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A PATH FOR HORIZING YOUR INNOVATIVE WORK

DETECTION OF CRACKS IN IMAGES

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Abstract: In this paper I have studied method for crack detection in images and paintings. This can be done by thresholding the output of morphological Top-Hat Transforms.

Keywords: Top-hat transforms, detection of cracks, virtual restoration of paintings, dilation, structuring element

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INTRODUCTION

Detection of cracks is the first step in the restoration of images. The restoration of digitized paintings gives art historians and museum curators clues as to how the painting originally appeared. This can then be used as a nondestructive tool in actual restoration of the paintings. A method that can detect cracks is presented here. There are various ways to detect cracks like use of multi oriented Gabor filters which rely on information got from adjacent frame for artefact detection. In this paper the method used for crack detection is top-hat transforms which in itself employs techniques like opening, closing, erosion and dilation of image processing. The cracks are obtained by thresholding the output of the Top-Hat transforms. This is executed in real time and thus the user can study parameter tuning on the image that is under study and choose values that give optimal and good visual results.

- **DETECTION OF CRACKS**

Top-Hat Transforms- Cracks are characterized by low luminance and can be thought of as local intensity minima with long structural characteristics. Thus we can apply crack detector to luminance component of the image to identify these minima. Top hat transform is a grayscale morphological filter defined as :

$y(x)=f(x)-f_{nB}(x)$ - (1)

where $f_{nB}(x)$ is opening of the function f(x)(here it is the luminance component) and nB is the structuring set defined as

$nB = B \oplus B \oplus .... \oplus B$ (*n times*) - (2)

Where $\oplus$ denotes dilation operation. Structuring

element B used can be a square or a circle. The

structuring set *nB* is evaluated only once using (2) and then used in (1). The opening function f_{nB} is a low pass non-linear filter which erases all peaks in which the structuring element *nB* cannot fit. Thus $f- f_{nB}$ contains only those peaks and no background at all. Top hat transforms should be applied to only the negated luminance image since cracks are local minima and not maxima. We can also detect cracks by using closing operation on original image *f(x)* with structuring set *nB* and the subtracting *f(x)* from the resulting closing $f^{nB}(x)$

$y(x)= f^{nB}(x)- f(x)$ -(3)

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the result of (3) is identical to that of applying (1) on negated image.

In cases where crack like artifacts have high luminance, negation of image before crack detection is not necessary as crack detection procedure can be directly applied on luminance of the image.

We can control the crack detection procedure by choosing choosing the appropriate values for the following parameters:

- The type of structuring element B;
- The size of structuring element B and the number of dilation used in (2)

These parameters affect the final structuring element and should be chosen according to the thickness of the cracks to be detected.

The output of top hat transform is a grayscale image m(k,l) where pixels with large grey values are cracks or crack like structures. Thus thresholding operation on m(k,l) is needed to separate cracks from the rest of the image. Threshold T is chosen by trial and error process. The result of thresholding gives a binary image b(k,l) which marks the possible crack locations. It is preferable to select threshold where less cracks are detected than the one which detects all cracks but also wrongly identifies cracks and changes the image structures.

III. EXPERIMENTAL SETUP

The test setup was designed for detecting cracks in digitized paintings from different periods for the first step in its virtual restoration. The first few paintings which were tested had many crack like artifacts. The

parameters chosen for the structuring element were as follows:

- Structuring element type: square
- Structuring element size: 3X3
- Number of dilations in (2) : 2

The processing and analysis of the image data is done using MATLAB R2012a. The cracks in selected image are detected using crack detection algorithm published by MATLAB.

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Method to detect crack in image:

1) First load the image.

2) The image is then converted to grayscale (f(x)).

3) A square 3X3 structuring element is used to evaluate a structuring set nB.

4) Then the possible openings in the painting are found using the structuring set.

5) These opening are then negated from the grayscale image to give the cracks.

IV. RESULTS

Figure 1) Original image

Figure 2) Greyscale image

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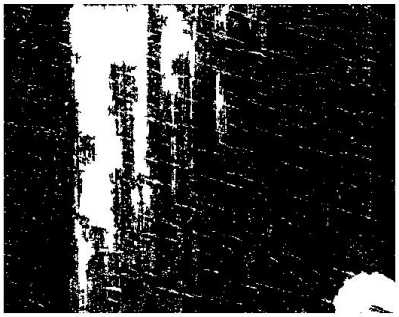

Figure 3) Openings in the image

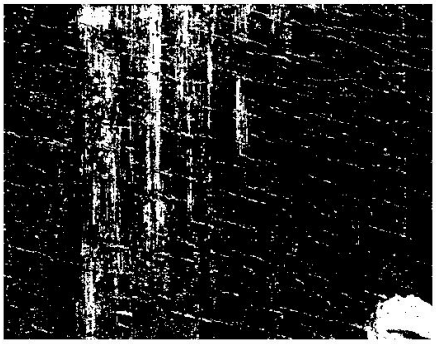

Figure 4) Thresholded output of top-hat transform

V. CONCLUSION

In this paper we have presented a method for crack detection in images. Cracks are detected by using of top-hat transform. This method can be applied as a first step in virtual restoration of paintings. This can be further improved as crack detection is not very efficient in dark image areas as the intensity of the crack pixel is very close to the intensity of the neighboring pixels. Solution for this would be application of crack detector locally and selection of very low threshold value. This method is not accurate on digitized paintings as it detects certain brush strokes also as cracks. This can then be rectified by using methods that will separate the brush strokes from cracks, this can be used further in restoration of paintings and images.

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