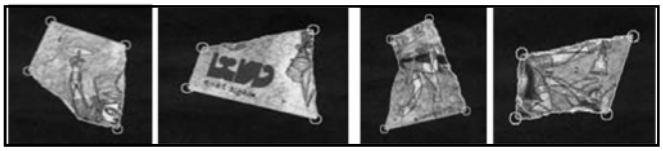

Fig. 2: Four Samples of Scanned Images of Torn Pieces

Fig. 3: Reconstruction Result of Four Pieces of Lord Durga

Experiment II

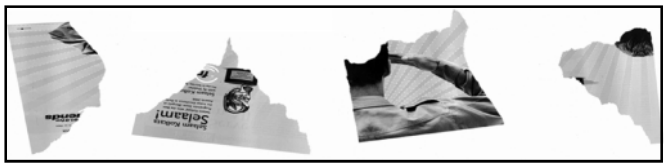

Fig. 4: Images of Torn Pieces

Fig. 5: Reconstruction Results

4. CONCLUSION/FUTURE SCOPE

Reconstruction of fragmented pieces in order to restore the original one is a difficult and time consuming task which is dealt with many departments like archeology, art works, forensics where an image construction is required from the scattered fragments. Documents may be torn by hand of by a mechanical shredder. The reconstruction is puzzling task to be performed by humans. Hence an efficient automation of the process can have effective and significant contribution to its solution. In this project, a novel technique is proposed for the reconstruction of hand-torn pages of documents, using the contour maps extracted from images of the torn pieces. The method is fast, efficient, and robust, and has produced encouraging results on experimenting with a varied set of In the case of shredding of pages, each fragmented piece of paper has straight edges only, and hence the problem may be considered as a variety of jigsaw puzzle. However, if the pages are torn by hands, then the torn pieces do not possess straight edges (borders) excepting the original (machined) straight edges. In that case, the jaggedness (both microscopic and macroscopic) of the torn edges pose severe problem in computer-aided solution of the reconstruction job. In this Work, we have adopted a preprocessing phase followed by a 2-stage reconstruction phase, where appropriate tolerance has been included to suitably accommodate the jaggedness of the torn edges, thereby ensuring the robustness and efficacy of the system. Minkowski Sum properly defined over the chain code of the contour map, has been used judiciously for providing the necessary tolerance, which is a basic prerequisite for reconstruction of hand-torn documents.

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