



A Rational Approach for Detecting and Removing Cracks from Digitized Paintings

* Deepika Pagotra **Er. Navneet Kaur

**Student (M.Tech) Deptt. of Computer Engineering, Punjabi University
 **Assistant Professor, Deptt. of Computer Engineering, Punjabi Univeristy*

Abstract—The quality of historical art work related painting around several hundreds of years, which are still available for reference today and which is preserved by museum and universities all around the world, is poor due to physical deterioration. Digital image processing techniques are necessary to improve the legibility of the paintings. Cracking is one of the most common deteriorations found in old masters paintings. Old paintings are great resource of transferring information from one generation to another. So it is very important to restore them. In this paper we present a fuse method for crack detection and virtual restoration of old deteriorated paintings.

I. INTRODUCTION

Old paintings are painted by hand not reproduced by any mechanical process. This especially makes them genuine, veritable and valuable but in the intervening time, more unguarded to deterioration. Cracking is one of the most common deteriorations found in old masters paintings; it is a sign of the inevitable ageing of materials and constitutes a record of their degradation. Generally speaking, a crack (or craque-lure) visible in paint layers when pressures spread within or on it through the action of various factors and cause the material to break [1]. The condition of preservation of a painting is mainly influenced by climate changes such as variations in temperature, relative humidity or pressurization [2]. Cracks figure undesired pattern that can be either rectangular, circular, web-shaped, unidirectional, tree- shaped or even entirely random[3].The way in which they manifest themselves and spread partly depend upon the choice of materials and methods used by the artist. This makes cracks useful for judging authenticity, as is proposed in [4]. Cracks can also assist conservators by providing clues to the causes of degradation of the paint surface. This can be used for degradation monitoring of the paint layer or a more in-depth study on which factors contribute to the formation of cracks, so that steps can be taken to reduce them.

Though, one can make use of digital image processing techniques to detect and abolish the cracks on digitized paintings. The proposed method for old cracked painting restoration shall perform more efficiently than the previous method. In the proposed method, first we target the problem of crack detection from the digitized paintings. Then we apply inpainting for crack filling.

The rest of the paper is structured as follows. The details of the proposed methodology are described in section 2.in section 3 application are discussed. An inpainting results on

digital cracked painting is presented in section 4. finally the conclusion is discussed in section 5.

A typical virtual restoration system of digitized cracked painting has mainly four functional blocks which explains the main working strategy of the restoration system is given in Figure 1.

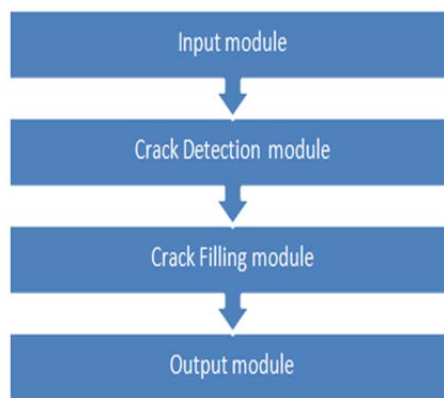


Figure 1 Basic Restoration System of Cracked Paintings

II. PROPOSED METHODOLOGY

The central idea of proposed work is same as the painters use for restoration of old cracked paintings. First of all they find cracks and then fill them with colors by most appropriate color information available. They do the whole painting for more visually pleasing result. In this work, firstly identification of the cracks is done and then fills them by the using improved exemplar based inpainting. This is some kind of Image processing with retouching or we can say repairing the images .In the proposed system detection method is employed which contains multi-scale morphology and then for filling or restore the image the improved exemplar based inpainting method.

Crack detection

Cracks can visually be categorized into two classes; bright cracks on a dark background and dark cracks on a bright background. Different crack detection techniques include simple thresholding, line detectors and various morphological filters.

A popular technique to detect details with particular size is the use of a morphological filter known as the top-hat transformation[5] which has already been successfully applied in crack detection [3,6,7]. For the detection of dark cracks on a lighter background we use the black top-hat (or closing top-hat) transform BTH which is defined as the difference between the morphological closing $(f \bullet g)$ of a

grayscale image I using a structuring element g and the input image f and results in a grayscale image with enhanced details.

A similar technique can be employed for the detection of bright cracks by replacing the blacktop-hat transform with a white top-hat (or opening top-hat) transform WTH which is defined as the difference between the input image f and its opening $(f \circ g)$ by a chosen structuring element g .

The opening and closing operations are defined, respectively, as:

$$(f \circ g) = \text{Dilation}(\text{Erosion}(f, g), g)$$

$$(f \bullet g) = \text{Erosion}(\text{Dilation}(f, g), g)$$

where, f is the image, g is the structuring element, \circ denotes the opening operation and \bullet denotes the closing operation

Multiscale top-hat: Morphological filtering performs image enhancement using the morphological top hat transform corresponding to the size/scale of the used structuring element. A morphological operation with a scalable structuring element can extract features based not only on shape but also on size. Also features of identical shape but of different size are now treated separately. Such a scheme of morphological operations where a structuring element of varying scale is used is termed as multi-scale morphology.

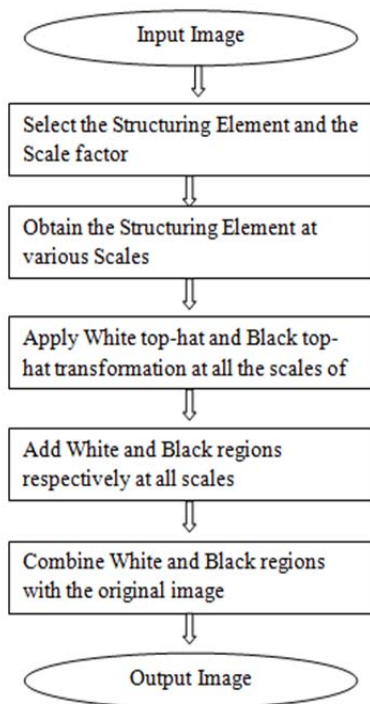


Figure 2 Multiscale Top-Hat

Suppose, there is a sequence of multi-scale structuring elements with the same shape and increasing sizes: $g_0, g_1, g_2 \dots g_m$, where g_i is obtained as the result of i times the dilation of g_0 with g_0 , $1 \leq i \leq m$. The white (WTH) and black (BTH) image regions at the i th scale can be extracted as follows.

$$WTH_i = f - (f \circ g_i)$$

$$BTH_i = (f \bullet g_i) - f$$

Compute the sum of white and black image regions extracted separately at all scales as follows.

$$fw = \sum_{i=1}^m WTH_i$$

$$fb = \sum_{i=1}^m BTH_i$$

where, fw is the extracted white multi scale image regions and fb is the extracted black multi scale image regions at all scales.

The final extracted white and black image regions given by fw and fb , the image f could be enhanced as follows.

$$fr = f + fw - fb$$

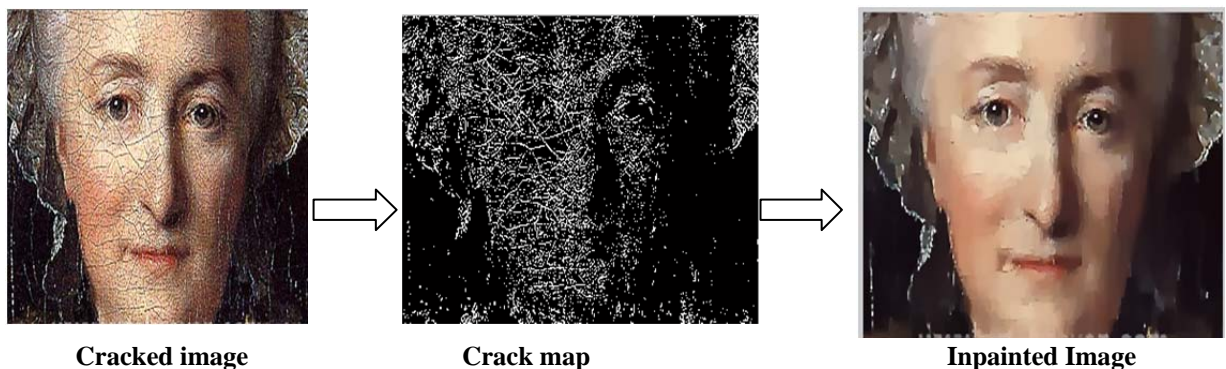
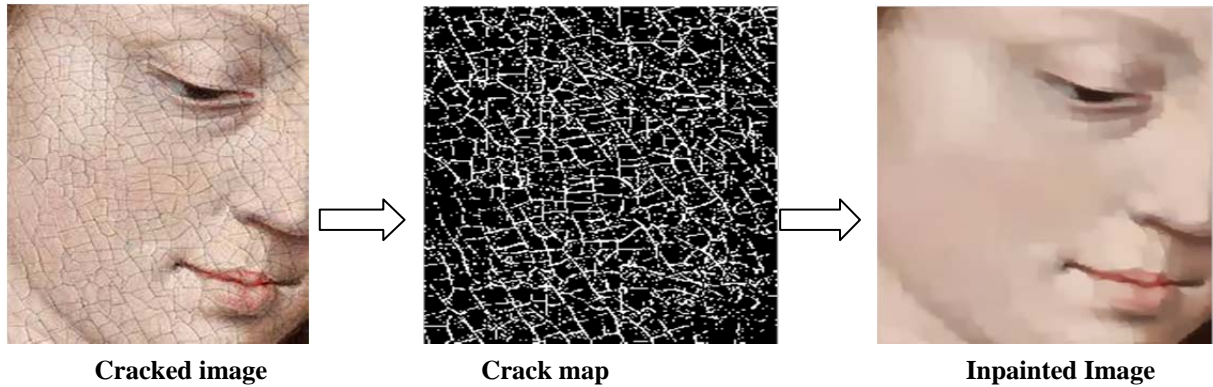
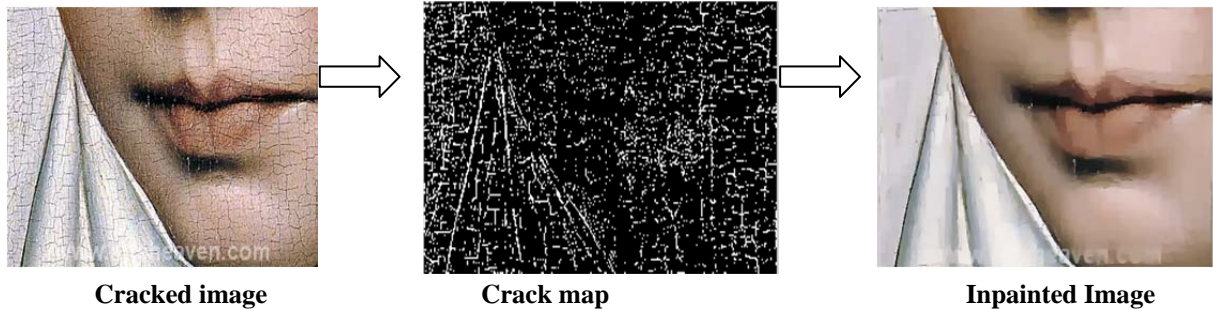
where fr denotes the resulting enhanced image obtained using the multiscale morphological technique.

Inpainting

Inpainting is a practice to redeem missing data or manually eradicate data from an image. This procedure is carried out in such a way that it seems rational to human eyes. The lost part of the image is filled with the residual available data of the image. Inpainting can be done using various techniques, mainly variation based, exemplar based and wavelet based. In this paper, exemplar based image inpainting techniques is used and an algorithm which improves and extends the previously proposed algorithm is presented [8]. Instead of searching the entire image, the approach has reduced the search region by searching the nearby pixels since most of the applicable information lies in neighbouring pixels which reduces time to complete inpainting. This method is principally used for abolishing objects and cracks from the image. In the earlier period, this problem has been addressed by two modules of algorithms: “texture synthesis” algorithms for generating large image regions from sample textures and “inpainting” techniques for filling in small image gaps [9]. Texture synthesis focuses on the texture part of image while inpainting focuses on the structural part of image. Exemplar based image inpainting is a combination of both of the above techniques, hence this technique can reconstruct structural as well as texture part of an image. In this inpainting approach user selects the target region which is to be restored then algorithm automatically starts filling in that region using the available information from the source region. The algorithm starts filling automatically because in this approach user does not have to specify where to search for that information. Filling proceeds based on the pixel’s priority, higher the priority faster the pixel gets filled. Priority of pixel is high if pixel lies on isophote lines receiving at the regions boundaries.

Steps Involves:

1. Load a image
2. Convert rgb image to grayscale image.
3. Take gradient of image
4. Rotate gradient to 90 degree.
5. Contour and normalize gradient.
6. Find confidence and data term
7. Compute patch priority
The formula for finding priority is given by:
Confidence term*data term.
8. Select the pixel with the highest priority having patch.
9. Find patch with minimum error.
10. Fill the region.
11. Update the confident term and data term.
12. Repeat until full inpainting is done.



III. APPLICATION

1. Restoration can provide clues to art historians, museum curators and the general public on how the painting would look like in its initial state, i.e., without the cracks.
2. Old artwork is very important for one's heritage, it has been used for conveying one's culture from one generation to another, our proposed system can be used for the of artwork conservation of one's heritage
3. It applied to analysis, preservation and restoration
4. It can be used as a non destructive tool for the planning of the actual restoration.

IV. SIMULATION RESULT

In this section, a set of images are considered to estimate the performance of the planned cracked painting restoration algorithm, and the digitized paintings used here for simulation have been sourced from internet [10].

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