

Analysis of Exemplar Image Inpainting using Segmentation with Graphcut

Prof. Swati. V. Sinha¹, Ms Yogita.K.Desai²

¹Department of Information Technology, SNJB's LS KBJ COE, swati_sinha_it@yahoo.co.in

²Department of Computer Engg., SND COE & RC, yogitadesai9@gmail.com

Abstract—This paper explains the problem of exemplar inpainting method where there are complex images and multiple objects. To overcome this problem we use Segmentation method where the images are segmented into region using graph cut method. Graph cut algorithm helps to solve the problem by representing the images with lowest cuts. In this method the image is represented in the form of structure of graph. Every pixel of image is shown in form of nodes and vertices where edges are calculated as distance between them. Nodes here are partitioned in such a way that graphs are split in two different subsets. This results in which unwanted object is selected and removed. This approach guarantees smoothing of image and simplify the image segmentation. Once target part is found out with the location of target pixel we calculate Data value and Confidence value using exemplar base approach and also calculate best patch for region filling.

Keywords-Segmentation, Image Inpainting, Exemplar based method, Graph cut, adjacency matrix, degree, volume.

I. INTRODUCTION

Image Segmentation is the defined as the method of dividing and further subdividing an image into several parts where there are ample methods to segment the image. The main aim of this paper is to improve the performance of segmentation techniques and enhance the quality of the output. Graph cut [7] method is introduced for solving the energy minimization in segmentation .Once this method is applied we further analyze the exemplar based inpainting.

There are many different types of segmentation techniques:

1. Region – Based segmentation [12]
2. Minimum – Spanning tree based Segmentation [13]
3. Energy Minimization using graph cuts [14]

Recovery of partially damage, corrupted and modified image plays very important role in Digital Image processing. The technique use to do this is called as Image Inpainting. Different Image inpainting can be adopted for restoration of damage part like Texture Synthesis Base inpainting, PDE Base Inpainting[11],Convolution Base inpainting[16],Fast Digital Image inpainting[12].

Bertalmio et al presented Inpainting method that is base on Partial Differential Equations .PDE based algorithm usually developed to extend geometric features of image .Bertalmio et al proposed algorithm worked on propagating already known information into the missing regions along the direction of isophote[1]. This direction of isophote is obtained by computing a discretized gradient vector and rotating this vector by 90 degree.

Oliveira algorithm proposed Convolution technique with the averaging filter. In this user selects/mask the damaged area manually. Then Algorithm will try find Inpainting contour.

Averaging filter used to compute the averages of pixel surrounding target area to take direction decision. Because of convolution, the speed of the algorithm is improved.

Pyramid-based texture synthesis algorithm proposed by Heeger and Bergen [8]. In this digitized text image and portion of mask/noise image is provided as input. Algorithm restore noise portion by using Image Pyramid. In [8] image pyramid can be a Laplacian Pyramid in which image represented as a sum of shifted, scaled, and dilated effect or it can be a Steerable Pyramid which developed to support orientation text. Histogram comparison method is method is applied to get result.

II. OVERVIEW OF TWO METHOD FOR IMAGE INPAINTING

2.1 Steps for Image Segmentation method using Graph Cut

- 1.) Selecting the Object : This is the initial step where the user selects the object to be removed from the original image.
- 2.) Image Segmentation: In this step , the image is segmented in different regions. Each pixel is classified according to color, texture, intensity which belong to the same region , whereas another region has some different characteristics pixel .
- 3.) Applying Graph cut method: To improve the segmentation images, graph cut method is applied to directed graph or disjoint sets. Mainly graph cut provides energy to every cut in the graph.
- 4.) Applying Exemplar based method: lastly to discard the unwanted object exemplar inpainting based is applied with calculation of confidence term[3] and data term [3] on every pixel to match the perfect patch of target region.

2.2 Graph-Cut Method

Minimum Graph Cut

Basically each pixel is be assumed as node in graph, edges are constructed in between 2 nodes and are assumed as distance between them. The degree of difference between two nodes can be calculated as total weight of the edge that has to be removed. It is called as cut :

$$\text{Cut}(A,B) = \sum_{u \in A, v \in B} w(u,v) \quad [7]$$

Steps for finding the minimum cut :

- 1) At first stage we have to achieve a source node(s) and sink node (t)
- 2) After achieving these two nodes they have to be separated by using cut method i.e they have to be in separate regions.
- 3) Then calculate the capacity of each edge , $C_{ij} = W_{ij}$,where W is the weight of each node.
- 4) Find the maximum flow from s to t , satisfying the capacity constraints ,

Minimum Cut= Maximum Flow [7].

5) To find Maximum flow : Consider:

- $D = (V, E)$ directed graph, $s, t \in V$
- $c : E \rightarrow \mathbb{R}^+$: capacity function

- may assume no arc entering s and no leaving t
- define the value $\text{val}(x)$ of an st -flow x as the amount of flow
- leaving the source s , i.e.,

$$\text{val}(x) = \sum_{e \in \delta^+(s)} X_e$$

The maximum flow problem is to find an st -flow x with maximum value $\text{val}(x)$. The min-cut of the resulting graph will then be segmentation of image. Pixel should be segmented so that they result in the same partition, pixels who are close to each other corresponding to the image.

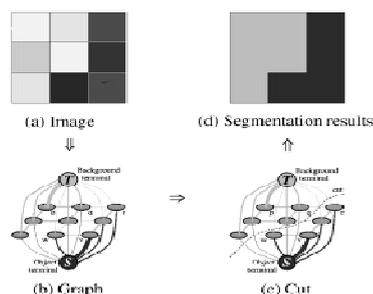


Figure 1: Example segmentation of a very simple 3-by-3 image. Edge thickness corresponds to the associated edge weight.

2.3 Exemplar based Inpainting

Let Ω stand for the region to be inpainted, and $\partial\Omega$ for its boundary. Intuitively, the technique will prolong the isophote lines arriving at $\partial\Omega$, while maintaining the angle of “arrival.” We precede drawing from $\partial\Omega$ inward in this way, while curving the prolongation lines progressively to prevent them from crossing each other.

The Inpainting Methodology is as follows:

1. The global picture determines show to fill in the gap, the purpose of inpainting being to restore the unity of the work.
2. The structure of the area surrounding Ω is continued in to the gap, contour lines are drawn via the prolongation of those arriving at $\partial\Omega$.
3. The different regions inside, as defined by the contour lines, are filled with color, matching those of $\partial\Omega$.
4. The small details are painted in other words, texture is added.

2.4 Exemplar base Image Inpainting

First, given an input image, the user selects a target region, Ω to be removed and filled. The source region, Φ , may be defined as the entire image minus the target region ($\Phi = 1 - \Omega$), as a dilated band around the target region, or it may be manually specified by the user.

The size of the template window Ψ must be specified. We provide a default window size of 9×9 pixels, but in practice require the user to set it to be slightly larger than the largest distinguishable texture element.

In algorithm, each pixel maintains a color value (or “empty”, if the pixel is unfilled) and a confidence value, which reflects our confidence in the pixel value, and which is frozen once a pixel has been filled. During the course of the algorithm, patches along the fill front are also given a temporary priority value, which determines the order in which they are filled. Then, our algorithm iterates the following three steps until all pixels have been filled.

A. Computing patch priorities

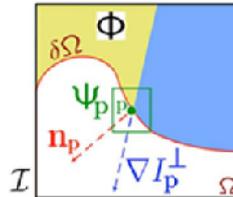


Fig 2. Patch Priority of point p

Given a patch Ψ_p centered at the point p for some $p \in \partial\Omega$ shown in Figure 1. we define its priority $P(p)$ as the product of two terms:

$$P(p) = C(p) \cdot D(p) \tag{1}$$

We call $C(p)$ the confidence term and $D(p)$ the data term, and they are defined as follows:

$$C(p) = \frac{\sum_{q \in \Psi_p} C(q)}{\alpha} \tag{2}$$

$$D(p) = \frac{|\nabla I_p|}{\alpha} \tag{3}$$

Where α is the area of Ψ_p , α is a normalization factor (e.g., $\alpha = 255$ for a typical grey-level image), n_p is a unit vector orthogonal to the front $\partial\Omega$ in the point p and \perp denotes the orthogonal operator. The priority $P(p)$ is computed for every border patch, with distinct patches for each pixel on the boundary of the target region.

During initialization, the function $C(p)$ is set to $C(p) = 0, \forall p \in \Omega$, and $C(p) = 1, \forall p \in I-\Omega$.

The confidence term $C(p)$ may be thought of as a measure of the amount of reliable information surrounding the pixel p . The intention is to fill first those patches which have more of their pixels already filled, with additional preference given to pixels that were filled early on (or that were never part of the target region).

The data term $D(p)$ is a function of the strength of isophotes hitting the front $\partial\Omega$ at each iteration. This term boosts the priority of a patch that an isophote “flows” into. This factor is of fundamental importance in algorithm because it encourages linear structures to be synthesized first, and, therefore propagated securely into the target region.

B. Propagating texture and structure information

Once all priorities on the fill front have been computed, the patch with highest priority is found. We then fill it with data extracted from the source region

C. Updating confidence values

After the patch Ψ has been filled with new pixel values, the confidence $C(p)$ is updated in the area delimited by Ψ as follows:

$$C(p) = C(\hat{p}) \quad , \quad \forall p \in \Psi \hat{p} \cap \Omega.$$

This simple update rule allows us to measure the relative confidence of patches on the fill front, without image-specific parameters. As filling proceeds, confidence values decay, indicating that we are less sure of the color values of pixels near the centre of the target region. To improve this we will use Wavelet transform for guide the confidence values.

CONCLUSION

In this paper, we have analysed about graph cut and segmentation. For each of the algorithms, we have reviewed and provided a detailed explanation of for region filling and how graph cut method can help segmentation

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