Comprehensive Survey on Various Image Inpainting Techniques

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Abstract— Inpainting is the process of reconstructing the missing or damaged contents inside an image using partly information loss in a plausible way that inpainted image look natural. In today’s life the persons that preserves the old photographs after some times this picture is damaged like scratches on that picture or some text is overlaid in that picture, so inpainting techniques can be used to obtain the resultant image that same as original image In this paper, we focus on the techniques that is multi-resolution technique, structure and texture propagation technique, virtual view synthesis Algorithm, watermarking-based inpainting, exemplar based image inpainting and sparsity based image inpainting. In each case for inpainted image, the goal is to fill the damaged portion of the image in a visually plausible way. Applications of image inpainting range from the removal of an object from a scene to the retouching of damaged painting or photograph

Key words: inpainting images; inpainting techniques

I. INTRODUCTION

Image inpainting is the process of reconstructing the damaged images and recover the missing portion of the images. It has been widely used in many applications like image restoration, image editing and encoding, etc [1].

![Fig. 1: Image Inpainting Example](image)

(a) original image

(b) inpainted image

In past days, people were preserving their visual works carefully. With time, photographs get damaged and scratched. Users can then use the software to remove the cracks from the photographs. By applying different techniques to recover the images in such way it can’t be differentiate between original images and reconstructed images.

In computer applications inpainting refers to the implementation of classy algorithms to substitute lost or corrupted parts of image data. Inpainting is conceded out by specialized artist and generally its very time consuming process because it is the manual process. Inpainting technique has set up extensive use in many applications such as restoration of old films, object removal in digital photos, red eye correction, super declaration, compression, image coding and communication.

In this paper, different types of image inpainting techniques are discussed here. Section II that describe the brief study of traditional techniques. Section III discuss about the survey on image inpainting techniques. In Section IV discuss about future work and section V contain conclusion of survey of inpainting techniques.

II. IMAGE INPAINTING APPROACHES

Basically inpainting approaches classified in following categories:
- Texture Synthesis based inpainting
- Partial Differentials Equation (PDE) based inpainting
- Exemplar based inpainting
- Hybrid inpainting
- Semi-automatic and fast image inpainting

A. Texture Synthesis Based Inpainting:

Texture synthesis based inpainting that is latest method of image inpainting. Texture synthesis algorithms are used to fill the missing area of regions using similar neighborhoods of the damaged pixels. The main aim of texture synthesis based inpainting is to create texture pattern which is similar to sample image. The texture synthesis approach that classified into three categories and it describes as, 1) Statistical (parametric), 2) pixel-based and 3) Patch-based (non-parametric). The statistical method that is successfully produces the stochastic/irregular texture but is fails to produce the structured/regular texture where pixel based texture method build on texture pixel by pixel and apply some filters in that the outcome image quality is better than the statistical but it is fails large structured texture. At last patch based method that build on sample texture based on patch by patch and produce the more faster result compare to statistical and pixel based method [2].

The patch based algorithm that first take the input image and apply binary mask on this image. By applying binary mask outcome image that consist the pixel value either one or zero. Now pixels that value is non-zero indicate region of image that is considered as hole to inpaint the images. In this step the images that contain black region and gray region. The main drawback of the system is result of outcome result is not suit for real word images. The limitation of this technique is the result will never be good for the real world images [3]. For approximating texture synthesis techniques that perform well. But drawback of this approach is methods address only a small subset of Inpainting issues and these methods are not suitable for a wide variety of applications [4].

B. Partial differential equation based inpainting:

The second approach of inpainting is partial differentials equation. The partial differential equation based algorithm that is proposed by the M. bertalmio [5]. The basic purpose behind this approach is continue with geometric and photometric that arrives at the border of occlude area. When missed region area of image is small then algorithm work
well but when the missed area of image is large then this algorithm takes much time so it not produces the good quality image. The total variation model [6] used in Euler Lagrange method anisotropic diffusion based on the strength of the isophote. But this model that only work for the noise removal and small region. This method is computationally expensive. Then TV model that extended to new method that is CDD (Curvature Driven Diffusion) it overcome the disadvantage of total variation model. This model gives curvature information to handle the curved structures in better manner [7].

The fast marching method is simple to compare with other PDE algorithm. The drawback of this system is it produce blurred resulting image. Other drawback of these algorithms is that the large textured regions are not well reproduced [8].

C. Exemplar based inpainting:
The exemplar based inpainting is that consists of two basic steps: in the first step priority assignment is done and the second step consists of the selection of the best matching patch. The exemplar based technique samples the best matching patches from the known region, whose similarity is measured by metrics, and pastes into the target patches in the missing region.
The exemplar based inpainting that contain the following steps[3]:
1) Initializing the target region: In this step missing area of images are extract and represented with data structure.
2) Computing Filling Priorities: In this step priority function used to compute the order for all unfilled pixels.
3) Searching Example and Compositing: Here similar example searched from the source region to compose the given patch.
4) Updating Image Information: The boundary of the target region and the required information for computing filling priorities are updated.

D. Hybrid Inpainting:
The hybrid inpainting techniques that is used to filling the large area in the images and hybrid inpainting that combines the texture synthesis and partial differential equations for fillings the holes in the images. In hybrid inpainting image decompose the images into two parts that is structure region and texture region. In this paper [9] developed a hybrid model is developed here uses total variation equation, divided into a structure part and texture part. Textures contain more dynamic information. Structure part is processed by a bi-directional diffused PDF and the texture part by an exemplars-based model

E. Semi-automatic and fast image inpainting:
Semi-automatic inpainting requires user assistance, in form of guidelines to structure completion. In short semi-automatic inpainting is the user assistance. In the fast marching method [8] the missing regions of image as level sets and uses propagate image information. This techniques that s not work well when region is larg in filling. So the result of this technique is blur effect in image.

III. SURVRY ON TECHNIQUES

A. Structure Recreation and Texture Synthesis Technique:
This technique combines structure recreation algorithm and texture synthesis algorithm. The problem with these techniques is that the quality and times are directly proportional to each other, if the quality of images is increase the required time is also increase and if time is decrease than quality is also decrease. So some techniques fail to produce good result [1].

B. Multiresolution technique:
The multi resolution technique used to inpaint the image Multiresolution technique that conduct four step processes. The first step, make the pyramid of the images with highest resolution images. Now, in the second step they have low resolution images, for that the patches at the center of point are denoted as the target patches and patches with highest priority is inpainted first. For that target patch location and current patch locations of image is store with their coefficient. In the third step, use the inpainted low resolution image and propagate the information to inpaint the higher resolution image just above it in the pyramid. Then repeat this process until the highest resolution image is inpainted. The result of the multi resolution technique is three time faster than state-of-the-art technique [10].

C. Exemplar based technique with super resolution:
Another technique that is exemplar based technique with super resolution algorithm. In that first the input picture is inpainted and in second, it creates improved resolution images. Major operation of the system is, first non-parametric patch sampling scheme. Here inpainting algorithm applied in the low resolution images. In second, the inpainted image computation time is reducing to compare with the full resolution image. For improvements in the robustness low resolution images that is inpainted with different parameter such as patch size and filling order. After combine this result visual relevance and robustness is improved. Low resolution images built from original image and after that inpainting algorithm applied in low resolution images and using single image resolution method the quality of inpainted region is improved [11].

D. Modified exemplar technique:
The novel approach for automatic inpainting images based on modified exemplar technique, to find the patches from the images. It uses the Euclidean metric for pixel brightness and Chi-squared histogram matching distance for local binary patterns. In the proposed algorithm first step is calculating the priority, priority calculation done by two factors that is confidence factor and variation factor. The priority is calculated for the each pixel of the images. After calculating the priority of the pixels in the boundary in the second step we have to define the pixel with maximum priority. The third step, defines the restored patch at the center of the pixel. The fourth step, calculates the Euclidean metric for true pixels and restored patch. In the fifth step, they have utilized the local binary patterns (LBP) as a texture descriptor for patches in image. The LBP operator is calculated by a thresholding of each pixel around the central pixel. In the sixth step, the histogram of the uniform patterns in a local region forms a powerful descriptor used to analyze the local regions in...
image. The seventh step, calculate the correspondence between the histogram by Chi-squared histogram matching. In eight step searching of similar patch using multiple criteria, for the multiple criteria, Euclidean metric for pixel brightness and Chi-squared histogram matching distance for local binary patterns in the form. At last step, reduce the visibility of the boundaries of image in EBM we use the algorithm for texture synthesis, and it allows the overlap region between patch using minimum error boundary cut. This technique is able to produce visually preferable results in reconstruction of missing small and large objects [12].

E. Exemplar based image inpainting technique:
The exemplar based image inpainting technique is used to fill the large region as well as small region of the images. The steps to perform in the exemplar based image inpainting is, first step is initialize the target region, and this is done by marking the target region by some special color. For example the color to mark in region is green then value of color format is R=0, G=255 and B=0. The second step is to find the boundary of the target region. The third step is to select the patch from the region to be inpainted, here patch size is larger than the texture element in the images and default patch size is 9*9 for largest texture element the in image. Fourth step that is, find the patch from the images for best matches the selected matches, and obtain the best match then calculate the mean square error. To obtain the best match by using priority functions confidence and data term. Using confidence term and data term we can calculate the priority and highest priority is selected as first patch to inpainted. Advantages of this technique are, the time taken in normal image inpainting is reducing using fast algorithm exemplar based inpainting. Exemplar based inpainting also work when region is large. It is computationally efficient and works well with larger images [13].

F. Sparsity based inpainting technique:
Sparsity based inpainting that use the patch wise image inpainting algorithm. Patch-wise image inpainting is done by using patch sparse representation on over complete dictionaries. Dictionary is a collection of prototype signals that is known as atom. Dictionary can be chosen such that it sparsify the representation. Earlier dictionaries such as discrete cosine transform (DCT), wavelets, contourlets, curvelets etc. DCT dictionary easily generate and it is fixed nature of problem. So sparse coding becomes simple. And DCT dictionary is created by 1D-DCT matrix directly by known region of an image to be inpainted. The Dictionary is generated by arranging known patches column-wise. To find sparse representation greedy approach is used. In greedy algorithm at every step takes one atom from the dictionary then determines the coefficient of the combination of the set of atoms that approximate the target region that is to be inpainted. The basic process of patch wise inpainting is, it start with source region and target region of input image. After then, it generates the fixed DCT dictionary and it is generated by sampling the patches from the source region and arranges that patch as dictionary atoms. Selected target patch define the some known pixel and some is missing pixels. Then the next step is find the missing pixel of target patch, find the estimate of target patch by considering only known pixels over complete dictionary by sparse coding techniques. In the last step pixels of the target patch is updated by the pixel in the estimated patch, if target region is filled then image is inpainted[15].

G. Watermarking-based inpainting technique:
The proposed system that divide into two phases first is water embedded phase, first they original image into half tone image using halftoning algorithm, after that they permute the half tone image to increase robustness and at last, they have embedded the permuted random binary image into the original image with LSB method. In the Second phase contain first they have extract the binary damaged image from the damaged image using LSB method, and then permute the random binary damaged image to obtain the damaged half tone image, and convert the damaged halftone image to the reference image with inverse halftoning algorithm and last after enhancing reference image with median filter, we substitute the pixels of attacked area in damaged image with the enhanced reference image in the same position [16].

IV. FUTURE WORK
Exemplar based technique with super solution system implemented as it could automatically find out the object in the image and give choice to user to remove selected item this will reduce the phase of manually selecting area to remove and mix from image. We can also implement multiple watermarking for image inpainting.

V. CONCLUSION
In this paper a variety of image Inpainting techniques such as texture synthesis based inpainting, sparsity based inpainting, exemplar based inpainting, and watermarking-based inpainting and fast Inpainting techniques are studied. For each technique a detailed explanation of the techniques can be given which are used for filling the missing region building use of image. The time taken in normal image inpainting is reducing using fast algorithm exemplar based inpainting. Exemplar based technique that work well when region is large. Advance study includes growth of efficient algorithm to reduce computational cost and to decrease the time required for inpainting. Advance study includes growth of efficient algorithm to reduce computational cost and to decrease the time required for Inpainting.

REFERENCES