

Object Removal from Digital Image in image Inpainting using Novel Framework

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Abstract— This paper aims for developing a function to remove unwanted object from digital photograph. Lacuna region is filled by using colour distribution analysis, sub-patch texture synthesis and weighted interpolation. Colour distribution analysis is used to obtain the neighbourhood characteristics of pixels to define relationship among the pixels. Weighted interpolation or Sub-patch texture synthesis method is used to synthesize the lacuna region which is determined by colour distribution analysis. Weighted interpolation is used to minimize the exhaustive computation time. Faulty region can be repainted by using artefact detection mechanism without human interaction. This algorithm aims to develop a object removal function for digital camera.

Keywords— Image inpainting, Segmentation, Colour distribution analysis, Sub-patch, Weighted Interpolation

I. INTRODUCTION

Image inpainting is the art of reconstructing the missing portions of images. It can remove selected portion from image and fill the whole left behind in a visually plausible way using background information. Object removal is a technique of removing object from digital image and fill the remaining portion i.e. lacuna region using information of neighbouring pixels characteristics. The problem of guessing the lost region from remaining part of image is introduced from image inpainting algorithm and texture synthesis. Work of texture synthesis is divided into three categories. Synthesizing texture by simulating physical generation process is first category [1]-[2]. Second one is parametric model by texture analysis of input texture and synthesizing output texture [3]-[4]. Last one is of texture synthesis algorithm. At each time one pixel is synthesized in Pixel based texture synthesis method [5]-[7] which requires much computation time. Structural features cannot be reconstructed in pixel based texture synthesis method. Patch-based texture synthesis algorithms are introduced to maintain the global features of texture [8]-[9].

II. METHODOLOGY

Methodology of proposed algorithm is as shown in fig 1. To get the lacuna region first we perform edge detection on input image followed by segmentation. Segmentation is the process of partitioning an image into its constituent parts, used to locate object and boundary in image. Color distribution analysis is used to determine

the threshold value to decide which method is used i.e. weighted interpolation method or sub-patch texture synthesis in lacuna region. Threshold value acts as switch between weighted interpolation method and sub-patch texture analysis. In case of faulty region, artifact detection mechanism is used for automatic repainting without human intervention.

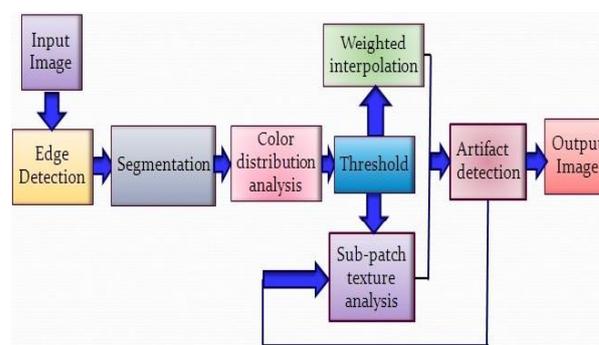


Fig.1: The Framework for object removal algorithm from Digital image

A. Edge Detection

Edge detection is process of detecting and locating sharp discontinuities in an image. Edge detection is used as fundamental step in identifying boundaries of the object.

B. Segmentation

Segmentation is used get the required lacuna region. Segmentation is based on two types one is discontinuities and other is based on similarities. Thresholding is the simplest method of segmentation.

C. Colour distribution analysis

Colour distribution analysis is used to decide the proper method for region filling of the lacuna region. The proposed algorithm uses colour distribution analysis for deciding whether the sub-patch algorithm or weighted interpolation algorithm should be applied. The spatial structure and colour distribution near the lacuna region can be distinguished by colour distribution analysis.

i) Determining Characteristics value

Characteristic value $\beta(\pi)$ is the sum of standard deviation in RGB channel which will be computed as

$$\beta(p_i) = \sqrt{\frac{\sum (R(p_k) - \bar{R}(p_i))^2}{X_i}} + \sqrt{\frac{\sum (G(p_k) - \bar{G}(p_i))^2}{X_i}} + \sqrt{\frac{\sum (B(p_k) - \bar{B}(p_i))^2}{X_i}}$$

Where, X_i =Number of valid pixels in i th block, $R(p_k)$, $G(p_k)$, $B(p_k)$ = Colour value at pixel p_k in RGB channels, $\bar{R}(p_i)$, $\bar{G}(p_i)$, $\bar{B}(p_i)$ = Mean colour value of X_i valid pixels centered at p_i in RGB channels.

ii) Mapping the classification map

Classification map is obtained by marking characteristic value of each pixel of lacuna region. Due to colour distribution texture region will be classified as homogeneous texture region characteristic value above the threshold value belongs to inhomogeneous texture region otherwise it is homogeneous texture region.

iii) Determination of Filled part and Synthesized part of lacuna region

For deciding texture type of a region in each row the colour distribution analysis and region filling Procedure are done in parallel, so that already filled pixels are taken into account.

D. Sub-patch texture synthesis

Pasting a sub-patch (line) each time with great efficiency and regularity is the main feature of sub-patch texture synthesis technique. It includes three parts:

i) Defining the notations

Input image is partitioned into source region and lacuna region. There are two patch pairs: One is current patch P_{cr} and its spatial neighbourhood $S(P_{cr})$, another one is candidate patch P_{ca} and its spatial neighbourhood. Frequency response of steerable filter decomposition of the adjacent source region of the lacuna region is used to determine direction of neighbourhood which is helpful searching the best candidate patch.

ii) Determination of L and U shaped orientation by Steerable pyramid decomposition

In sub-patch texture synthesis, lacuna region is synthesized by comparing similarities of the neighbourhood of current patch and neighbourhood of candidate patch. Frequency response of steerable pyramid is used to determine direction of neighbourhood. The current patch of lacuna region will be synthesized by neighbourhood in the horizontal orientation.

iii) Adaptively searching the best candidate patch

Two primary models of sub-patch technique are L-shaped and U-shaped for the neighbourhood. To maintain the causal property the neighbourhood of each patch must include only the original source region. Number of pixels in the neighbourhood of current patch and candidate patch

For L-shaped orientation is given by,

$$PH \times PL + \sum_{i=1}^{PH} 2 \times i$$

and For U-shaped orientation is given by,

$$PH \times PL + \sum_{i=1}^{PH} 4 \times i$$

Where, PH = Patch Height, and PL = Patch Length.

After deciding the direction of L-shaped or U-shaped neighbourhood, the size of neighbourhood is determined. Smooth image requires larger neighbourhood size and structural image needs smaller neighbourhood size.

Neighbourhood of the current patch is compared with all possible neighbourhoods of the candidate patch to determine the pixel values of current patch. Patch length can be set manually. Best candidate patch is searched from source region, best candidate patch with highest level of similarity denoted $N(P_{ca})^*$, replaces current patch quality of output image will be dominated by features of similarity criterion.

E. Weighted interpolation

The colour distribution analysis decide the direction. This method is used to infer the filled part of lacuna region. Pixel in the same row of source region is used to infer the filled part of lacuna region. The target region pixels and sample pixels belongs to target region are calculated as below.

$$P(R_i) = \frac{(\sum_{i=n-2}^{n+2} W_i \times P(L_i)) + (\sum_{i=n-2}^{n+2} W_i \times P(M_i))}{2}$$

Where, W_{n-2} , $W_{n+2} = 0.05$, W_{n-1} , $W_{n+1} = 0.25$, $W_n = 0.4$,

$$\begin{aligned} P_{n+1} &= 2 \times P_n - P_{n-1} \\ P_{n+2} &= 2 \times P_n - P_{n-2} \\ P_{n-1} &= 2 \times P_n - P_{n+1} \\ P_{n-2} &= 2 \times P_n - P_{n+2} \end{aligned}$$

Here, $P(L_i)$ and $P(M_i)$ are pixels in the source region, $P(R_i)$ are pixels in the target region, n denotes column or row in the image, and W_i are the weighting value of the pixels.

F. Artifact detection mechanism and resynthesizing

The user can apply the artefact detection mechanism to filled region in order to provide robust quality of output image, if the result is not satisfactory after first pass of region filling. The spatial region violation problem is based on the Sobel and Kirsh edge operator.

The proposed technique uses colour ratio gradients to detect the violation regions and it is based on texture similarities. To calculate the colour ratio gradients an offset value is added. The image is divided into number of blocks with particular size of pixels. Every block which is present in the target region is compared with the surrounding blocks by intersection of histogram. When the histogram intersection value is over the threshold value which is more than four neighbourhood blocks then that block is considered as the violation block rather than the boundary of different textures.

➤ **Faulty Region Repainting**

The violation region is fixed by applying repainting to the faulty region after artifact detection technique. Also the proposed technique uses the algorithm of sub-patch texture synthesis to fill those regions.

III. EXPERIMENTAL RESULTS

We use MATLAB R12 and other test images for evolution of this proposed algorithm.

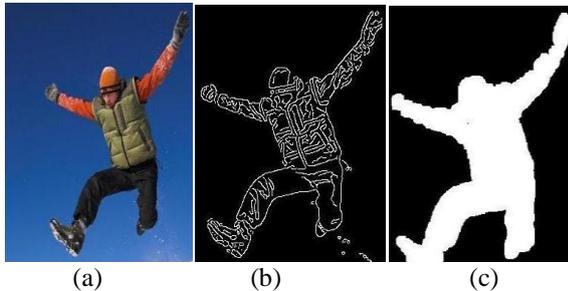


Fig 1: (a) Original Image, (b) Edge detected Image, (c) Segmented Image.

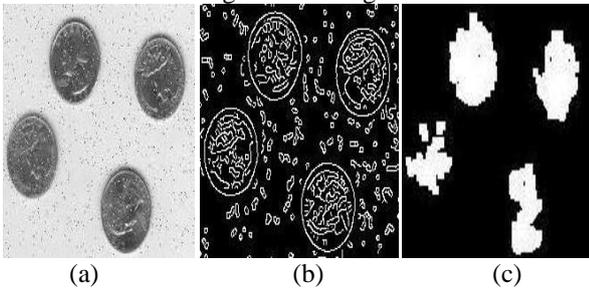


Fig 2: (a) Original Image, (b) Edge detected Image, (c) Segmented Image.

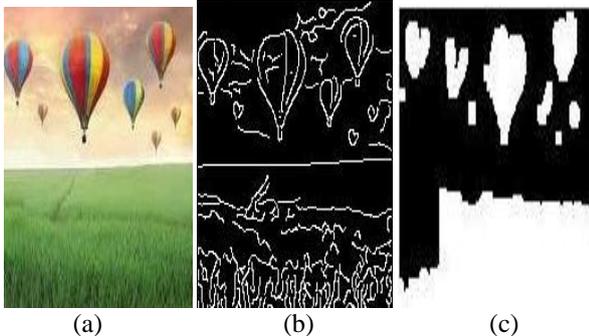


Fig 3: (a) Original Image, (b) Edge detected Image, (c) Segmented Image.

IV. CONCLUSION

There are various algorithms available for edge detection process. The canny edge detection algorithm has ability to detect the weak edges more accurately than that of sobel edge detection algorithm as well as prewitt edge detection algorithm. In this paper, we use canny edge detection algorithm for object detection. The process of partitioning of an image is done by using segmentation technique. This proposed technique uses the edge based segmentation. The segmentation is done depending on similarity type that is thresholding is used.

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