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A Survey on Various Image Inpainting Techniques to Restore Image

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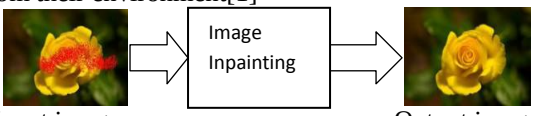
Abstract
Image Inpainting or Image Restore is technique which is used to recover the damaged image and to fill the regions which are missing in original image in visually plausible way. Inpainting, the technique of modifying an image in an invisible form, it is art which is used from the early year. 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]



Input image Output image
Fig 1 Image Inpainting Method


(1) (2)


Figure.2. Ice Drill

Figure 2(1) Original Ice Drill Image.2(2) Image with mask for guiding inpainting 2(3) Result of simple Exemplar Base Inpainting 2(4) Adaptive Inpainting with patch size 10 X 10 pixels. [2]

The following groups of Various Image Inpainting Techniques

A. Partial Differential Equation (PDE) based
B. Texturesynthesis based
C. Exemplar and search based
D. Wavelet Transformbased
E. Semi-automatic and Fast Inpainting.

II. Partial Differential Equation(PDE) based algorithm.

Partial Differential Equation (PDE) based algorithm is proposed by Marcelo Bertalmioet.al [1].This algorithmis 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 theinformation in the direction of minimal change using is ophotelines. This algorithm will produce good resultsif missed regions are small one. But when the missed regions are large this algorithm will take so long time andit will not produce good results.

Then inspired by this work, Chan and Shen [3] 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.

III. Texturesynthesis based Image Inpainting

The Texture synthesis is a field of study independent from, butrelated to inpainting.In the general definition of this problem,an input sample of a texture is given, and the goal is to producemore of that texture.The simplest solution is to tile the texture sample on arectangular grid of desired size. However, even if the sample can be tiled seamlessly, the resulting larger grid structureis easily noticeable and it distorts the perception of theactual texture. More sophisticated techniques are required forreproducing the actual texture with all its features and nothingmore.

A regular (also called deterministic, structured, periodic) textureis characterized by a primitive element (texton or texel) that isregularly 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 globalstatistical properties.The texture synthesis based Inpainting perform well inapproximating textures.

These algorithms have difficulty in handling natural images as they are composed ofstructures in form of edges.

Hencewhile appreciating the use of texture synthesis techniques in Inpainting, it is important to understand that thesemethods address only a small subset of Inpainting issues and these methods are not suitable for a large objects.

IV. ExemplarbasedImage 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 bestmatching patches from the known region, whose similarity is measured by certain metrics, and pastes into thetarget patches in the missing region.Exemplar- based Inpainting iteratively synthesizes the unknown region i. e. target region, by the mostsimilar 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 forreconstructing 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∈δΩ in the beginning of each filling iteration.
III. Searching Example and Compositing: in which the most similar example is searched from the sourceregion Φ to compose the given patch, Ψ (of size N × N pixels) that centered on the given pixel p.
IV. Updating Image Information: in which the boundary δΩ of the target region Ω and the requiredinformation for computing filling priorities are updated.

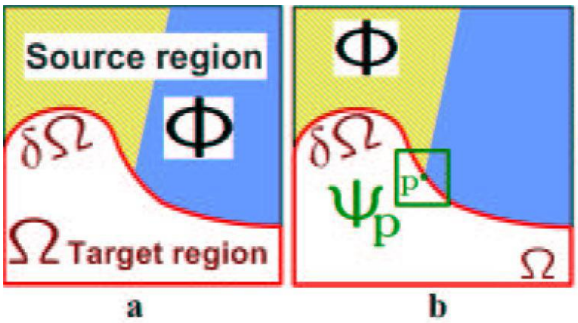


Figure 3: Structure propagation by exemplar-based texture synthesis.

(a) Original image, 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 ψpcentred on the point p €δΩ

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 andtexture. And if there are not sufficient samples in image then it is impossible to synthesize the desired image.

V. Wavelet Transform based

The algorithm [4] 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 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.

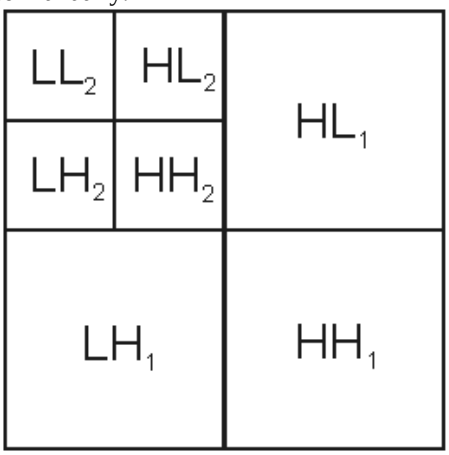


Figure.4. Wavelet transform decomposition of image [2]

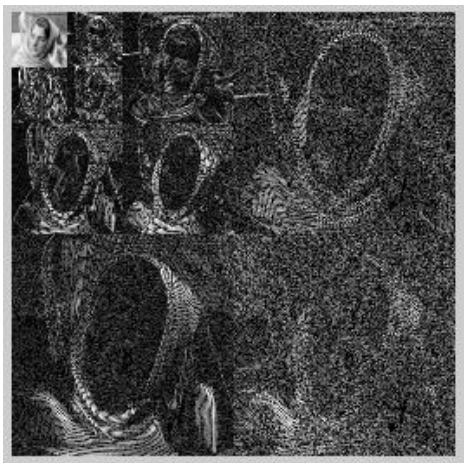


Figure.5. Result of Wavelet Transform [2]

VI. Semi-automatic and Fast In painting.

This image in painting requires user assistance the in theform of guide lines to help in structure completion has found favour with researchers. The method by Jian et.al [5] 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 theknown to the unknown region and then a patch based texture synthesis is used to generate the texture. Themissing 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 beused to derive the optimal answer if only a single curve is present. For multiple objects, the optimization is greatdeal 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 hencemaking it unacceptable for interactive user applications. To speed up the conventional image Inpaintingalgorithms, new classes of fast Inpainting techniques are being developed. Oliviera et.al [6] proposed a fast digital In painting technique based on an isotropic diffusion model which performs Inpainting by repeatedlyconvolving 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 [7]. 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.

VII. 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 semi-automatic and fast Inpainting techniques are studied.Image inpainting is recently very important research area in the field of image processing. Theperformance of different techniques is compared based on the area to be inpainted. Most of the algorithms work wellfor small scratch regions or small regions to be inpainted. In future we would like to implement algorithms reviewedin this paper would like to compare their performances. We would like to improve those algorithms and would liketo propose a new inpainting algorithm for inpainting large regions. And includes growth of efficient algorithm to decrease the time required for Inpainting and reduce computational cost.

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