

Survey on Different Techniques for Image Inpainting

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Abstract – Inpainting is derived from art restoration, also called re-touching. Image Inpainting refers to the application of sophisticated algorithms to replace lost or corrupted parts of the image data. The main aim of inpainting is to fill scratches in the image or photos as well as to remove larger objects from them. The main objective of inpainting is to reconstruct the missing region in such a way that the observer does not come to know that the image has been manipulated. Application of image inpainting include interpolation, photo restoration, zooming and super resolution, etc. In this paper several image inpainting techniques are explained with its pros and cons.

KeyWords: Image Inpainting, Restoration, Re-touching, Interpolation

1. INTRODUCTION

The story of Inpainting begins in the art world. People have been interested in repairing missing regions of oil paintings, and doing so in a way that renders the restoration as imperceptible as possible. The term Inpainting is borrowed from paper art, where restoration artists are tasked with restoring faded and damaged paintings. In art however, the major concern is to hide the damage in whichever way complements the existing pigments and image the best, rather than repaint the damage parts of the painting since erasing paintings is generally not an option (that would be called over painting). Retouching images targets from the restoring of paintings to scratched photographs, to the removal or replacement of arbitrary objects in images. Retouching moreover can be used to create special effects (e.g., in movies). Ultimately, retouching should be carried out in such a way that when viewing the end-result it is impossible for an arbitrary observer, or at least very hard, to determine that the image has been manipulated or altered.

There are many methods proposed for inpainting. In this paper brief description of methods has been given. In section 2 introduction of each method is given. Next, section 3 gives comparison of these methods. Final section concludes the paper.



Fig-1.1: Example of Inpainting

1.2 Basic Image Inpainting Process

Fig 1.2 shows the basic image inpainting process. Digital Inpainting alludes how to perform Inpainting digitally through image processing. Thereby also automating the process and reducing the interaction required by the user. Ultimately, the only interaction required by the user is the selection of the region of the image to be inpainted.

The basic process of Inpainting in four steps as follows:

1. The global picture determines how to fill in the gap.
2. The structure of the surroundings of the gap is continued into the gap, contour lines are drawn via the prolongation of those arriving at the boundary of the gap.
3. The different regions inside the gap, as defined by the contour lines are filled with color, matching those of the boundary of the gap.
4. The small details are painted, i.e. texture is added.

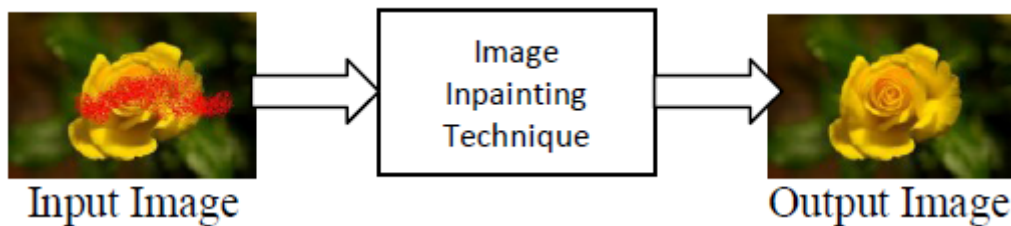


Fig-1.2 : Image Inpainting Process

2. IMAGE INPAINTING METHODS

There are multiple techniques for Image Inpainting of images. In this paper, few of them are described.

2.1 Partial Differential Equation (PDE) Based algorithm

Partial Differential Equation (PDE) based algorithm is proposed by Marcelo Bertalmio et al [1]. This algorithm is the iterative algorithm. The algorithm is to continue geometric and photometric information that arrives at the border of the obstructed area into area itself. This is done by propagating the information in the direction of minimal change using is lines. This algorithm will produce good results if missing regions are small one. But when the missed regions are large this algorithm will take long time and it will not produce good results. Then inspired by this work, 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.

2.2 Exemplar Based Inpainting

The exemplar based inpainting consists of two basic steps : 1) 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 the 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.

2.3 Texture Synthesis Based 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. 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 and not suitable for a large objects.

2.4 Wavelet Transform Based

The algorithm Wavelet Based [3] presented the technique with the help of the wavelet transform. 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). 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 that, it 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.

2.5 Semi-Automatic and Fast Inpainting

The method by Jian et.al [4] proposed inpainting with Structure propagation. This performs 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. To speed up the conventional image Inpainting algorithms, new classes of fast Inpainting techniques are being developed. Oliviera et.al [5] 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 as level sets and uses Fast Marching Method (FMM) to propagate image information has been proposed by Teleain [6]. These fast techniques are not suitable in filling large hole regions as they lack explicit methods to inpaint edge regions. This technique results in blur effect in image.

3. COMPARATIVE STUDY OF DIFFERENT METHODS

Table 1 shows the comparison among the different methods used for inpainting of the images.

Table -1: Comparison of various image inpainting methods

Method	Advantages	Disadvantages
Partial Differential Equation (PDE)[1]	It produces good results if missing regions are small one.	If missing regions are large algorithm takes long time and does not produce good results.
Exemplar Based Inpainting[7]	Efficient for large target regions.	Calculation time is more.
Texture Synthesis Based Inpainting	Performs well in approximating textures.	Difficulty in handling natural images. Not suitable for a large objects.
Wavelet Transform Based[3]	Good image representation quality. Maintain texture and structure quality.	Difficulty for large regions and mask for regions are defined manually.
Semi-Automatic and Fast Inpainting[4]	Computational time is less	This technique is not suitable in filling large hole regions. Results in blur effect in image.

4. CONCLUSIONS

Image Inpainting is the process of reconstructing lost or deteriorated parts of images and videos. It refers to the application of sophisticated algorithms to replace lost or corrupted parts of the image data. In this paper various techniques for inpainting of images are described with its advantages and disadvantages.

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