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ISSN: 2277-9655
[Rajpoot * *et al.*, 7(7): July, 2018] Impact Factor: 5.164
IC™ Value: 3.00 CODEN: IJESS7

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

PERFORMANCE ANALYSIS OF COLOR IMAGE DENOISING USING CURVELET TRANSFORM BASED TECHNIQUE

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DOI: 10.5281/zenodo.1305851

ABSTRACT
In this paper we propose a new method to reduce noise in color image. The images corrupted by Gaussian Noise is still a classical problem. To reduce the noise or to improve the quality of image we have used different parameters. The proposed method succeeded in providing improved image denoising performance to recover the shape of edges and important detailed components. The experimental results proved that the proposed technique can obtain a better image estimate than the curvelet transform based restoration methods.

KEYWORDS: Image Denoising, Image Filtering, Curvelet Transform and Thresholding, MAE, PSNR, MSE, etc.

I. INTRODUCTION
Over the last decade, there has been abundant interest in curvelet methods for noise removal in signals and images. The method uses curvelet transform to denoise a color image technique. The initially we obtain a noisy image by degrading it by adding additive Gaussian noise. Then we implement our algorithm, which firstly passes it through a filter. The resultant image is denoised and also retains the important image information. Fig.1 shows the flow of the proposed algorithm. Related works on curvelet features are also investigated. In this investigation, we generate a texture features descriptor using wrapping based discrete curvelet transform. This descriptor is used to represent images in a large database in terms of their features and to measure the similarity among images. The optimal level of curvelet transform decomposition is also investigated to obtain the highest retrieval outcome in terms of effectiveness and efficiency. From the experimental results, we find that curvelet texture feature is robust to a reasonable scale distortion.

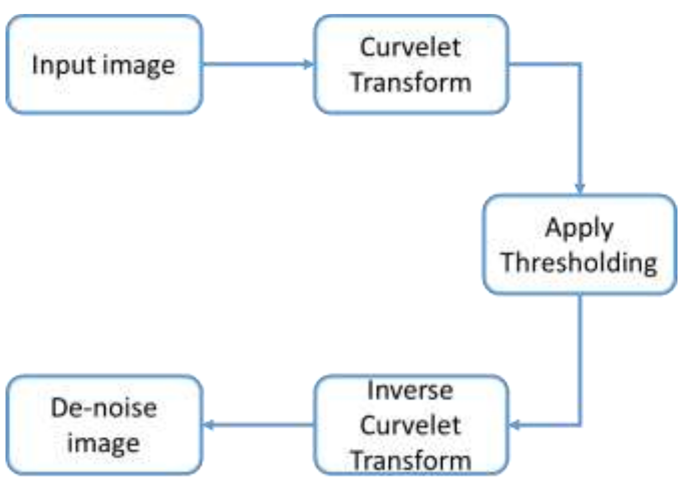

Fig.1 Block diagram of image de-noising

ISSN: 2277-9655
Impact Factor: 5.164
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The wrapping method is faster in computation time and more robust than ridgelet and USFFT technique based curvelet transform. To our knowledge, wrapping based curvelet transform has not been used in content based image riterval and there is no work on a systematic evaluation of curvelet in content based image riterval (CBIR). The first describe the curvelet transform approaches and their advantages in texture representation over other spectral approaches. Then, we provide a brief description of the related works already done using curvelet transform.

The curvelet are based on multiscale ridgelet combined with a spatial band pass filtering operation. A 2-D wavelet transform is used to isolate the image at different scales and spatial partitioning is used to break each scale into blocks system. Large size blocks are used to partition the large scale wavelet transform components and small size blocks are used to partition the small scale components. The ridgelet transform is applied to each block. In this way, the image edges at a certain scale can be represented efficiently by the ridgelet transform because the image edges are almost like straight lines at that scale. The Curvelet transform can sparsely characterize the high-dimensional signals which have lines, curves or hyper plane singularities.

The curvelets transform based on multiscale ridgelets combined with a spatial bandpass filtering operation to isolate different scale. Like ridgelets, curvelets occur at all scales, locations, and orientations. Width and length at fine scales are related through a scaling law width equal to length2 and so the anisotropy increases with decreasing scale like a power law. The recent work shows that thresholding method of discrete curvelet coefficients provide near optimal N–term representations of otherwise smooth objects with discontinuities along curves.

II. PROPOSED METHOD

In this paper, a novel denoising method is proposed. The technique uses curvelet transform with hard thresholding for color image denoising. The input image is degraded by adding different noise with different noise levels. After calculating the threshold value curvelet transform of noisy image is computed. Then by hard thresholding the curvelet coefficients and taking the inverse curvelet transform denoised image is obtained.

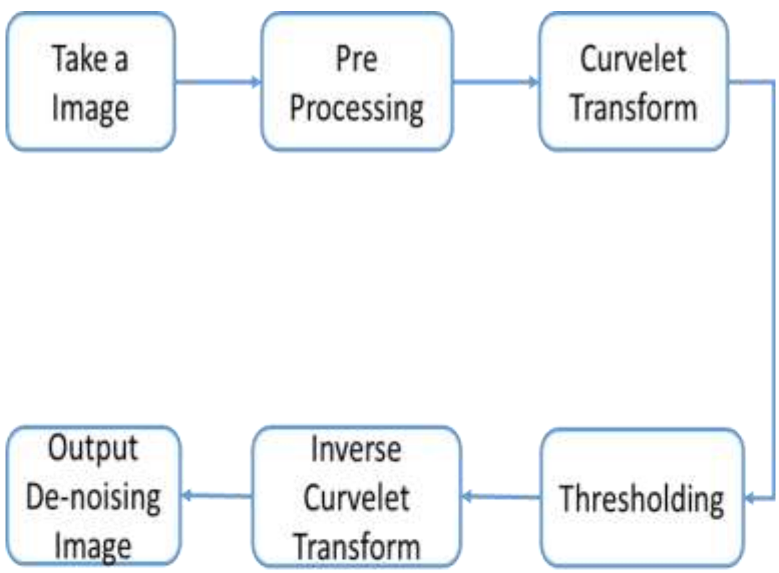

Fig. 2 Block Diagram of the Proposed Denoising Method

- Step1: Read an image.
- Step2: Take Curvelet Transform of an image.
- Step3: Add noise to the original image.
- Step4: Create an array of original image:
- Step5: Compute the inverse Fourier Transform for Step5.

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- Step6: Compute the Norm of curvelet.
- Step7: Apply Thresholding (Hard or Soft) for all the coefficients.
- Step8: Take Inverse Curvelet Transform.
- Step9: Calculate Signal-Noise-Ratio using,
- Step10: Calculate different parameter.

The parameters which are used in the filter performance evaluation are Signal to Noise Ratio (SNR), Mean Square Error (MSE), Peak Signal to Noise Ratio (PSNR) and Structural Similarity Index Measure (SSIM).

Parameter Estimation for Threshold Value

The threshold value is selected at 3*sigma_jl for all but the finest scale where it is set at 4*sigma_j1; here sigma_j1 is the noise level of a coefficient at scale j and angle (equal to the noise level times the I^2 norm of the corresponding curvelet. There are many ways to compute the sigma jl 's, e.g. through calculating the norm of every individual curvelet transform and in this method do an exact computation by applying a forward curvelet transform on the image which contains a delta function at its center.

Threshold Selection

The thresholding parameter in the thresholding process is the choice of the threshold value. The several methods for choosing a threshold exist users can manually choose a threshold value, or a thresholding algorithm can compute a value automatically, which is known as automatic thresholding. The method relatively simple, does not require much specific knowledge of the image, and is robust against image noise, is the following iterative technique.

A. Hard Thresholding

Hard thresholding sets any coefficient less than or equal to the threshold to zero. The hard thresholding is used to suppress the noise we apply the following nonlinear transform to the empirical wavelet coefficients:

$$F(x) = x.I(|x| > t)$$

Where x is a noisy image and t is a certain threshold. The choice of the threshold is a very delicate and important statistical problem.

B. Soft Thresholding

The only difference among the hard thresholding and the soft thresholding procedures are in the choice of the nonlinear transform on the empirical wavelet coefficients [5]. For soft thresholding the following nonlinear transform is used:

$$S(x) = sign(x)\ (|x| - t)I(|x| > t)$$

Where x is a noisy image and t is a threshold. The menu provides you with all possibilities for choosing the threshold and exploring the data. Soft thresholding not only smooths the time series, but moves it toward zero.

Curvelet Transform

Digital curvelet transform can be implemented in 2 ways which differs by spatial grid which is used to translate the curvelets at each scale and angle. This paper is a newly constructed and improved version of curvelet transform called FDCT (Fast Discrete Curvelet Transform) is implemented. The new technique is simpler, less redundant and faster than the original curvelet transform which is based on ridgelets. This transform is constructed using parabolic scaling law, tight framing and wrapping. There are two implementations of FDCT:

- unequally spaced Fast Fourier transforms (USFFT)
- wrapping function

Both implementations of Fast Discrete Curvelet Transform differ mainly by the choice of the spatial grid which is used to translate curvelets at each scale and angle. Both digital transformations returns a table of digital curvelet coefficients indexed by an orientation parameter ,a scale parameter, and a spatial location parameter. The wrapping based curvelet transform is based on wrapping the specially selected Fourier samples, and it is easier to implement and understand.

A. Wrapping Based Curvelet

By applying FDCT via wrapping for multiscale analysis the image is decomposed into a series of disjoint subbands, which are composed of the curvelet coefficients. The subbands are mainly classified as three groups, firdt is namely the coarse scale, seond and thkird is detail scale and fine scale. The innermost scale is the coarse scale composed of the low frequency curvelet coeeficients, which provides the general information and key energy present in an image.

The outermost scale is the finescale containing to high frequency curvelet coefficients transform which gives the detail information and edge feature of the image. For remaining scales are classified as the detail of scales which contains the middle high frequency curvelet coefficients transform, which also provides the edge feature information of the image. Thresholding the curvelet coefficients and taking inverse transform denoising is complete.

III. SIMULATION AND RESULTS

The experiments are performed on several types of gray scale images of size 256 x 256 in MATLAB platform and the Curvelet transform via USFFT and wrapping technique was Implemented based on curvelet. The noisy images are simulated by adding Gaussian white noise on the original images. The performance of the method is illustrated with both quantitative and qualitative performance measure. The qualitative measure is the visual quality of the resulting image. The peak signal to noise (PSNR) is used as quantitative measure. It is expressed in dB units. The fig. shows the steps applied on the image.

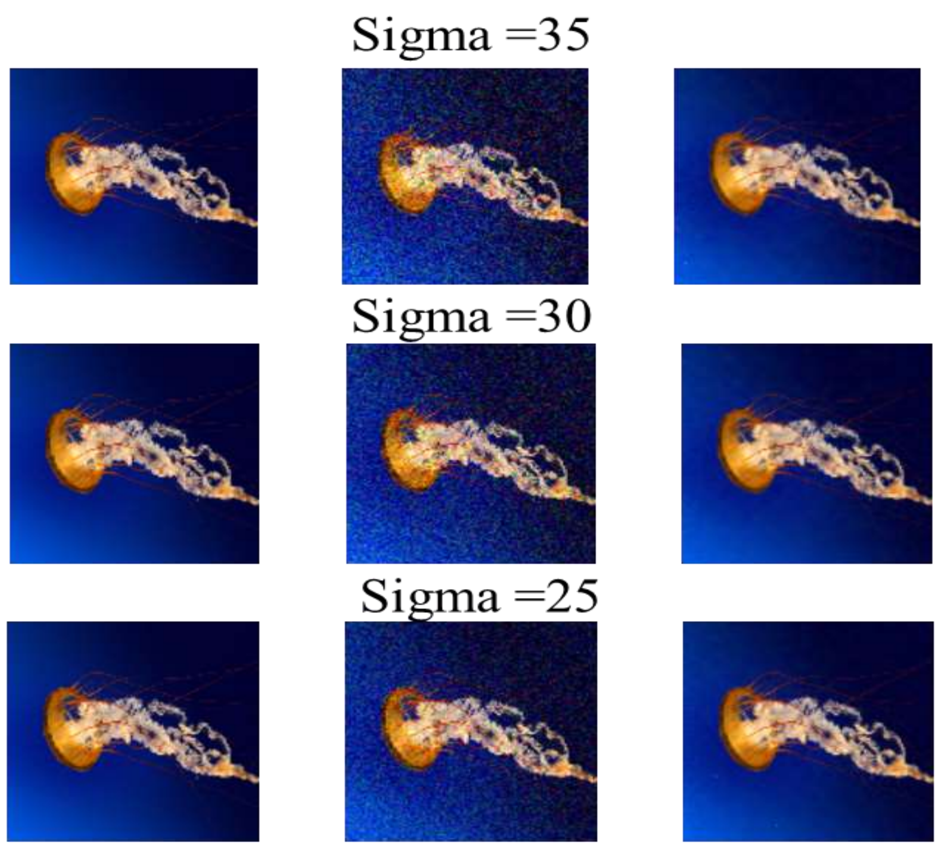

Fig. 3 Performance of noisy and de-noisy image using different sigma value

The performance of noising Image with different parameter

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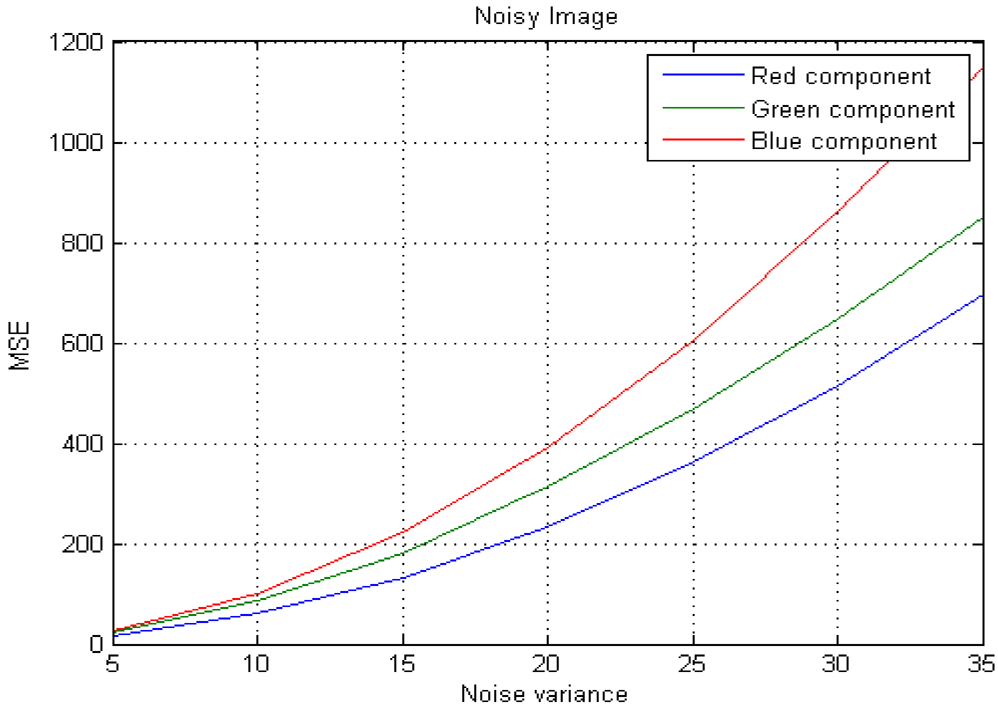

Fig. 4 Performance of MSE Vs Noise Variance

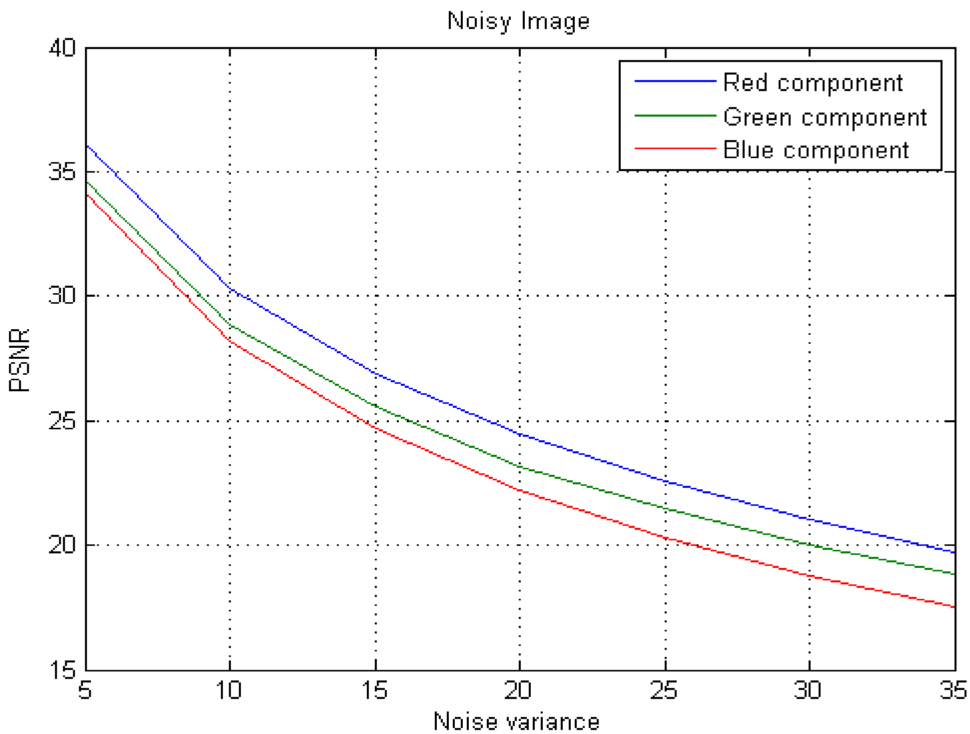

Fig. 5 Performance of PSNR Vs Noise Variance

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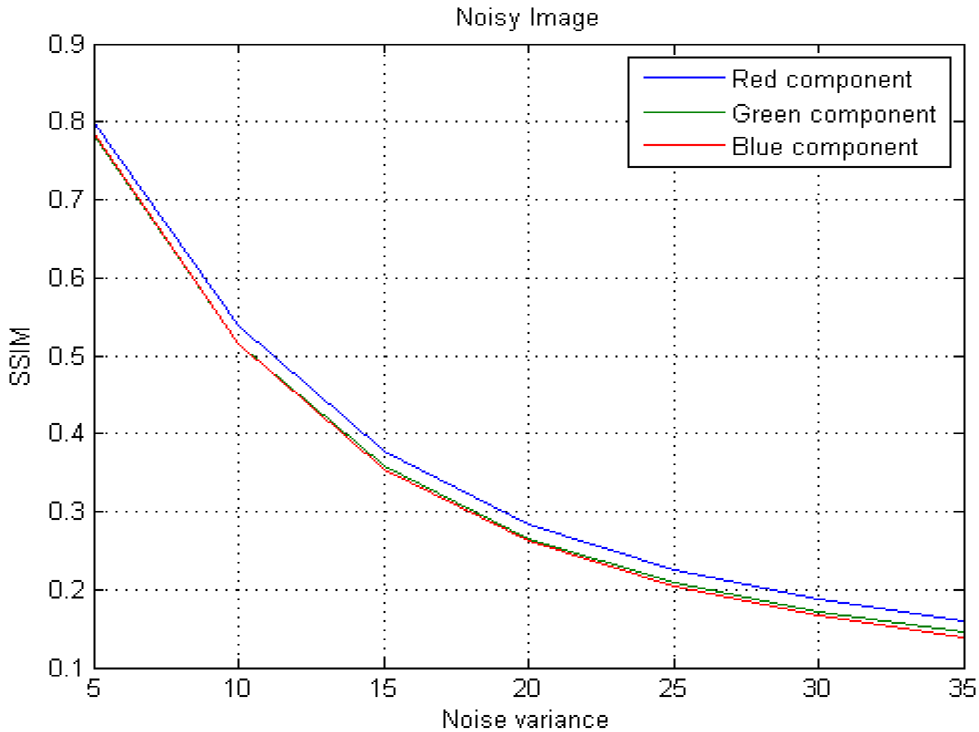

Fig. 6 Performance of SSIM Vs Noise Variance

The performance of De-noising method

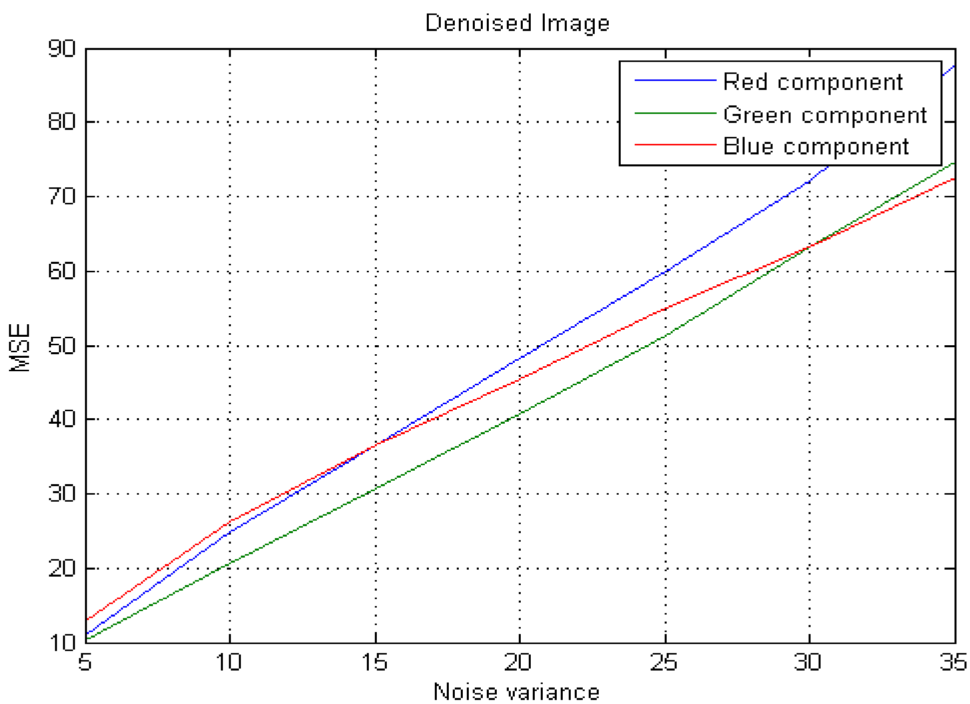

Fig. 7 De-noising Image of MSE Vs Noise Variance

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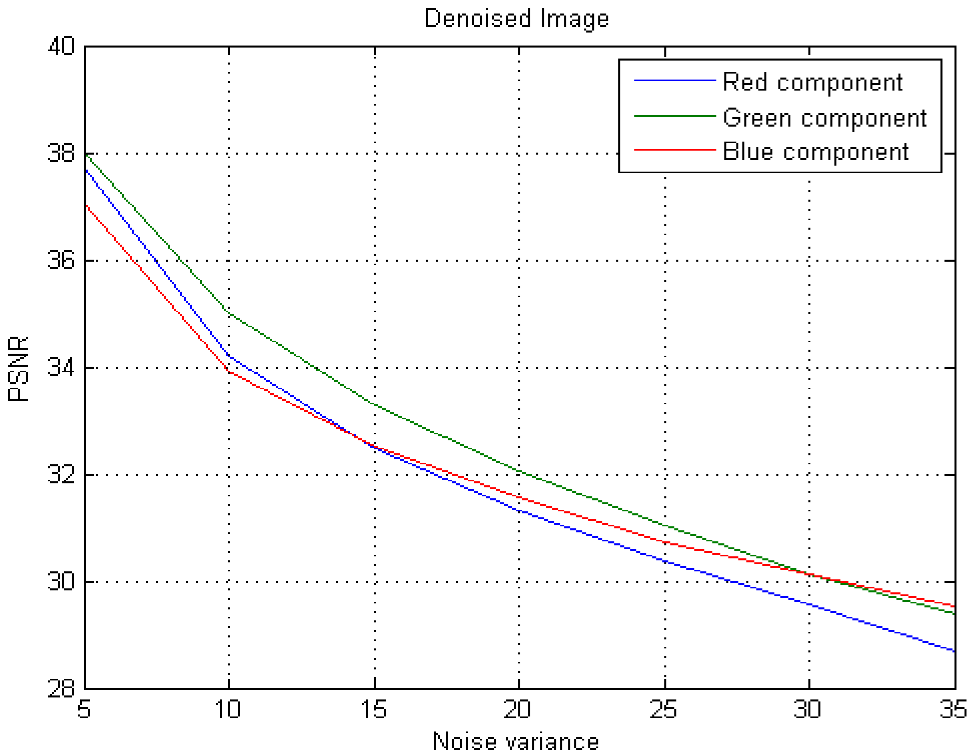

Fig. 8 De-noising Image of PSNR Vs Noise Variance

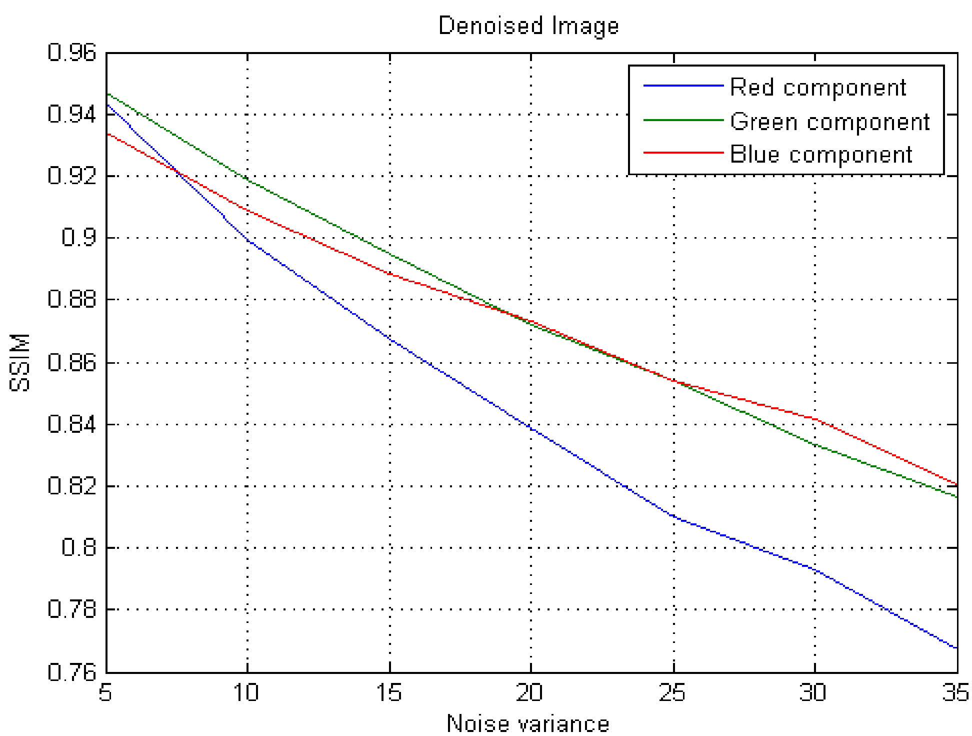

Fig. 9 De-noising Image of SSIM Vs Noise Variance

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IV. CONCLUSION

The curvelet transform using noise reduction is to remove the noise without losing much detail contained in an color image. The experimental results show that the curvelet transform with thresholding gives better results/performance than other denoising methods in terms of PSNR and other parameter. The curvelet transform denoised various color images under various noises and this denoising method performs well under Gaussian with hard thresholding in terms of PSNR value. The graph shows a decrease in PSNR value as the sigma value increases, which is natural because, as the noise increases the signal to noise ratio is expected to decrease.

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