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Digital Inpainting Techniques- A Survey

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ABSTRACT : *Digital inpainting can be described as a technique of filling gaps or occlusions in an input image for making it more visually plausible. It is a method of image reconstruction. We know that image reconstruction is done to recover degeneration or degradation caused to the images due to some image processing activities. The filling of gaps or lost area is done using data from remaining region of the image. Depending on several applications there are number of inpainting techniques available. The major aim of this paper is to do a comparative study on these techniques to understand and criticize the effectiveness of each.*
KEYWORDS **-** *Digital image inpainting, PDE, Image painting.*

I. INTRODUCTION

Digital image inpainting means virtually painting some regions of an image that appears to be part of original image. Now a days important has lots of applications like removing logos from videos, digital reconstruction of images that lost some parts due to aging like fading, to remove a particular object or person from an image without affecting the visual quality of image etc. An example of inpainting technique is illustrated using the figure below [11].

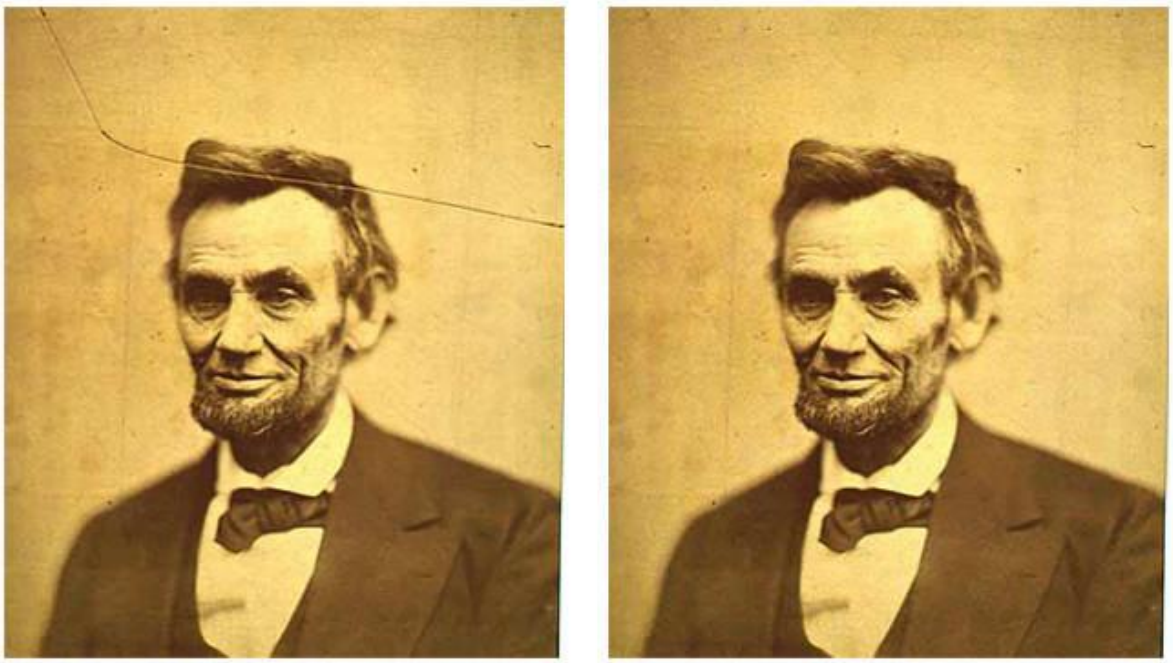

Fig 1: Image before and after inpainting

Image inpainting should not get confused with another technique called image painting where instead of removing some areas and reconstruction afterwards it simply paints some regions of image artificially. The image painting algorithm uses Poisson image editing tool and its application lies in healing tool of Adobe Photoshop. The major difference between image inpainting and painting is in image painting inclusion of a region over a large region is made where source and destination is provided by the user, where as in image inpainting automating filling is done after input image is provided by the user.

II. INPAINTING TECHNIQUES

As already mentioned there are a number of inpainting techniques available whose importance depends on the applications where it is used. Inpainting algorithms are broadly classified to different categories like texture based inpainting, exemplar based inpainting, PDE based inpainting, hybrid inpainting and fast semi-automatic inpainting.

TEXTURE BASED INPAINTING

The algorithm used here completely depends on neighboring pixels of an image. That is texture needed for filling holes are generated from the pixels of nearby portions of the picture. There are many inpainting algorithms works on the basis of this texture based synthesis. The major differences between these algorithms sticks on the way in which they maintain the continuity between pixels of area which is subjected for inpainting and pixels of neighborhood regions. D.H. Heeger and J.R. Bergen proposed an algorithm where most matching texture for performing inpainting is generated from target region itself [7]. Yamauchi, Haber and Seidel together proposed an algorithm for image reconstruction where texture for filling holes are generated under different brightness conditions and these algorithms seems to be working for images under different resolutions [4]. All texture synthesis algorithms seems to be distinct due to their uniqueness in doing inpainting on different colors, intensity, and gradient and even statistical characteristics. If accuracy is the primary condition user should not go for texture synthesis algorithms for inpainting of natural images, because of its inability to handle boundaries and edges well. The method also need much user interaction as user need to specify texture that should be used for inpainting in some cases and so the method cannot be used for images of larger size.

EXEMPLAR BASED IMAGE INPAINTING

This algorithm is mainly used for removing large objects from a particular image. The algorithm which is proposed by Criminisi et al, uses the advantages of both texture synthesis and inpainting techniques [5]. Here both texture and structure of an image is needed to be replicated. The ultimate success of algorithm for structure synthesis depends on order priority through which the filling process is done, since the method uses good structure and texture synthesis together they can be very well used for a large number of images. The most important problem associated with this method is that the curved structures are not handled properly. Iddo Drory et al proposed an algorithm for generating the unknown areas of an image iterative approximation is used [3]. On all methods till we'd gone through uses same image pixels for filling holes but James Hays and Alexei A Efros proposed an approach of using a database of images that contains millions of images for filling holes [2]. The most perfect match for filling holes are found using a database search.

INPAINTING BASED ON PDE

The PDE (Partial Differential Equation) method make use of the concept of isophotes, which are edges which are linear in the surrounding area. The method was introduced for the first time by Bertalmio et al. [1]. The major negative associated with this method is that the replication of large image regions cannot be done effectively due to the blurring effect of diffusion process. David Tschuperle proposed another PDE based algorithm known as vector valued regularization with anisotropic diffusion frame work [6]. Chan and Shen proposed TV (Total Vibrational) model uses Euler's Lagrange equation along with anisotropic diffusion. CDD (Curvature Driven Diffusion) model which is derived from TV model make use of the curvature information of isophotes for inpainting [4].

FAST AND SEMI-AUTOMATIC INPAINTING

Inpainting with structure propagation is an example of Fast and Semi-automatic inpainting. It was proposed by Jian et al and it is a two-step process [8]. Another fast inpainting method introduced by M. Oliviera performs inpainting using iterative convolution of the region to be inpainted with diffusion kernel [9]. Fast Marching Method is another approach used for image information propagation. Since there is no specific method is used for edge detection this method cannot be used for filling image with large holes.

HYBRID INPAINTING

As same as the name indicates it is a hybrid combination of two inpainting methods texture based synthesis and PDE based method for filling holes. First and foremost step of this method is to divide the image into texture and structure region. Then these regions are filled by corresponding algorithms. The algorithm needs more time for filling holes.

THE CRITERIAS CHOSEN FOR THE EVALUATION OF PERFROMANCE OF INPAINTING ALGORTIHMS.

Even though scientifically no methods are mentioned for the evaluation of performance of various inpainting algorithms, we can define some logical criteria for the purpose.
They are:

- Capacity of filling large areas.
- Texture replication capability.
- Effectiveness of algorithm in dealing with curved regions.
- Time required.
- The number of images supported by the algorithm.

PSNR and MSE values are also used for the comparison of inpainting algorithms.

III. CONCLUSION

The survey shows various approaches and techniques used in digital image inpainting. Studied about prominent methodologies used for inpainting and studied about the advantages and disadvantages of each method and also studied about various parameters and criteria used for comparing and evaluating the performance of each and every inpainting algorithms.

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