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# Image Restoration of Damaged Mural images based on Image Decomposition

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***Abstract***—The most significant challenges in image processing and pattern recognition is image decomposition and restoration. Image Restoration is the operation of taking a noisy image and estimating the clean, original image. Corrupt image may come in many forms such as motion blur, noise and camera mis-focus. Restoration is a process of eliminating degraded noise and increases the quality of image. Image decomposition is to decompose an image into its component structures. When two image signals are considered, a combined image signal should contain the image structure of both these signals In this paper, the mural images are decomposed into cartoon component or geometrical part of blurred images and Texture component or small scale special pattern using Bilateral filter. In cartoon component augmented Lagrangian method has been used to fill the missing pixel. In texture component the blurring can be removed using median filter and conservative filter. Median filter is used to remove noise and conservative filter is used for smoothening the image. By using these filters, degraded mages can be restored successfully. The restoration efficiency can be measured with MSE (Mean Square error) and PSNR (Peak Signal to Noise Ratio) parameter. Various mural images have been analyzed and tested. The accuracy is comparatively better than the existing.

***Keywords***— Image restoration, Cartoon component, Texture component, Image decomposition.

## I. INTRODUCTION

Image decomposition and restoration are two crucial problems in image processing. In image decomposition, image is divided into two components such as cartoon component and texture component. Cartoon component is the sketchy approximation or geometrical part of an image and the other is the small scale special patterns or oscillating part of an image. These two components plays a major role in object identification, astronomical imaging, biomedical engineering, segmentation and inpainting problems .The main task is to elicit the cartoon and texture parts from the degraded images. For image enhancement and visual quality evaluation applications, just noticeable difference (JND) estimator is more convenient, because the transformation from substand is eliminated. The procedure of improving the quality of the image and the degradation parts are done in image restoration which is nothing but recovering the original image from degraded image with or without pixels by reversing the physical degradation parameters such aslinear motion, defocus, additive noise and atmospheric[1].

In Anmin Liu, Weisi Lin, Manoranjan Paul, Chenwei Deng and Fan Zhang proposed total-variation based image decomposition to decompose image into structural image. In Michal k Ng, Xiaoming Yuan and Wenxing Zhang used augmented Lagrangian method to regularize cartoon and texture parts. Blurred images can be restored and the clarity of image is measured using Signal-to-Noise Ratio.

## II.LITERATURE SURVEY

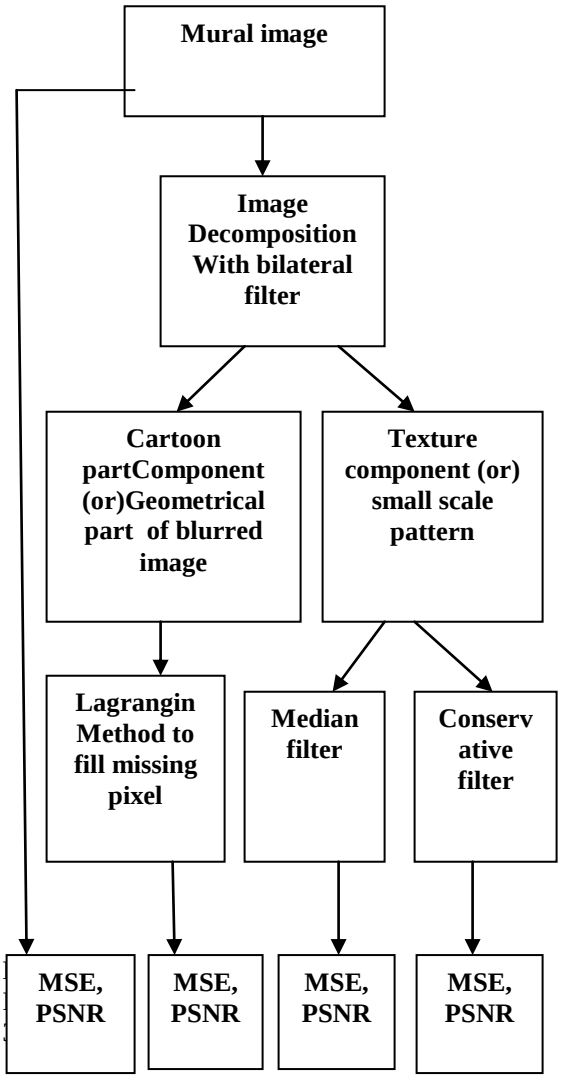
M. Bertalmio, L.Vese, G.Sapiro and S .Osher[5] this paper addresses the simultaneous filling in texture and structure in region of missing image information is presented in this paper. Initially, the image is decomposed into the sum of two functions with different basic characteristics, and each one of these functions is reconstructed separately with structure and texture filling in algorithm. The original image is then reconstructed by adding two sub images.

J.F.Aujol, G.Gilboa, T.Chan and S.Osher [6] this paper proposes to construct an algorithm to split an image into a sum of a bounded variation component and a component containing the textures and the noise. To find the decomposition by minimizing a convex functional which depends on the two variables u and v, alternately in each variable. Each minimization is base on a projection algorithm to minimize the total variation to carry out the mathematical study of our method. It presents some numerical results. In particular, to show how the u component can be used in non textured SAR image restoration.

Stanley Osher, Ansres Sole and Luminita Vese[2] this paper also continues the ideas introduced by the authors of previous work on image decomposition models into cartoon and texture component. Which follows results of Meyer. Indeed, by the alternative formulation, an initial image *f* is decomposed here into a cartoon part *u* and a texture or noise part *v*. The *u* component is modeled by a function of bounded variation, while the *v* component is modeled by an oscillatory function, bounded in the norm dual formation.

## III.METHODOLOGY




### *A. IMAGE DECOMPOSITION*

By using bilateral filter, the given image is decomposed into cartoon and texture parts. It is non-linear, edge-preserving and noise-reducing smoothing filter [1].

- The bilateral filter is defined as:

$$I(xi) - I(x)||)gs(||xi - x||)\ Ifiltered(x) = \Sigma\ I(xi)fr(||xi - x||)$$

xi€Ω

where:

- Ifiltered is the filtered image
- I is the original input image of to be filtered
- X are the coordinates of current pixel to be filtered
- Ω is the window centered
- fr is the range kernel for smoothing difference intensities. This function is can be a Gaussian function

gs is the spatial kernel for smoothing difference coordinates. This function can be a Gaussian function
The bilateral filter has several qualities that explain it:
Its formulation is simple

- It depends on two parameters that indicate the size and contrast of the features to preserve
- It can be used in a non-iterative manner. This make the parameters easy to set since their effect is not cumulative over several iterations
- It can be computed at interactive speed even on large images [1].

For image decomposition, initially bilateral filter parameters such as half-width (w) and standard deviation (sigma) of image abstraction parameters are set. Then grayscale or color bilateral filtering is applied to the black and white and color image respectively.

In the grayscale bilateral filtering, Gaussian distance weight is computed. Local region of the given image is extracted. Gaussian intensity weights and bilateral filter response to calculated. In the color bilateral filtering, the given color image which is in sRGB color space is converted into the CIELab color space. Then the process which is done the grayscale filtering is performed. Finally the filtered image is converted back into RGB color space. After performing the grayscale or color bilateral filtering, gradient magnitude of luminance is determined by using this magnitude simple edge map is created. Finally, gradient edges are added to the quantized bilaterally filtered image. Thus cartoon part is extracted from the image. From this component, texture part is retrieved [1].

*a. Cartoon Component*

Knowing that texture synthesis algorithms exist to accurate fill in regions of missing texture, and image inpainting algorithms exist to fill in regions of missing image structure, a method is desired in decomposing a given image into two sub-images. One sub-image will be a structure image which will be a cartoon-like version of the input image where large-scale edges are preserved but interior regions are smoothed. The other sub-image will be a texture image which will

contain all of the texture information of an image, including noise. These sub images can then be reconstructed using I mage inpainting and texture synthesis techniques [2]. The output image of cartoon component is shown in fig1 (b)

*i. Augmented Lagrangian method*

Augmented Lagrangian method are certain class for solving constrained optimization problem. They have similarities of methods in that constrained optimization problems and series of unconstrained problems and add a penalty term to the objective; the difference is that the augmented Lagrangian method adds yet another term, designed to mimic a Lagrange multiplier[.4 ]

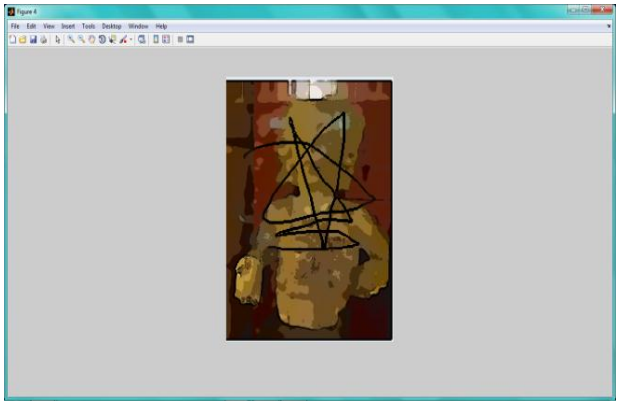


Fig. 1 output image of cartoon component using lagrangian method

*b. Texture Component*

The aim of this texture part is to reduce the sophisticated norms to capture oscillating patterns. In particular he proposed a weak norm dual of the TV norm, T(v) = ||v||G where the space G contains signals with large oscillations, and thus in particular textures and noise, use the H−1 norm to extract high frequency patterns. Hilbert norm defined by some symmetric positive kernel K, T(v) = hKv, viL2 . They showed an example where the Hilbert norm promotes a single frequency in the extraction of the texture. Similarly to the cartoon case, several approaches are based on the sparsity of the texture in a well chosen dictionary. The morphological component analysis of uses a local cosine dictionary to model oscillating patterns. It improves this fixed sparse regularization by using an adaptive grouplet frame for geometric textures that makes use of a local orientation field [2]. The output of texture component is shown in fig2(i) & (ii).

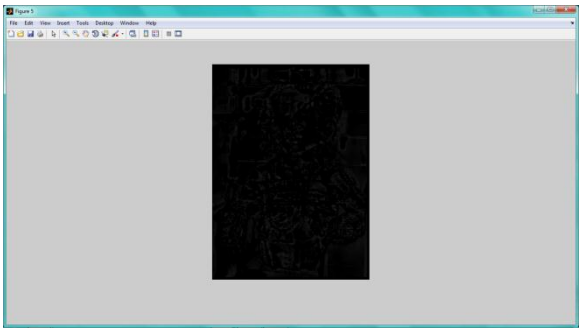


Fig 2

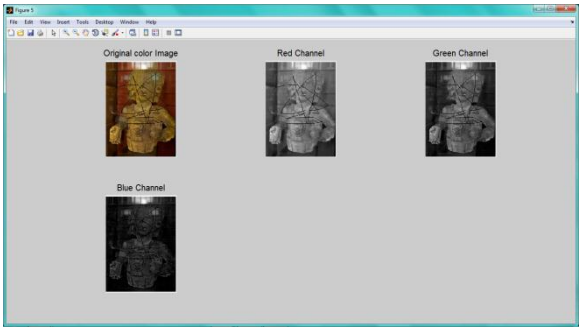



Fig 3

Fig. 2 i) output image of Texture component using median filter ii) output image of Texture component using conservative filter

*i. Median filter*

The median filter is an effective method, that can be used to distinguish out-of-range isolated noise from legitmate image features such as edges and lines. Specifically, the median filter replaces a pixel by the median, instead of the average, of all pixels in a neighborhood $w$ [4]

$$Y[m,n] = median\{x[i,j],(i,j) \in \omega\} \quad (1)$$

*ii. Conservative Filter*

It is a noise reduction technique. It derives its name is a simple, fast filtering algorithm. It reduces noise suppression power in order to preserve the high spatial frequency in an image.[4 ]

*B. IMAGE RESTORATION*

Image restoration refers removal or minimization of degradations in an image. This includes de-blurring of images degraded by the limitations of a sensor or its environment, noise filtering, and correction of geometric distortion or non-linearity due to sensors.

After decomposition of red, green and blue channels are separated. The noise is calculated for individual channel. Finally, all noise images are removed by using median and

conservative filtering concepts. Median filter is a non-linear filter that removes the small moderate levels of noise such as speckle and salt & pepper noise. Main idea of this filter is to run through the signal entry by entry with the median of neighboring entries. The pattern of neighbors is called the"window", which slides entry by entry over the entire image. If the window has an odd number of entries, then the median is just the middle value after all the entries in the window are stored numerically.. Conservative filter is also a non-linear smoothing filter. It ensures that the value of the output pixel is within the bounds of its neighbors. The maximum and minimum values of the pixels adjacent to input pixel are calculated. If the input pixel is within this range, it is not be changed. If it is greater than its largest neighbor, then the output pixel is set to that maximum value. Similarly, if it is less than its smallest neighbor, then the output is set to that minimum value. It does not involve any averaging so conservative smoothing preserves edges [3]. The output of Restored image is shown in fig3.

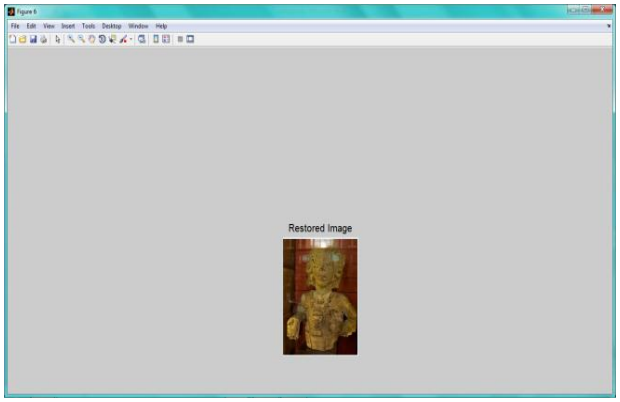



Fig 4 output of Restored image

## I. DATA SET

Experimental data of Mural Images have been collected from www.google.com[4]

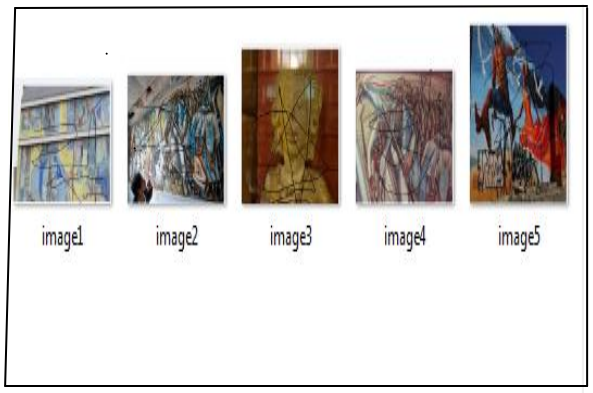



Fig 5. Data Set of Mural Images

## II. EXPERIMENTAL RESULTS

Mural Images were used for experimental analysis. Filtering Technique has been applied to restore the images. Performance Measurement such as Mean Square Error (MSE), Peak Signal Noise Ratio(PSNR) were calculated.

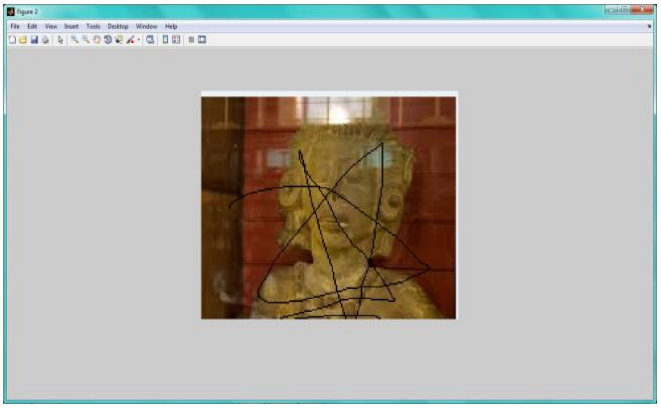


Fig 6 Input Image

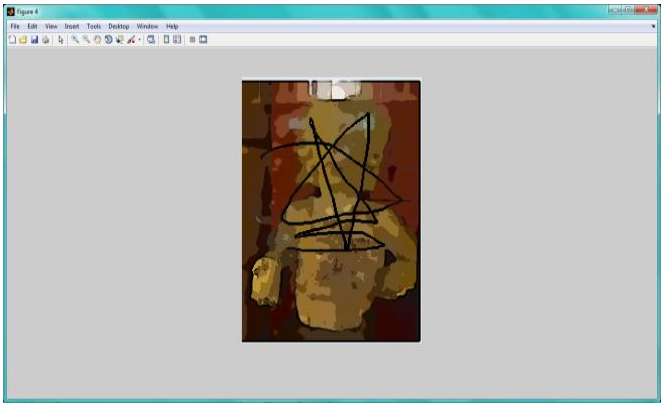


Fig 7 Decomposition of Cartoon Part using bilateral

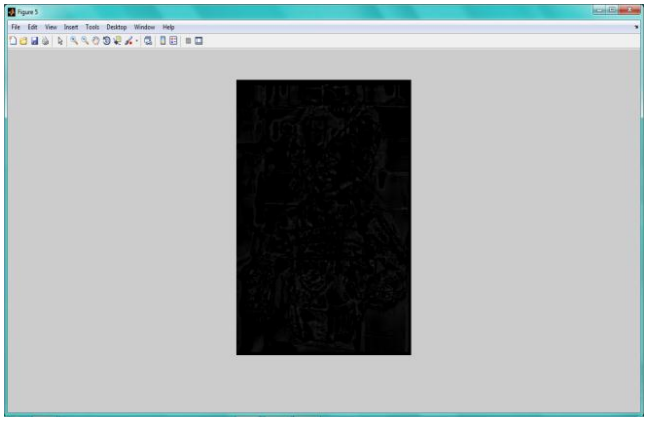


Fig 8 Decomposition of Texture Part using median filter

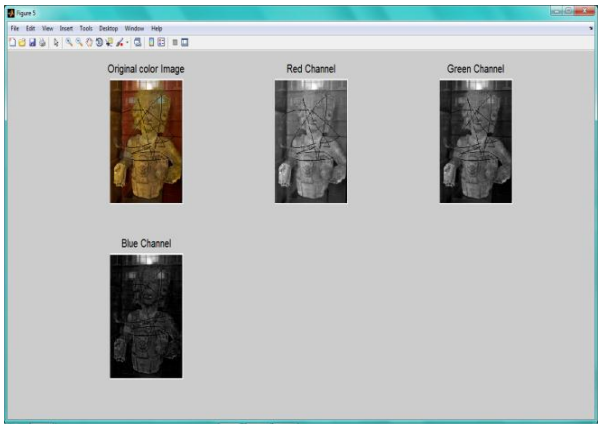


Fig 9 Decomposition of Texture part using conservative filter

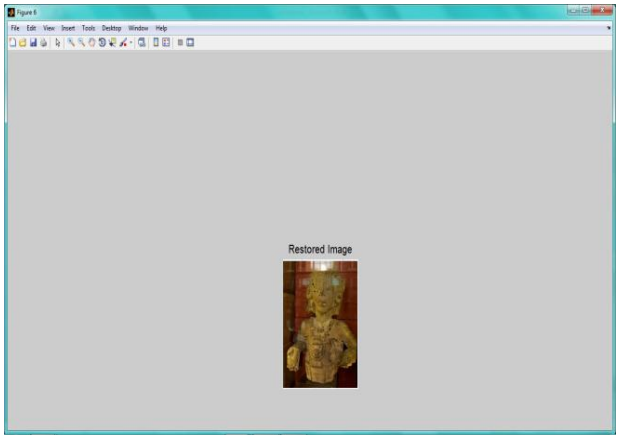


Fig 10 Restored image

## IV.ESTIMATED PARAMETERS

*a) Mean Squre Error (MSE)*

MSE (Mean Square Error) indicates average error of the pixels throughout the images. It refers to a greater difference between the original and de noised image .This means that there is a significant speckle reduction [4].

*MSE = sum (D (:)) /numel (outputimg);*

*b) Peak Signal to Noise Ratio (PSNR)*

PSNR stands for the peak signal to noise ratio. The ratio between the maximum power of signal and the minimum power of corrupting noise that affects the fidelity of representation is calculated. It is most commonly used as a measure of quality of reconstruction in image compression [4] .It is calculated as following

*PSNR =10*log10 (255*255/mse);*

Table 1 and Table 2 shows the Mean Square Value and Peak Signal Noise Ratio estimated values.

| Image | Input Image | Cartoon Component | Texture median | Texture conservative |
|---|---|---|---|---|
| 1 | 0.887604 | 0.161333 | 2.733920 | 2.553140 |
| 2 | 0.781921 | 0.154280 | 2.446248 | 2.245086 |
| 3 | 0.715409 | 0.208693 | 2.233839 | 2.053609 |
| 4 | 0.822849 | 0.203142 | 2.554402 | 2.367010 |
| 5 | 0.732556 | 0.193619 | 2.282324 | 2.107408 |

Table 1 Mean Squre Values of various texture Table 2. PSNR values of various texture

| Image | Input Image | Cartoon Component | Texture median | Texture conservative |
|---|---|---|---|---|
| 1 | 48.648609 | 56.053577 | 43.762712 | 44.060057 |
| 2 | 49.199175 | 56.247696 | 44.245798 | 44.618475 |
| 3 | 49.585257 | 54.935734 | 44.640285 | 45.005626 |
| 4 | 48.977602 | 55.052802 | 44.057911 | 44.388803 |
| 5 | 49.482398 | 55.261330 | 44.547031 | 44.893317 |

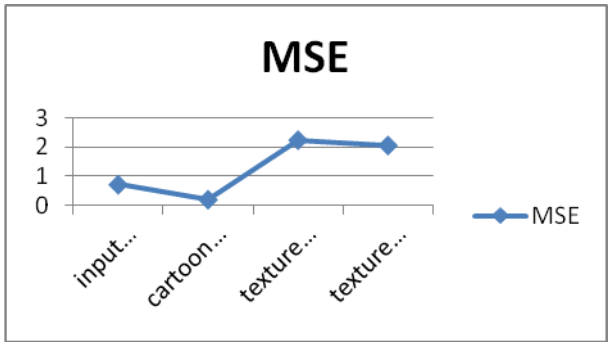


Fig 11. Graphical View of MSE for various textures

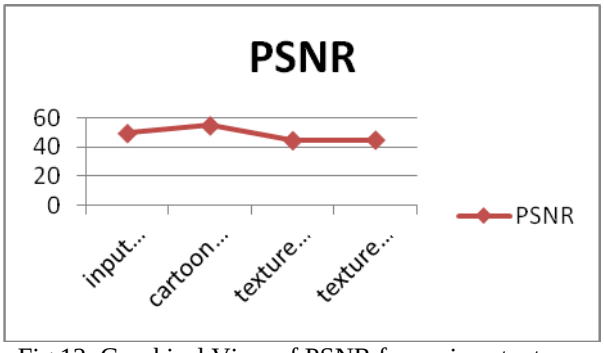


Fig 12. Graphical View of PSNR for various textures

## V.CONCLUSION

In this paper, restoration of Mural Images have been analysed by using Decomposition method. To find the missing Pixels in the region, the cartoon component was applied. To analyse the texture, texture component was used. In which two filters such as median filter and conservative filter were applied to remove the noise. The output of each filter is restored image. Performance measurement like

MSE(Mean Square Error) and PSNR(Peak Signal To Noise Ratio) values were measured and tabulated. Experimental results have shown that the effectiveness of the model and the efficiency of the algorithm.

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**Authors Profile**

Dr. R. Shenbagavalli is currently working as Assistant Professor in the Research Department of Computer Science of Rani Anna Government College for Women, Tirunelveli. I have published 8 papers in International Journal. I have 28 years of teaching experience for B.Sc., M.Sc., M.Phil., and Ph.D., Currently I am guiding 4 Ph.D., Scholars. One full time and three are part time.

Ms. M. Rathika is an M.Phil Scholar studying in Research Department of Computer Science of Rani Anna Government College for Women, Tirunelveli. She did her PG in the same Institution and passed with Distinction. Her areas of Interest include Image Processing and Cloud Computing.

 