PERFORMANCE IMPROVEMENT IN IMAGE INPAINTING BASED ON TV MODEL

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ABSTRACT: Inpainting, a set of techniques for making undetectable modifications to images, is as ancient as art itself. Applications of image inpainting range from the removal of an object from a scene to the retouching of a damaged painting or photograph. For photography and film, inpainting can be used to reverse deterioration (e.g., cracks in photographs, scratches and dust spots in film), or to add or remove elements (e.g., stamped dates, “red-eye,” and, infamously, political enemies) from photographs. In each case, the goal is to produce a modified image in which the inpainted region is merged into the image so seamlessly that no one is aware that any modification has occurred. A fast image inpainting algorithm based on TV model is proposed on the basis of analysis of local characteristics, which shows the more information around damaged pixels appears, the faster the information diffuses. The algorithm first stratifies and filters the pixels around damaged region according to priority, and then inpaint the damaged pixels from outside to inside on the grounds of priority again. Experiment shows that the inpainting speed of the algorithm is faster and greater impact.

Image inpainting technique has been widely used for restoring damaged old photographs and removing unwanted objects from images. Now many inpainting algorithms are introduced because of better filling results. However, there always exists a shortcoming, i.e. long filling time.

I. PROBLEM DEFINITION
An inpainting image is constructed by filling the target area using the surrounding regions in the same image; therefore, the key problem in recognizing the fake region is to search for similar regions in the faked image. However, a non-faked image may have some very similar parts in the background, especially uniform regions such as the sky or sea, which will interfere with the detection process. This paper proposes an effective forgery detection algorithm for inpainting forged images. Suspicious region detection searches for similar blocks in an image to find the suspicious regions and uses vector filtering to filter out non-forged regions. Forged region identification applies a multi-region relation (MRR) technique to recognize the forged region. MRR can effectively remove some suspicious regions from a uniform region. The technique has improved the recognition accuracy for the images containing a uniform background. Moreover, we propose a two-stage searching algorithm based on weight transformation to speed up the similarity computation. To improve the searching speed of similar blocks, we propose a two-stage searching algorithm based on a weight transformation. The method is able to reduce the searching time of the best matched block by examining key values for similarity detection. The experimental results show that the proposed algorithm can locate the forged region in forged images and performs well in terms of speed. In addition to the inpainting forgeries, our algorithm is also capable of detecting copy move forgeries.

Figure 1: Restoration of an old photograph

Proposed System
In image processing, the most commonly used method to eliminate morbidity is to join regularization items, whose basic idea is to use prior knowledge of physical problems, adding more constraint to the problem, which makes the
solution of the problem continuously depend on the observational data, and additional items must be in line with prior knowledge of physical meaning[7]. Inspired by the above, I make full use of information around damaged region to iteratively inpaint the damaged region quickly in the inpainting template fixed-size case. This Document mainly focuses on the following aspects:

- Basically 2 kinds of methods are used for image inpainting one is structure based and another is texture based but we only focuses on structure based inpainting method.
- In which first of all we have to find information about damaged region. This is what we can find by diffusion method.
- Now for inpainting observation of surrounding of damaged region is best solution
- Than segment that surrounding of damaged region and then find its edge.
- After it we can restore it by using algorithm
- By this our speed will increase for inpainting , accuracy will also increase and better result we can get.

Figure 2: General process flow for image inpainting

Image inpainting using Poisson equation:
First we decompose the image into two components. The structure and texture and then repair the two components separately according to their image characteristics. The texture Image is repaired by the exemplar based method. The structure image, Laplacian operator is employed to enhance the structure information and the Laplacian image is inpainted by the exemplar based algorithm followed by a reconstruction based on the Poisson equation.

In most existing inpainting methods, the inpainting domain is assumed as the smoothest continuation of the local structure, where smoothness can be defined in different ways. However, these assumptions become inappropriate when the size of the inpainting domain increases or there is texture inside the hole. Moreover, these methods only employ a small ring area surrounding the inpainting domain to repair the missing part, which makes the algorithms sensitive to noise and inappropriate for inpainting large holes. Moreover, if the inpainting domain includes both texture and structure, the texture will disturb the inpainting process of the structure, which causes false edges in the repaired image.

1. Find the portion need to be inpainted.
2. Split image into two components as structure and texture.
3. Do process as same as exemplar for texture image.
4. Do smoothing process for structure image- Laplacian operator.
5. Combined both output produced by step 3 & 4

6. Result would be inpainted image.

Image inpainting based on successive elimination model:
To improve the efficiency in Exemplar method successive elimination algorithm (SEA) is employed to obtain global optimal solution. The basic idea is to obtain the best estimate of the vectors by successively eliminating the search positions in the search window and thus decreasing the number of matching evaluations that require very intensive computations. The computational efficiency is increased by choosing the successive elimination algorithm which is based on sum of absolute differences (SAD) to obtain the global optimal solution, and the definition of SAD is as follows:

\[
d(Y_p, Y_q) = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} |f(x+i,y+j) - f(m+i,n+j)|
\]

\[
M(m,n) = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} |f(m+i,n+j)|
\]

\[
R = \sum_{i=0}^{N-1} \sum_{j=0}^{N-1} |f(x+i,y+j)|
\]

That implies

\[
R - SAD(u,v) \leq M(m,n) \leq R + SAD(u,v)
\]

Now the successive elimination algorithm is as below:
1. Find all boundary point of cracked portion
2. Find data pattern & confident for each boundary point
3. Multiply data pattern & confident of each boundary point (It is total point/strength/priority of particular pixel)
4. Find the pixel on boundary point which one having highest priority
5. Create patch window by keeping that highest priority pixel as central one
6. Match this window with entire image from (0, 0)th pixel to (x, y)th pixel and identify the matched window.
7. Stop the process of fetching another match window once you got first match window (In exemplar we will find all the possible match window then we do finding high priority for matched window then we choose the best window, but in SEA if one window matched means it will not fetch another match window)

8. Replace the patch window, which has been created in point number (5), with currently got matched window

9. Repeat the above steps unless there is no further inpainting needed

Image inpainting based on 8 pixel neighbour model:
The neighbourhood of a pixel is the set of pixels that touch the neighbourhood of a pixel can have a maximum of 8 pixels (images are always considered 2D). The 8 pixel neighbourhood of a pixel, P, is the set of 8 pixels which share a vertex or edge with that pixel. These pixels are namely pixels P1, P2, P3, P4, P5, P6, P7 and P8 shown in Figure 3 below.

Criminisi, in exemplar method proposed a repair method based on the formation of the texture, filling the blank areas by choosing suitable texture on the border of the region to be repaired by block matching methods, it has a better effect to the texture inpainting, but it has worse effect to structural repair. These methods above can be achieved good results in a certain type of image, but there are obvious limitations, that is not suit for each case and most of them are based on iterative formula, one point restoration often need thousands of iteration, running a long time and repair one image it has to cost 3 or 4 minutes to complete, which limits their promotion and application. In light of this situation, in this paper, we propose a new algorithm based on the 8-neighbourhood fast sweeping method on the basis of maintain the effectiveness of rehabilitation to shorten repair time greatly.

Image Encoding and Decoding Scheme Based on Digital Image Inpainting Technology:
Recently, digital image inpainting technique based on variation al and partial differential equation has been researched widely. In this paper, image inpainting is applied to image encoding and a novel scheme of encoding is proposed. In the encoding, applying an edge detector to detect the edge. In addition, the four boundaries of the image also belong to the edge collection; next, generating small neighbourhoods of the edge collection to get an edge-extended image, then encoding the addresses of the edge-extended image and using high bit rate to accurately code the gray values of it. So, a high compression rate is achieved.

Unlike the traditional decoding, here the decoding is realized by a harmonic inpainting model to achieve a good quality of reconstructed image. At the end, a lot of images are simulated. These simulated results show that with this scheme proposed, one can get a good quality of reconstructed image in a high compression rate. Good inpainting algorithms are motivated by questions in image compression in that inpainting may provide an alternative method to compress images by taking out portions of an image in which the inpainting algorithm can reconstruct well. Based on this, we take full advantage of digital image inpainting technology and introduce the inpainting approach to image coding and compression based on the edge information. Then we proposed an image compression scheme based on image inpainting. Figure is the block diagram of image compression.
Image inpainting based on TV model:
A fast image inpainting algorithm based on TV model is proposed on the basis of analysis of local characteristics, which shows the more information around damaged pixels appears, the faster the information diffuses. The algorithm first stratifies and filters the pixels around damaged region according to priority, and then iteratively inpaint the damaged pixels from outside to inside on the grounds of priority again. Experiment shows that the inpainting speed of the algorithm is faster and greater impact. In general, image inpainting methods can be divided into two categories: structure-based inpainting and texture-based inpainting. Structure-based inpainting refers to the process of image inpainting which employs information around damaged region to estimate isophote from coarse to fine and diffuses information by diffusion mechanism. The method includes the following models: BSCB model [1], TV model [2], CDD model [3] and elastic model [4] and so on. These models have a good inpainting effect on the small-scale and non-texture damaged region such as the scratches, the creases and the spots and so on, but it is easy to cause the blurriness when they are used to inpaint relatively large damaged region. The above essentially solve partial differential equations (PDE) describing information diffusion, while the numerical solution of PDEs requires a large number of iterations, so that the inpainting speed is very slow. Therefore, how to improve the solution speed of these models has become a very valuable research. At present, the fast structure-based image inpainting algorithm has fast marching method [5] and Oliveira method [6] and so on. Fast marching method uses the weighted-average method to inpaint damaged image so that the edge-preserving is not ideal. Oliveira method is faster, but does not maintain the isopods’ directions in the inpainting process, and therefore it was almost no ability to restore the details of the edges. The methods of texture-based inpainting are to fill missing information by texture synthesis techniques, and are suitable for inpainting relatively larger damaged region. It can also be divided into image inpainting based on decomposition and image inpainting based on texture synthesis.

Image inpainting based on TV model[2] was proposed by T.Chan et al in 2002, described as follows.

In Fig. D is defined as region to be inpainted, and it is generally ring, E is the outer neighbourhood of D, u denotes target pixel value, the cost function was defined as:

$$r(u) = \int_{E \cup D} |\nabla u| dx dy$$

And it must meet the following noise constraint conditions:

$$\frac{1}{A(E)} \int_{E} |u - u^0|^2 dx dy = \sigma^2$$

Here as shown on the table comparative result of image inpainting algorithm with different 3 models.
II. METHODOLOGY

It is well-known that image inpainting is an ill-posed problem [3], which manifested information around damaged region is insufficient to fully restore missing information. In image processing, the most commonly used method to eliminate morbidity is to join regularization items, whose basic idea is to use prior knowledge of physical problems, adding more constraints to the problem, which makes the solution of the problem continuously depend on the observational data, and additional items must be in line with prior knowledge of physical meaning[7]. Inspired by the above, we can make full use of information around damaged region to iteratively inpaint the damaged region quickly in the inpainting template fixed-size case. The basic idea is as follows:

Step 1. Segment the damaged region.
Step 2. Find the edge of damaged region.
Step 3. Calculate the priority of the pixels on the edge and sort in accordance with the priority, if the priority of the pixel is greater than a certain threshold T, then reserve the pixel, else delete it.
Step 4. Store the reserved pixels according to the order of priority as a layer.
Step 5. Update the damaged region.
Step 6. Repeat the Step 2, the Step 3, the Step4, the Step 5 until the area of damaged region is zero.
Step 7. Iteratively inpaint according to the size of priority from outside to inside.

Now the algorithm we can use for this kind of method is as shown below:

Simulation result and important discussion
By applying this algorithm we can get inpainting of an image faster than TV model and we can get improved result and accuracy will also be increased. Here we can use MATLAB platform for implementing the algorithm because this is only the platform by which we can get very accurate result and implementation is also somewhat easy. The experiments are performed with 2.20GHz Intel Core 2 Duo T7500 CPU and 1GB of RAM. Experiment results are analysed by carrying on simulated image and real image, also we compared the effectiveness of inpainting and time to inpainting both the TV model and the exemplar-based texture synthesis technique. As can be seen from Table 1, the inpainting speed and inpainting accuracy are improved by the proposed algorithm compared with the traditional algorithm based on TV model. The inpainting effectiveness of the algorithm is superior to the traditional algorithm. This also validates the correctness and rationality of our standpoint.

<table>
<thead>
<tr>
<th>Method</th>
<th>Time (Sec)</th>
<th>Masked Pixels</th>
</tr>
</thead>
<tbody>
<tr>
<td>TV Model</td>
<td>813.500000</td>
<td>12469</td>
</tr>
<tr>
<td>Method Presented</td>
<td>5.05589</td>
<td>996</td>
</tr>
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</table>

Table: Observation 1
III. CONCLUSION

The traditional model of image inpainting based on TV is essentially solving partial differential equations (PDE) describing the diffusion of information, while its numerical solution requires a large number of iterations, so that the inpainting speed is very slow. I make full use of the information around damaged region in the inpainting template fixed-size in the paper, which can make information diffusion stronger and the inpainting speed faster. In fact, the idea I put forward has certain guidance functions to other model based on partial differential equations. By comparison of some methods, I am going to improve inpainting time, object-connecting, and inpainting effect.

REFERENCES


[27] An Image Inpainting Approach Based on the Poisson Equation, Xiaowei Shao, Zhengkai Liu, Houqiang Li. Department of Electronic Engineering and Information Science, University of Science and Technology.