iJRASET
International Journal For Research in Applied Science and Engineering Technology



INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 7 **Issue:** VI **Month of publication:** June 2019

DOI: http://doi.org/10.22214/ijraset.2019.6100

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
Volume 7 Issue VI, June 2019- Available at www.ijraset.com

Satellite Image Enhancement: A Review

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Abstract: ***In different fields of research and applications, satellite images are used. Its resolution is the main limitation of satellite images. Improvement of image resolution is therefore very necessary and the first step in the processing of images. The image resolution enhancement is to modify an image under some consideration so that the image obtained is superior to the original image for the specified application. In different domains such as Spatial and Transform domain, resolution enhancement of images can be performed. High-resolution images yield better results for a particular application.***
Keywords: Satellite Image Resolution, Stationary Wavelet transform, Bicubic interpolation.

I. INTRODUCTION

Generally speaking, satellite remote images are of very low quality and low resolution. The purpose of techniques for image enhancement and restoration is to enhance the quality and feature of a satellite image, resulting in better image than the original image. The term enhancement implies a process to enhance an image's visual quality. An Image Enhancement System consists of a collection of methods that explore to improve an image's visual quality or to modify an image to a form that is best suited for human or machine analysis.

An Image Enhancement converts images so that the subtle details are better represented. Improving an image is vital to improve the appearance of the image or to highlight some condition in which the image is converted from one to another, which can be collected, scanned, transmitted, copied or printed in an image. An Image enhancement has come to mean in particular a smothering irregularities or noises procedure that has distorted the image and its quality in some way. In the past, the term "image enhancement" has been widely used to define any operation that uses certain criteria to improve or enhance the image quality. An enhancement method's main objective is to process an image so that the output is more suitable for specific uses and applications than the original image. There is no conscious effort in an image enhancement process to improve a reconstructed image's fidelity to some ideal image type as performed in an image restore.

Satellite images are currently used in various applications such as monitoring, navigation, communication, remote sensing, and earth observation. Remote sensing applications include those related to meteorology, agriculture, mining, geology, mapping, urban planning, environmental monitoring and monitoring of disasters. One of the most important remote sensing issues is the image resolution that plays an important role.

Resolution can be defined as the amount of detail that a picture contains. Resolution can be considered equivalent to pixel count in the case of digital images. Spatial resolution is generally defined as ground sample distance in remote sensing, which is the distance between centers of pixels measured on the ground. It is important to resolve an image so that even minute details and variations are clearly visible, particularly in an image zoom. It is therefore very important to increase its resolution before analyzing the satellite images in order to extract detailed information.

II. LITERATURE SURVEY

Bhutada et al proposed [1] a novel approach using wavelet and curvelet characteristics that transform, separately and adaptively, into' homogeneous," non-homogeneous' and' neighboring homogeneous or non-homogeneous' regions identified by variance approaches. Wavelet approach extracts the edgy information that could not be retained from its residue by denouncing it with curvelet transform.

This extracted information is used to fuse offshore regions of denounced images obtained through the use of wavelet and curvelet transform as edge structure information (ESI). It also provides better background smoothness (homogeneous region or non-edgy region) due to the curvelet transformation's removal of fuzzy edges developed during the denoising process.

In order to maintain the tonal distribution of the input image and avoid experiential manipulation, Yun Ling et al[2] presented an adaptive tone-preserved algorithm for image detail enhancement. Initially, a multi-scale image decomposition based on domain transformation is performed to quickly divide the input image into a base image containing the information of the coarse-scale image and the detail layers containing the details of the fine-scale image.

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The authors then built an adaptive detail enhancement function based on the edge response during the process of detail enhancement and synthesis to prevent the exaggeration of strong edges and increase the enhancement of small details. Finally, a tonal correction algorithm based on energy optimization is presented to eliminate the distinct tonal differences of the enhanced image from the input image in order to maintain the color values of the input image and the gradient values of the enhanced image. Their experimental results show that for arbitrary input images with unified parameter setting, which is superior to the state-of - the-art methods, tone-consistent image detail enhancement effect is available.

An improved multi-band satellite contrast enhancement technique based on singular value decomposition (SVD) and discrete cosine transformation (DCT) was proposed in the study conducted by Kumar et al[3] for the extraction of low contrast satellite images using standardized vegetation index (NDVI) technique.

Their method uses multi-spectral remote sensing data technique to find the spectral signature of various objects as presented in the satellite image, such as the vegetation index and land cover classification. Their proposed technique converts the image into the SVD-DCT domain and reconstructs the enhanced image using inverse DCT after the normalization of the singular value matrix. The visual and quantitative results included in this study clearly demonstrate the proposed method's increased efficiency and flexibility over existing methods.

Their simulation results showed that the enhancement-based NDVI using DCT-SVD technique is extremely useful in detecting the visible area surface features that are extremely beneficial for municipal planning and management.

In[4] Bhandari et al used singular value decomposition (SVD) to present wavelet filter based on low contrast multispectral remote sensing image enhancement.

Through discrete wavelet transformation (DWT), the input image is decomposed into the four frequency subbands and estimates the singular value matrix of the low-low subband image, then reconstructs the enhanced image by applying reverse DWT. Their technique is particularly useful for improving INSAT and LANDSAT satellite images for improved extraction of features. The singular value matrix represents the image's intensity information, and any change in the singular values changes the image's intensity.

Their proposed technique converts the image into a DWT-SVD domain and reconstructs the enhanced image with the help of IDWT after normalizing the singular value matrix. The visual and quantitative results clearly demonstrate the edge sharpness, increased efficiency and flexibility of the proposed method based on Meyer wavelet and SVD over the different wavelet filters as well as the exiting GHE technique.

Their experimental results (Mean, Standard Deviation, MSE and PSNR) from Meyer wavelet and SVD show superiority over conventional methods in the proposed method.

Arici et al[5] proposed a general framework for enhancing image contrast based on histogram equalization. Contrast enhancement is presented in their framework as a problem of optimization that minimizes a cost function. The authors also stated that the level of contrast enhancement can be adjusted by introducing specifically designed penalty terms; noise robustness, white / black stretching and preservation of mean brightness can be easily incorporated into the optimization. Analytical solutions are presented for some of the key criteria. Finally, a contrast enhancement low-complexity algorithm is presented.

Bhandari et al[6] also proposed a novel technique for contrast enhancement of a low-contrast satellite image based on singular decomposition value (SVD) and discrete cosine transformation (DCT).

The singular value matrix represents the image's intensity information and any change in the singular values changes the image's intensity.

Their proposed technique converts the image into the SVD-DCT domain and reconstructs the enhanced image using inverse DCT after the normalization of the singular value matrix. Their visual and quantitative results suggest that their proposed SVD-DCT method clearly shows their proposed method's increased efficiency and flexibility over the exiting methods such as histogram equalization, gamma correction and techniques based on SVD-DWTThe observed image is blurred by optical system and atmospheric effects in the process of satellite imagery and corrupted by additive noise.

The method of restore images known as Wiener deconvolution intervenes to estimate an image as close as possible to the original image from the degraded image. Obviously, the efficacy of this method depends on the regularization term that requires a priori knowledge of the original image's power spectral density that is rarely, if ever, accessible, so estimating approximate values can affect the restored image quality. In [7] Aouinti et al came up with the idea of applying the genetic approach to satellite image restauration to the Wiener deconvolution by optimizing this regularization term to achieve the best possible result.

Sajid and Khurshid[8] proposed an adaptive algorithm for Recursive Least Square (RLS) that is used to restore images from images that are corrupted by high noise.

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ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.177
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The implementation of their proposed methodology is carried out by estimating wireless channel noise patterns through the configuration of RLS adaptive algorithm system identification. Then, the configuration of Signal Enhancement with RLS algorithm eliminates these estimated noise patterns.

The images restored are used to further denounce and enhance techniques. Performance is assessed through the Human Visual System, quantitative measures in MSE, RMSE, SNR & PSNR and graphical measures. Their experimental results showed that the RLS adaptive algorithm effectively eliminated noise from distorted images and delivered a virtuous assessment without abundant performance degradation.

Zhang and Man[9] have proposed a method of restore satellite image adaptive that avoids ringing artifacts at the boundary of the image and retains oriented features.

Their method combines regular plus smooth decomposition of the image with complex transformations of the wavelet packet. First, the framework breaks down a degraded satellite image into a "periodic component" and a "smooth component."

The Bayesian method is then used to estimate the parameters of degradation of the modulation transfer function and the noise. Using complex wavelet packet transformations, the periodic component is deconvoluted with the deconvolution result of the periodic component then combined with the smooth component to achieve the final recovered result. Their test results showed that, while preserving local image details, their strategy effectively avoids ringing artifacts.

Thriveni and Ramashri[10] proposed a fusion based on DWT-PCA and a morphological gradient for satellite image enhancement. DWT breaks down the input image into different sub-bands. PCA-based fusion applies to the low-low sub-band and contrast enhancement input image.

Using IDWT, the enhanced image is reconstructed. An intermediate stage estimating the fine detail sub-bands is needed to achieve sharper boundary discontinuities of the image.

This was done by successfully decomposing the threshold, using morphological gradient-based operators to detect edge locations and sharpen the edges detected. Their proposed method has shown that different digital satellite images have improved visibility and perceptibility.

Aedla[11] et al presented a new technique of contrast enhancement for satellite images based on the equalization of clipping or histogram plateau. Their technique adopted Bi-Histogram Equalization for image decomposition with Plateau Limit (BHEPL) and Self-Adaptive Plateau Histogram Equalization (SAPHE) for threshold calculation.

Soni et al[12] proposed an improved method for denouncing satellite images based on evolutionary algorithms. The stochastic global optimization techniques such as Cuckoo Search (CS) algorithm, artificial bee colony (ABC), and particle swarm optimization (PSO) techniques and their various variants are used in their approach to learn the parameters of adaptive thresholding function required for optimum performance.

It was found that the CS algorithm and the denoising approach based on ABC algorithms gave better performance in terms of the edge preservation index or edge preservation index (EPI or EKI) peak signal-to-noise ratio (PSNR) and signal-to-noise ratio (SNR) compared to the denoising approach based on PSO. Their proposed technique was tested on images from the satellite. The results of quantitative (EPI, PSNR and SNR) and visual (denoised images) show superiority of the proposed technique over conventional and state-of - the-art techniques of image denotation.

Bidwai and Tuptewar[13] developed a method for improving image quality. Both in terms of resolution and contrast, the enhancement is done. DWT and SVD are used in their proposed technique. Their technique breaks down the input image into four sub-bands using DWT and estimates the low-frequency sub-band image's singular value matrix, then reconstructs enhanced image by applying reverse DWT. Their technique has been applied to the gray level, color image and image of the satellite and their comparative analysis has been done. Their experimental results showed superiority over conventional techniques in their proposed method.

III. CONCLUSION

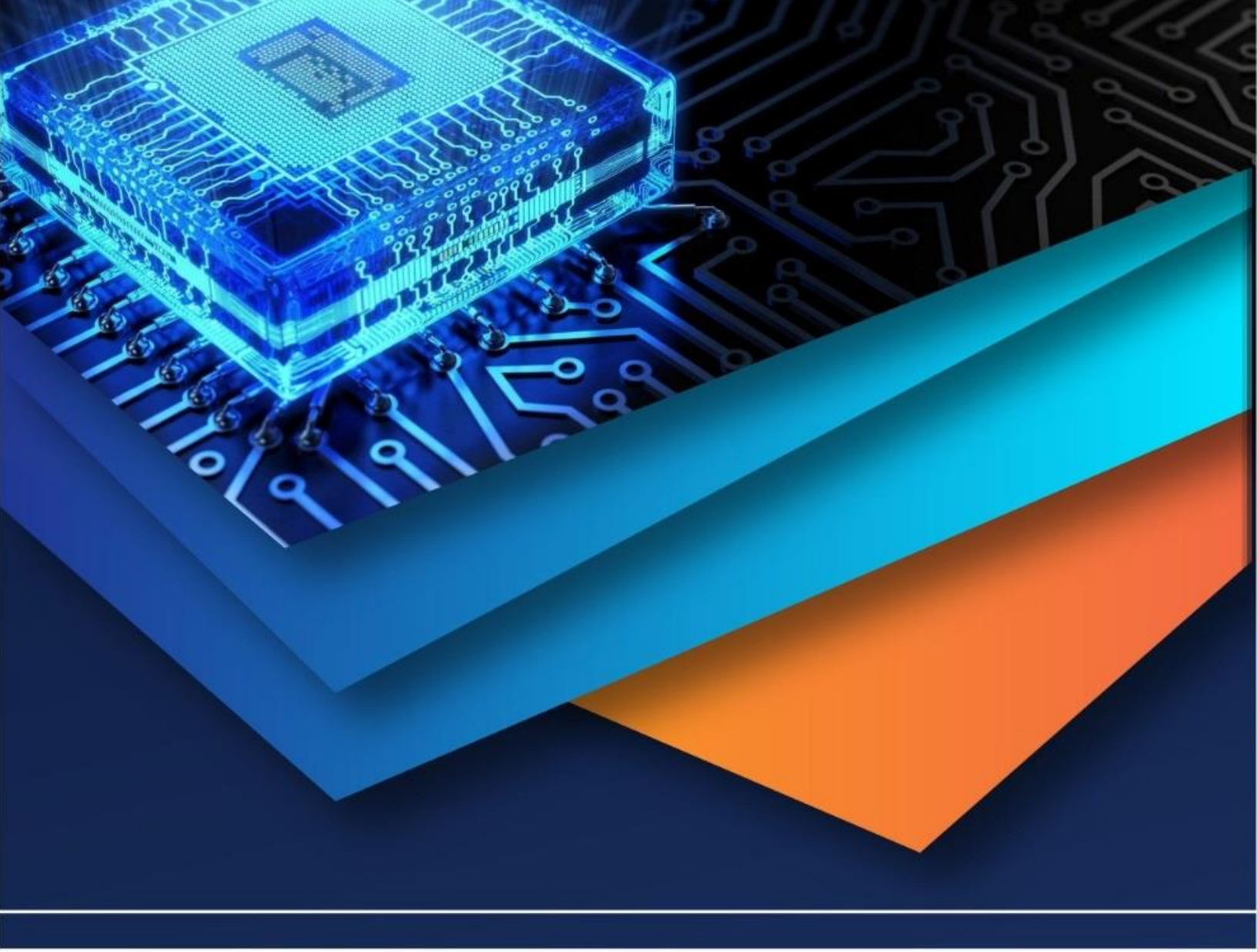
A review of major techniques of Satellite Image Resolution was presented. A comprehensive anlysis of various existing techniques has been presneted. A number of techniques exists in enhancing the spatial resolution as well as increasing the quality of the satellite image. The insights obtained in this review will be utilized to implement a satellite image enhancement scheme in future.

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