A Review on Image Inpainting with K-Nearest Neighbor (KNN) Method

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Abstract— Reconstructing and editing of photographs is as old as photography itself. In reality yourself, myself and many majority people need to restore their photographic memories, art work, designs, drawings etc. Damage of the same can be due to many reasons like occlusions, overlaid texts, scratches, graph scaled images etc. We can enhance the visual appearance of the photographs and make it good looking once with the help of inpainting and we can say retouching. In the digital world, in painting (also known as image interpolation or video interpolation) refers to the application of sophisticated algorithms to replace lost or corrupted parts of the image data and majority times to remove the small areas or defected parts of the picture.

Key words: Inpaiting, PDE, Texture Synthesis, Exaplar Method, Patch Based, KNN based

Fig. 1: Image Inpainting

I. INTRODUCTION

Image inpainting refers to a specific image restoration task, where missing or damaged portions of an image are reconstructed. For example, cracks on old paintings or letters covering parts of magazine photos would be considered the missing or damaged portions of an image. Inpainting methods use the known image information to recover those missing areas.[7]

Image inpainting is the technique of filling in the missing regions of an image using information from surrounding area. In the conversation of digital inpainting, the missing region is often referred to as hole, and is usually provided by the user in the form of mask or can be obtained by automatic or semi-automatic means. Some of the earlier nomenclature referred small region filling as inpainting and large area inpainting as image or video completion. Image inpainting has found widespread use in many applications such as restoration of damaged old paintings and photographs, removal of undesired objects and writings on photographs, transmission error recovery in images and videos, computer-assisted multimedia editing and replacing large regions in an image or video for privacy protection. The goal of the inpainting technique is to modify the damaged region in an image or video in such a way that the inpainted regions undetectable to a neutral observer.

The major objective of inpainting procedure is to rebuild damaged parts or missing parts of image Inpainting technique has set up an 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 [12]. Image Inpainting restructure the damaged region or mislaid parts in an image utilizing spatial information of neighboring region. In image inpainting would like to create original image but it is absolutely not viable without prior knowledge about the image.

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II. RELATED WORK

In [1] Exploring contour and texture features for context-aware patch-based inpainting paper, they explore the use of contour and texture features for context-aware patch-based image inpainting. Both of these features are obtained by analyzing the image filtered with the bank of filters at multiple orientations and scales, specifically Gabor filters. The priority is used to determine the filling order of the missing region, which is crucial for the success of the algorithm. They have use texture features, together with color features, as contextual descriptors of image regions. The benefit of the context-aware approach is twofold: the chance of choosing wrong matches is reduced and the search for candidate patches is accelerated.

In [2] A patch-based image inpainting based on structure consistence they have design a patch-based inpainting based on structure and texture as our main framework. To keep the structure consistency between the damaged areas and the non- damaged areas, we redefine two factors, confidence and illumination variation, which use to determine the priority of the filling order of target (damaged) regions. With these two defined factors, they propose an algorithm to obtain the best patch in each filling step for the target region. To solve the challenging problem of repairing structure in image completion, they design a novel image completion approach based on automatic salient structure propagation.

In [3] Image Completion Approaches Using the Statistics of Similar Patches n this paper the problem through novel statistics of similar patches. They observe that if we match similar patches in the image and obtain their offsets (relative positions), the statistics of these offsets are sparsely distributed. They further observe that a few dominant offsets provide reliable information for completing the image. Such statistics can be incorporated into both matching-based and graph-based methods for image completion.

In [4] In this paper, they first introduce a general approach for context-aware patch-based image inpainting, where textural descriptors are used to guide and accelerate

the search for well-matching (candidate) patches. A novel top-down splitting procedure divides the image into variable size blocks according to their context, constraining thereby the search for candidate patches to nonlocal image regions with matching context. This approach can be employed to improve the speed and performance of virtually any (patch-based) inpainting method.

Here with we tried to discuss all the major state of art methods along with the problems. Work need to be done on the above discussed and extracted problems so as to achieve more accuracy and quality results.

III. DIFFERENT METHODS

Image inpainting techniques can be broadly classified or categorized in detail as under. Here we have discussed all inpainting methods with different problem.

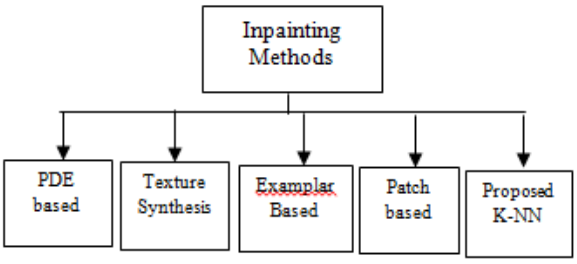

Fig. 2: Inpainting Technique

A. PDE

Partial Differential Equations (PDE) are mainly designed for filling narrow or small holes (also known as "inpainting" [1]). They work less well for large missing regions due to the lack of semantic texture/ structure synthesis.[5] the missing region at the pixel point. Fundamentally these algorithms are based on the variational method and Partial Differential equation (PDE). The algorithm is to continue geometric and photometric information that arrives at the border of the occluded area into area itself. 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. Then inspired by this work, Chan and Shen 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.

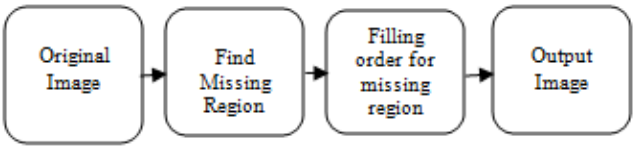

Fig. 4: PDE based inpainting

The main difficulty with this algorithm is imitation of large texture regions. This algorithm also unable to recover partially degraded image. Then CDD (Curvature Driven Diffusion) [6] model used in which it included the curvature information of the isophotes to handle the curved structures in a better manner. PDE based technique has been widely used in various applications such as image segmentation, restoration etc.

B. Texture Based

Texture Synthesis based Inpainting [5]: 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 main objective of texture synthesis based inpainting is to generate texture patterns, which is similar to a given sample pattern, in such a way that the reproduced texture retains the statistical properties of its root texture. Texture synthesis approaches (Efors et al.1999) [7] can be categorized into three categories: Statistical (parametric), pixel-based and patch-based (non-parametric). Statistical methods are more likely to succeed in reproducing stochastic/irregular textures, but usually it fails to reproduce structured/regular textures. On the other hand, pixel-based methods "build" on the sample texture pixel-by-pixel instead of applying filters on it, and their final outputs are of better quality than those of statistical methods, but they usually fail to grow large structured textures.

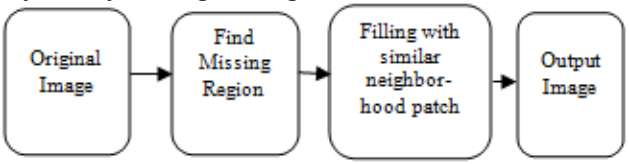

Fig. 3: texture synthesis based inpainting

Finally, patch-based methods "build" on a sample texture patch-by-patch as opposed to pixel-by-pixel, thus they yield faster and more plausible regular textures. The texture synthesis is 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. Also they have complex interaction between structure and texture boundaries.

C. Examplar Based

Exemplar based Inpainting [4]: Exemplar based inpainting technique is determining class of inpainting algorithms. Exemplar based inpainting technique is considering structure and texture region. The exemplar based inpainting technique is consists of two basic steps. Priority is given to all the patches. Best matching patch is selected.

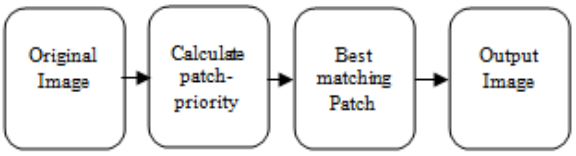

Fig. 4: Examplar based inpainting

The exemplar based algorithm includes mainly the following four steps.

- Initializing the Target Region: in which the initial missing areas are extracted and represented with appropriate data structures.
- Computing Filling Priorities: in this a predefined priority function is used to compute the filling order for all unfilled pixels in the beginning of each filling iteration.
- Searching Example and Compositing: in which the most similar example is searched from the source region to compose the given patch, Ψ (of size $N \times N$ pixels) that centered on the given pixel p.

– Updating Image Information: in which the boundary of the target region and the required information for computing filling priorities are updated.

The Exemplar-based algorithms adopt the greedy strategy, so these algorithms suffer from the 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.

D. Patch Based

Patch-based methods fill in the missing region patch-by patch by searching for well-matching replacement patches in the undamaged part of the image and copying them to corresponding locations. While these approaches share some ideas with patch-based texture synthesis they focus additionally on structure propagation either by defining the filling order, using human intervention or decomposing the image into structure and texture components . Compared to diffusion-based methods, patch-based methods typically produce better results, especially when inpainting larger holes.

Patch-based methods can be categorized into:

– Greedy: The "greedy" ones choose only one best match for each patch to be filled, called the target patch, based on its known pixels. This is achieved in an iterative process that gradually completes the missing region.
– Multiple Candidate: Multiple candidate methods infer the missing region using weighted average or a sparse combination of multiple candidate patches at each location.
– Global: global methods define inpainting as a global optimization problem[7].

E. Proposed KNN Based

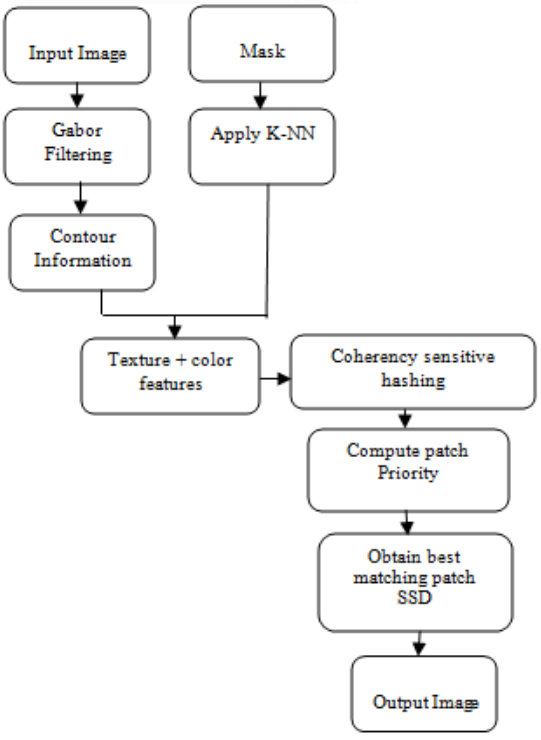

Fig. 5: Flow of Proposed System

We use the combination of texture and color features as contextual descriptors. Texture features are obtained by multi-channel filtering and then averaging the magnitudes of filter responses within square non-overlapping blocks As a filter bank, we again use a bank of complex Gabor filters, like for extracting contour features. Color features represent the average color estimated by KNN color segmentation algorithm. They are additionally normalized to be within the same range of values as texture features. Finally, contextual descriptor 'g' represents a (Nf+ C)–dimensional feature vector, where N is the number of filters (18 in our case) and C = 3 is the number of color channels.12

IV. COMPARISON TABLE

Techniques	Advantages	Disadvantages
PDE based inpainting [13]	Smoothly inpainted.	Blurred result. Large texture regions are not reproduced.
Texture synthesis based inpainting [8]	Edge based good inpainted.	Cannot handle natural scenes effectively.
Exemplar based inpainting [13]	Handle large hole. , No blurring effect. Remove large object. Fill small scratches.	Difficulty in handling curved Structure
Patch Based[5]	It Produce better results when inpainting larger holes.	-
K-NN	Effective if the training data is large	-

Table 1: Compression Table

V. CONCLUSION

Image inpainting is recently very important research area in the field of image processing. From various studies of different papers related to "Image inpainting" can be use to filling missing part or holes which are created by damage or removal of any unwanted object. Image inpainting is consider spatial and temporal information.

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