A SURVEY ON VARIOUS IMAGE INPAINTING TECHNIQUES TO RESTORE IMAGE

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Abstract
Image inpainting is the art of restoring lost parts of an image and reconstructing them based on the background information. Inpainting, the technique of modifying an image in an invisible form, it is art which is used from the early year. Applications of this technique include rebuilding of damaged photographs & films, removal of superimposed text, removal/replacement of unwanted objects, red eye correction, image coding. The main goal of the Inpainting is to change the damaged region in an image. In this paper we provide a review of different techniques used for image Inpainting. We discuss different inpainting techniques like Exemplar based image inpainting, PDE based image inpainting, texture synthesis based image inpainting, structural inpainting and textural inpainting.
Keywords: Image inpainting, Image Restore, Exemplar, Object Removal, wavelet transformation.

I. INTRODUCTION

Inpainting is the art of restoring lost parts of an image and reconstructing them based on the background information. This has to be done in an undetectable way. The term Inpainting is derived from the ancient art of restoring image by professional image restorers in museums etc.

Digital Image Inpainting tries to imitate this process and perform the Inpainting automatically.The filling of lost information is essential in image processing, with applications as well as image coding and wireless image transmission, special effects and image restoration. The basic idea at the back of the algorithms that have been proposed in the literature is to fill-in these regions with available information from their environment[1].

The image inpainting algorithm based on sample block is called as the Criminisi algorithm because it is first proposed by Criminisi et al. Its core idea is to determine the target block to be repaired by the priority formula, and filling the target block with the known pixel block that is searched from the source region according to the corresponding algorithm, until the completion of the repair area.

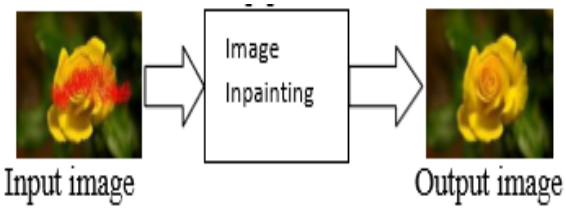

Fig 1 Image Inpainting Method

The following groups of Various Image Inpainting Techniques

A. Partial Differential Equation (PDE) based
B. Texture Synthesis based
C. Exemplar and search based
D. Wavelet Transform based
E. Hybrid based Iimage Inpainting
F. Semi-automatic and Fast Inpainting.

A. IMAGE INPAINTING TECHNIQUES

Image Inpainting algorithm can be classified in to the following way.

1. Partial Differential Equation(PDE) based algorithm. .

Partial Differential Equation (PDE) based algorithm is proposed by Marcelo Bertalmioet.al [1].This algorithm is the iterative

algorithm. The algorithm is to continue geometric and photometric information that arrives at the border of the occluded area into area itself. This is done by propagating the information in the direction of minimal change using is ophotelines. This algorithm will produce good results if missed regions are small one. But when the missed regions are large this algorithm will take so long time and it will not produce good results.

Chan and Shen [2] proposed the Total Variational (TV) Inpainting model. This algorithm is good due to Isophote driven Approach we find the line of equal gray scale values which contains the more promising information and this used to complete the image with less time. This algorithm also provide some problem, The main difficulty with this algorithm is imitation of large texture regions. This algorithm also unable to recover Partially Degraded Image.

2. Texturesynthesis based Image Inpainting

The Texture synthesis is a field of study independent from, but related to inpainting. In the general definition of this problem, an input sample of a texture is given, and the goal is to produce more of that texture. The simplest solution is to tile the texture sample on a rectangular grid of desired size. However, even if the sample can be tiled seamlessly, the resulting larger grid structure is easily noticeable and it distorts the perception of the actual texture. More sophisticated techniques are required for reproducing the actual texture with all its features and nothing more.

A regular (also called deterministic, structured, periodic) texture is characterized by a primitive element (texton or texel) that is regularly placed on a grid or a lattice. For example, floor tiles,brick walls are regular textures, sand, smoke are non-regular.Contrarily, in non-regular (stochastic, random) textures, thereis no apparent repeating pattern or local structure, but global statistical properties.The texture synthesis based Inpainting perform well in approximating textures.

These algorithms have difficulty in handling natural images as they are composed of structures in form of edges. Hence while appreciating the use of texture synthesis techniques in Inpainting, it is important to understand that these methods address only a small subset of Inpainting issues and these methods are not suitable for a large objects.

3. Exemplar based Iimage Inpainting

The exemplar based consists of two basic steps1.priority assignment is done and the 2.the selection of the best matching patch. The exemplar based approach samples the best matching patches from the known region, whose similarity is measured by certain metrics, and pastes into the target patches in the missing region. Exemplar- based Inpainting iteratively synthesizes the unknown region i. e. target region, by the most similar patch in the source region. The method fills structures in the missing regions using spatial information of neighboring regions. This method is an efficient approach for reconstructing big target regions. Normally, an exemplar-based Inpainting algorithm includes the following four main steps: I. Initializing the Target Region:, in which the initial missing areas are extracted and represented with appropriate data structures. II. Computing Filling Priorities: in this a predefined priority function is used to compute the filling order for all unfilled pixels $p \in \delta\Omega$ in the beginning of each filling iteration. III. Searching Example and Compositing: in which the most similar example is searched from the source region Φ to compose the given patch, Ψ (of size $N \times N$ pixels) that centered on the given pixel p. IV. Updating Image Information: in which the boundary $\delta\Omega$ of the target region Ω and the required information for computing filling priorities are updated.

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required information for computing filling priorities are updated.

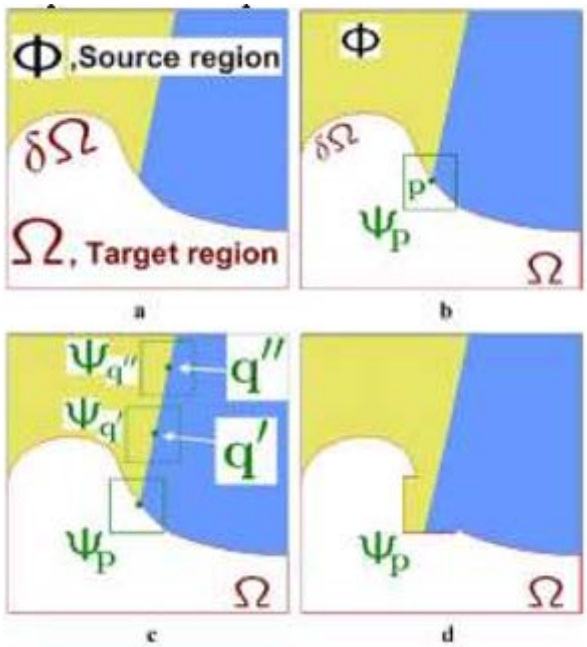

Figure 2 : Structure propagation by exemplar-based texture synthesis, (a) Original im99age, with the target region Ω, its contour δΩ and the source region Φ clearly marked. (b) We want to synthesize the area delimited by the patch ψp centred on the point p €δΩ (c) The most likely candidate matches for ψp lie along the boundary between the two textures in the source region, e.g., ψq' and ψq". (d) The best matching patch in the candidates set has been copied into the position occupied by ψp therefore achieving partial filling [3].

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For the better quality of image the algorithm checks the boundary area for Sharpe changes like edges and assigns more weights to the unknown pixels nearest to the edges. This algorithm also gives more weights to the pixels near the boundary. These are obtained by calculating the edge factor E(p) and known pixels factor K(p) for a patch Pp centered at the pixel P.

The Exemplar-based algorithms adopt the greedy strategy, so these algorithms suffer fromthe common problems of the greedy algorithm, being the filling order is very critical. Exemplar based Inpainting will produce good results only if the missing region consists of simple structure and texture. And if there are not sufficient samples in image then it is impossible to synthesize the desired image.

4. Wavelet Transform based Iimage Inpainting

Here we expect the best global structure estimation of damaged regions in addition to shape and texture properties. If we consider the fact of multi-resolution analysis, data separation, compaction along with *the* statistical properties then we have to consider the wavelet transform due to its good image representation quality. Wavelet transform try to satisfy the human visual system (HVS).

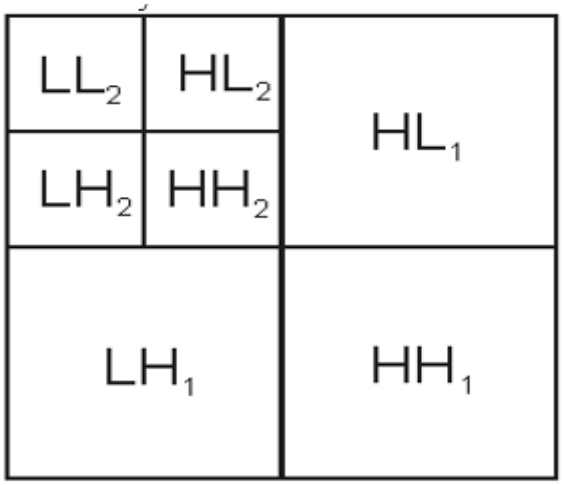

Figure.3. Wavelet transform decomposition of image

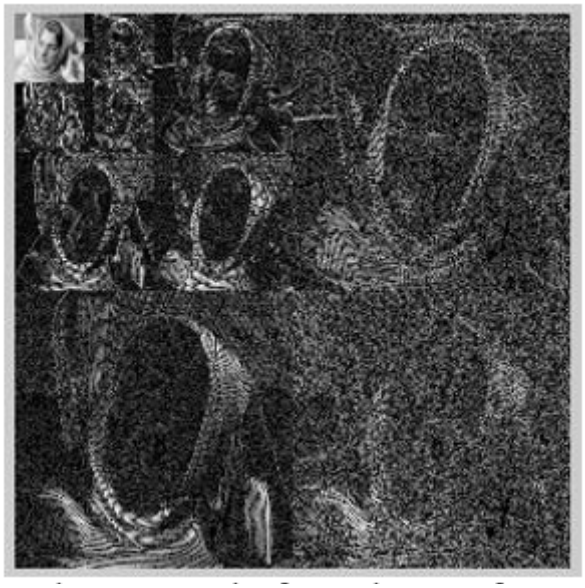

Figure.4. Result of Wavelet Transform

The algorithm decomposition of incomplete image is done with the help of wavelet and after that wavelet and scaling coefficients is found. The image inpainting process is applied in the wavelet domain by considering both scaling and wavelet coefficient from coarse to fine

scales in the target region. Using this algorithm one benefit is This utilizes inter and intra scale dependency to maintain image structure and texture quality using Wavelet Transform. But difficulties In this algorithm mask for regions are defined manually.

5. Hybrid based Iimage Inpainting

Hybrid inpainting technique is also called as the image completion. These approaches combine both texture synthesis and PDE based inpainting for completing the hole [4]. The main idea behind these approaches [5] is that it decomposed the image into two separate parts, Structure region and texture regions. The corresponding decomposed regions are filled by edge propagating algorithms and texture synthesis techniques in [3]. It is used for filling large target (missing) regions. And also preserves both structure and texture in a visually plausible manner. It requires more computational time for large holes.

6. Semi-automatic and Fast In painting

This image in painting requires user assistance in the form of guide lines to help in structure completion has found favour with researchers. The method by Jian et.al [6] proposed inpainting with Structure propagation. this perform two-step process. First A user manually specifies important missing information in the hole by sketching object boundaries from the known to the unknown region and then a patch based texture synthesis is used to generate the texture. The missing image patches are synthesized along the user specified curves by formulating the problem as a global optimization problem under various structural and consistency constraints.

Simple dynamic programming can be used to derive the optimal answer if only a single curve is present. For multiple objects, the optimization is great deal more difficult and the proposes approximated the answer by using belief propagation. All the methods discussed above take minutes to hours to complete depending on the size of the Inpainting area and hence making it unacceptable for interactive user applications. To speed up the conventional image Inpainting algorithms, new classes of fast Inpainting techniques are being developed. Oliviera et.al [7] proposed a fast digital In painting technique based on an isotropic diffusion model which performs Inpainting by repeatedly convolving the Inpainting region with a diffusion kernel. A new method which treats the missing regions aslevel sets and uses Fast Marching Method (FMM) to propagate image information has been proposed by Teleain [8]. These fast techniques are not suitable in filling large hole regions as they lack explicit methods to in paintedge regions. This technique results in blur effect in image.

3. COMPARISION OF TECHNIQUES

Table 3.1 Comparative study of various image inpainting techniques shown in below table

Image Inpainting Methods	**Advantages**	**Disadvantages**
PDE based image inpainting	It is perform well for smaller inpaint region and noise removal application.	It cannot fill the large missing regions. This method is that due to blurring effect of diffusion process replication of large texture is not perform well. Pixel on edges are not handle properly.
Texture Synthesis based image inpainting	The structure reconstruction good for selected set of image.	This method not perform well for natural image. It is not handle edges and boundaries well.
Exemplar based image inpainting	This method will prouce good result for inpainting the large missing region also these algo can inpaint both structure and textured image as well.	Curved structure are not handle properly and biasing in due to incorrect selection of patches. This algorithm generate staircase effect in image inpainting.
Hybrid based image inpainting	In this technique the tensor voting	Tensor voting method is not perform well

	method is good for maintaining curvature.	on complex structures and image segmentation of natural image.
Semi-automatic and Fast In painting	This method gives better speed as compared to the conventional image Inpainting algorithms.	This in painting requires user assistance in the form of guide lines to help in structure completion.

4. CONCLUSION

In this paper a variety of image Inpainting techniques such as texture synthesis based Inpainting, PDE based Inpainting, Exemplar based Inpainting, wavelet transformation and semiautomatic and fast Inpainting techniques are studied. Image inpainting is recently very important research area in the field of image processing. The performance of different techniques is compared based on the area to be inpainted. Most of the algorithms work well for small scratch regions or small regions to be inpainted. In future we would like to implement algorithms reviewed in this paper would like to compare their performances. We would like to improve efficient algorithm to decrease the time required for Inpainting and reduce computational cost.

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