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# Image Inpainting Using Robust Exemplar-based Technique

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***Abstract*—** Image in-painting is the art of restoring lost and selected parts of an image based on the background information in such a way so that the change is not observed by the observer. Image in-painting techniques is used in many fields like heritage preservation, films etc. In this paper, we are using exemplar based inpainting algorithm, this approach propagates the image information from the known region into the missing region at patch level. We first note that exemplar-based texture synthesis contains the essential process required to replicate both texture and structure; the success of structure propagation, however, is highly dependent on the order in which the filling proceeds. The existing algorithms are combined to improve the efficiency for finding the line association in selected region. Main focus is on data term and confidence term to find association in selected region which is to be inpainted. The region filling is done from that line associated to other section in selected region.

***Index Term*—** Image Inpainting, Robust-Exemplar Inpainting, Image Segmentation, Object Removal

## I. INTRODUCTION

The filling-in of missing region in an image, which is called image inpainting, is an important topic in the field of computer vision and image processing. Image inpainting has been widely investigated in the applications of digital effect (e.g., object removal), image restoration (e.g., scratch or text removal in photograph), image coding and transmission (e.g., recovery of the missing blocks), etc[8]. The main goal of this process is to fill the missing region/restoring lost part of an image based on the background information. This process reconstruct image in such a way so that the change cannot be noticeable by an observer. Image in-painting technique is used in so many fields like preservation of heritage films and television and for special effects production. It is used to restore old/damaged photographs, object removal from an image without affecting the image, image coding and transmission (recovery of the missing blocks)etc [1].

The restoration can be done by using two approaches , image inpainting and texture synthesis , whereas the meaning of approach is restoring of missing and damage parts of images in a way that the observer who doesn't know the original image cannot detect the difference between the original and the restored image. The second approach is filling unknown area on the image by using the surrounding texture information or from input texture sample. This technique could be employed to restore digitized photographs especially if a damaged area needs to be filled with some pattern or structure. However, texture synthesis usually fails if the area to be reconstructed contains additional color or intensity gradient[6]. Most algorithms combine both texture synthesis and inpainting approach to restores the image. Both are collectively used to fill holes as they remove unwanted features or holes in the image.

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Following are the Mostly used in-painting methods:-

- Geometry-based method
- Exemplar-based method

We can also call Geometry based methods as structure in-painting methods. In this method missing region is filled by diffusing the image information from the known region into the missing region at the pixel level. This type of algorithm is basically based on PDE (partial differential equation). Geometry-based in-painting methods shows good result in propagating smooth level line or gradients or filling the non-textured target region. This method is generally used when the unpainted region is small. The drawback of this method is, it introduces blurring artifacts in textured or when filling large missing region[2].

The second category is exemplar-base in-painting algorithm. It provides an efficient approach for reconstructing large target regions. Basically it consists of two main steps:
The first step is of priority assignment and the second step consists of the selection of the best matching exemplar and updates all the priorities. Exemplar based in-painting iteratively synthesizes the target region, by the most similar patch in source region[4]. They provide good results in recovering textures or repetitive patterns. This algorithm overcomes the drawback of PDE based in-painting.

In this paper, we are using Exemplar region filling algorithm.in this computing approximate solution and search problems. The basic requirements of all image inpainting algorithms is that the region to be inpainted should be selected manually by user , because no mathematical equation is capable of detecting or knowing the region to be inpainted without taking desired area. The algorithm has set of algorithm such as initialize the target region, find boundary of target region, select a patch region needed to be inpainted, select the best patch to inpaint, and update the image [1].

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## II. SURVEY OF LITERATURE

For any project literature survey is considered as the backbone. Hence it is needed to be well aware of the current technology and systems in market which is similar with the system to be developed.

So many methods has been proposed for image inpainting, the most fundamental inpainting approach is the diffusion based approach, in which the missing region is filled by diffusing the image information from the known region into the missing region at the pixel level. These algorithms are well founded on the theory of partial differential equation (PDE) and variation method [2]. Bertalmio filled in holes by continuously propagating the isophotes (i.e., lines of equal gray values) into the missing region.

In the inpainting based on partial differential equation, the goal was to maintain the angle of arrival. The basic idea was the smooth propagation of information from the surrounding areas in the isophotes direction. The drawback of this method was that the CPU time required for inpainting depends on the size of selected region. Therefore, was a time consuming process as it took nearly 8 to 10 minutes for inpainting.

In inpainting by total variance and curvature-driven diffusion methods proposed by Chan and Shen, they used Euler-Lagrange equation and inside the inpainting domain the model simply employs anisotropic diffusion based on the contrast of the isophotes. This was used for inpainting small regions and was also good in removing noise but it did not connect broken lines or edges. Then a curvature-driven diffusion equation was proposed to realize the connectivity principle which does not hold in the TV model. Recently, image statistics learned from the natural images are applied to the task of image inpainting [2],[3]. The diffusion-based inpainting algorithms have achieved convincingly excellent results for filling the non-textured or relatively smaller missing region. However, they tend to introduce smooth effect in the textured region or larger missing region[4].

The CDD model extended the TV algorithm by taking also geometric information of isophotes while defining strength of the diffusion process, allowing large area inpainting. The major drawback of the TV inpainting model was that it was unable to restore well a single object when its disconnected remaining parts were separated far apart by the inpainting domain[5]. A. Telea proposed a fast marching algorithm that can be looked as PDE based approach without the computational overheads. It is fast and simple to implement than other PDE based methods, this method produced very similar result comparable to other PDE methods. The main limitation of this method is the blurring produced when inpainting regions thicker than 10—15 pixels, especially visible when sharp isophotes intersect the region‘s boundary almost tangentially. Oliveira proposed a fast image inpainting method based on convolution operator . This algorithm produces the result in few seconds with both the diffusion kernels after more than 100 iterations and faster than any image inpainting algorithms but produce blurring. Exemplar-Based algorithm combines the strengths of both approaches into a single, efficient algorithm. The work decomposes the original image into two components; one of which is processed by inpainting and the other by texture synthesis. The output image is the sum of the two processed components[7].
Limitations in this are: the synthesis of regions for which similar patches do not exist does not produce reasonable results, the algorithm is not designed to handle curved structures, and finally, this algorithm does not handle depth ambiguities.

## III. PROPOSED SYSTEM

In proposed system, the robust exemplar-based inpainting and region segmentation map this two algorithm are used.
The modules of proposed system are:

i. *Initialize the target region.*
This is generally performed separately from the inpainting process and requires the use of an additional image processing tool. This is performed by marking the target region in some special color. Without any loss of generality, let us consider that the color that the target region will be marked in is green (i.e. R = 0, G = 255, B = 0).

ii. *Find the boundary of the target region.*
After selecting the target region the boundary of the patch is determined.

iii. *The source image is divided by using segmentation map.*
In this module, the target region is separated as foreground and background region. Moreover, source regions are divided and represented as gray-scale values according to their local texture similarities. This is done to recognize the patch easily.

iv. *Find a patch from the image which best matches the selected patch.*
The proposed method fills efficiently the target region with patches in source regions. We can adaptively choose the patch size between 4×4 and 17×17 using segment information in the target patch. If the image is more complicated then patch size will be high else for easy image the patch size will be less. It is always necessary to selected a patch size.

v. *Update the image information* according to the patch found in the previous step and the inpainting is performed.

## IV. ALGORITHMIC STRATEGY

*A. Region segmentation*

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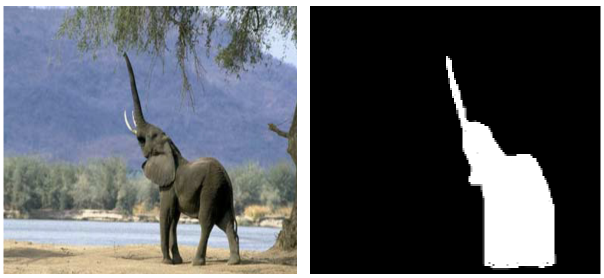
We use a graph-based region segmentation algorithm .An initial graph $G = (V, E)$ is refined as a segmentation map $M$ that provides significant structural information of $I$, where $V$ represents initial vertex set and $E$ denotes the corresponding set of edges. A segmentation map $M$ is a set of properly refined regions through iterative merging process[7].



(a) (b)

Fig. 1. Comparison of result image by a proposed method. (a) input image. (b) Image after segmentaion algorithm applied.

First, the segmentation algorithm is used to produce an initial segmentation map. Next, we merge segments in $T$ of the initial segmentation map into one segment and then assign a new label that indicates the target region. The segmentation map in the robust exemplar-based inpainting method performs two functions: as an indicator of $T$ and as selection criteria of patch size and candidate source regions.

Using this algorithm it will divide the target region and source region of image, so the filling will be take place in target region easily. Segmentation maps are labelled with gray-scale values [0, 255]. We update labels of an initial segmentation map to classify target region. We set the label of user-defined target region to 255 (white). Also, if there are source regions that have values of 255, we change the label to an unused gray-scale value. Moreover, source regions are divided and represented as gray-scale values according to their local texture similarities[1]-[7].

*B. Robust exemplar inpainting*

Considering local texture similarity using a segmentation map, the proposed method fills efficiently the target region with patches in source regions. We can adaptively choose the patch size between 9×9 and 17×17 using segment information in the target patch. An image can be separated into several regions depending on texture similarity while dominant structures are identified as boundaries of adjacent segments.

In our experiments, we set the maximum window size of patches to 17×17 to achieve high quality results. Next, to prevent undesirable source patch selection, we restrict search region using adjacent segments. We assume that an image is grouped according to texture similarity, thus search area is restricted to adjacent neighbouring regions. The proposed method searches corresponding candidate source regions that contain target region. With this approach, we can reduce the computation time and error propagation.

## V. SYSTEM ARCHITECTURE

This is a system based application and aims for removing the object or any damage part of the image. The filling-in of missing region in an image, which is called image inpainting, is an important topic in the field of computer vision and image processing. Image inpainting has been widely investigated in the applications of digital effect (e.g., object removal), image restoration (e.g., scratch or text removal in photograph), image coding and transmission (e.g., recovery of the missing blocks), etc. The main goal of this process is to fill the missing region/restoring lost part of an image based on the background information. This process reconstruct image in such a way so that the change cannot be noticeable by an observer.

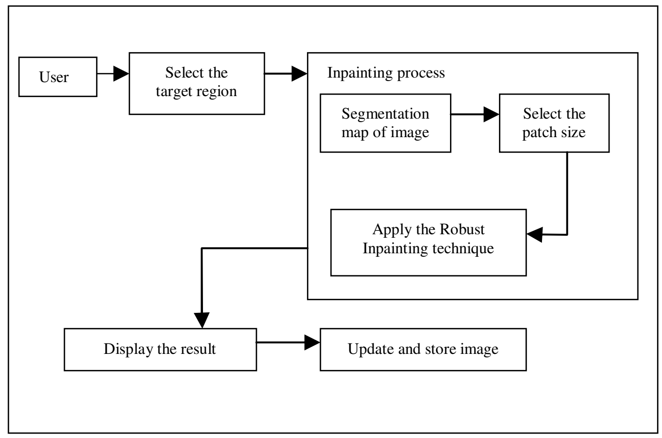



Fig. 2: System Architecture

We propose a robust exemplar-based inpainting method using region segmentation. The proposed method utilizes structure and texture information using a segmentation map. The structure and texture information are used to determine appropriate patch size and candidate source regions and to automatically select robust parameter values. With this approach, we can reduce the number of iterations and error propagation caused by incorrect matching of source patch. Experimental results show the effectiveness of the proposed method with natural inpainting results.

We studied how effectively exemplar algorithm is used for patch selection in image inpainting method. We proposed an inpainting algorithm that produces better completeness of linear edges and reduces the error propagation problem. The empirical results on natural images show better performance than well-known greedy algorithms, and better or similar performance than highly complex algorithms that need to inpaint the full missing part several times until convergence. Instead, our algorithm only needs to inpaint the missing region once and therefore the complexity.

## V. RESULT

When user selects the target region the object is removed from the image. In experiments with a large number of test images and several existing inpainting methods, the

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proposed method shows good performance. Our robust exemplar inpainting gives plausible result in object removal of photographs. Performance of the proposed method is close to that of other inpainting methods that use complex optimization process. Also, the proposed method can be applied to many image processing and computer vision applications. The exemplar based approach is used to removing large objects from digital photographs. The technique is capable of propagating both linear structure and two-dimensional texture into the target region with a single, simple algorithm. Also, segmentation map helps in achieving:

- i Speed efficiency
- ii Accuracy in the Synthesis of texture (less garbage growing).
- iii Accurate propagation of linear structures.

Fig. 3. Result of proposed system showing the source image, segmentation map and the output image.

## VI. CONCLUSION

This paper proposes a robust exemplar-based image inpainting algorithm using region segmentation. Exemplar-based inpainting methods iteratively search the source region and fill the missing or damaged region, i.e., target region, with the most similar patch in the source region. The proposed method uses segmentation map to improve the performance of robust inpainting, in which a segmentation method is used to utilize spatial information in the source region. With the segmentation map, the proposed method automatically selects parameter values of the robust priority function, adaptively determines patch size, and reduces search region. Experimental results with a number of test images show the effectiveness of the proposed method. Future research will focus on the application to hole-filling in DIBR using segmentation and depth information for three-dimensional video systems

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