Survey on Satellite Image Resolution Techniques using Wavelet Transform

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Abstract— Satellite images are used in many research fields. The main problem with the satellite images are their low resolution and blurring effects. Thus, in order to use these images, we need to enhance their quality. Thus, in this paper we have described various wavelet transform techniques such as WZP (Wavelet Zero Padding), CS-WZP (Cyclic Spinning WZP), UWT (Undecimated Wavelet Transform) and DWT (Discrete Wavelet Transform). These all are wavelet transform techniques which are used for image resolution enhancement. In these all techniques and algorithms, we give a low resolution image obtained from any satellite image as the input and get a high resolution image as the output. The comparison of these techniques is made based on two factors MSE (Mean Squared Error) and PSNR (Peak Signal to Noise Ratio).

Key words: Satellite Image Resolution Techniques, Wavelet Transform

I. INTRODUCTION

Image processing includes many steps like Image Enhancement, Image Segmentation, Image Compression, Noise Removal, etc. High resolution images means that the image contains more detailed information or higher number of pixels. Varying size of pixels is included in the image resolution enhancement technique. In order to obtain a clearer image than the original image we need image resolution enhancement. The general and common categorization of satellite sensors by resolution is given below:

- Low Resolution – These are generally at range of 1km to 10km and suitable for whether, typically free.
- Medium Resolution – They are generally at the range of 100m to 1km and are typically free of low cost.
- High Resolution – They are at range of 10m to 100m and are medium to high cost per scene.
- Very High Resolution – They range from 1m to 10m and are very high cost per scene.

The capacity of a whole remote sensing framework to render a sharp characterized picture is called as resolution. Resolution of a remote detecting is of distinctive sorts. They are as follows:-

A. Spatial Resolution:

Spatial resolution of an imaging framework is not precisely characterized but rather can be measured in a wide range of ways relying upon one's motivation. Generally, measure utilized depends on the geometric properties of imaging system is momentary field of view.

B. Spectral Resolution:

Spectral determination defines as the measurement and number of particular wavelength intervals in the electromagnetic range to which a sensor is sensitive.

C. Radiometric Resolution:

Radiometric determination is a measure of what number of gray levels is measured between pure black and pure white.

D. Temporal Resolution:

Temporal resolution defines as the length of time it takes for a satellite to complete one entire orbit cycle.

1) Applications [2]:

Satellite applications nowadays are used to a great extent. There are many applications like fishing, oceanography, biodiversity conservation, educational purposes, sprawl detection, regional planning, forestry etc. where images from satellite are used and also image enhancement techniques are used.

2) Advantages [2]:

They can see and store a considerable measure of data. The light spectrum they utilize can be controlled to get exceptionally small point of interest and phenomenon on the world's surface. For case, archaeologists may utilize them to find unobtrusive varieties in soils to discover potential destinations. Alternately, environmentalists can utilize them to distinguish varieties in vegetation and dampness.

3) Disadvantages [2]:

You will be unable to find or see what you are searching for. Overcast spread can influence quality. In couple of ranges, particularly shady puts in, in request to get a clear picture, you need to work patch savvy or select pictures from distinctive time periods. For instance, the dirt in the rain forests may be obstructed by tree spread. They additionally take up bunches of information stockpiling and PC power. In few cases, they all can be costly. Additionally, climate conditions influence picture quality relying upon the sensor that is utilized, for instance, it's hard to take pictures of peaks where it is covered with cloud.

II. TYPES OF WAVELET BASED ENHANCEMENT TECHNIQUES

A. Wavelet Zero Padding (WZP) [4]

Wavelet zero padding is one of the least complex strategies for image resolution enhancement shown in Fig. 1. In this method, wavelet transform of Low Resolution (LR) picture is taken and zero matrices are inserted into the transformed picture by disposing of high frequency sub bands through the inverse wavelet transform and along these lines High Resolution (HR) picture is acquired.

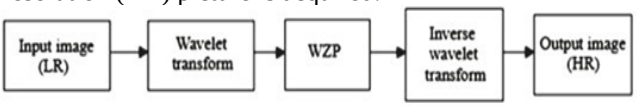

Fig. 1: Wavelet Zero Padding

B. CS-WZP (Cyclic Spinning WZP) [4]

In this method, we follow given below steps in order to get the high resolution image as shown in Fig. 2.

- First we obtain an intermediate High Resolution (HR) image through WZP method.
- After that we obtain N number of images through spatial shifting, wavelet transforming and discarding high frequency component.
- Again, WZP process is applied to all Low Resolution (LR) images to get different High Resolution (HR) images.
- These High Resolution (HR) images are realigned and averaged to give a final High Resolution (HR) image.

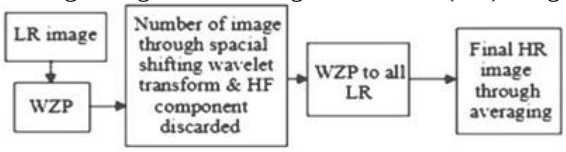

Fig. 2: CS-WZP

C. Undecimated Wavelet Transform (UWT) [4]

Undecimated wavelet transform is wavelet transform technique which does not use decimation after the decomposition of images into different frequency sub bands. In this technique, first WZP method is applied to acquire an estimate of HR picture. If the LR image is meant with Y of size m*n then the estimated HR picture is given by:

Where, b is the zero matrix of size m*n and IDWT is the inverse discrete wavelet transform. In next step, undecimated wavelet transform is performed on the estimated HR picture, as a result of which picture is decomposed into two bands called estimated details and approximation coefficients. Then, these coefficients are replaced with estimated initial values of HR image and thus inverse UWT is performed in order to get the HR image.

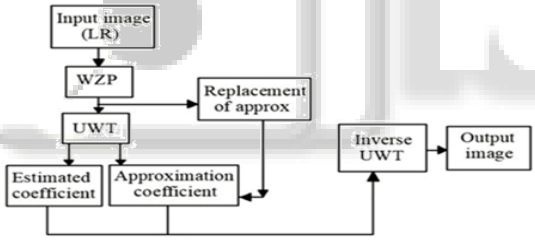

Fig. 3: Undecimated wavelet Transform

D. Discrete Wavelet Transform (DWT) [4]

Discrete wavelet change based method is most broadly utilized method for performing image interpolation. To decompose an LR image into 4 sub-bands LL (low low), LH (low high), HL (high low), HH (high high) we use DWT. Then all these sub bands are combined or interpolated. Then we can get a difference of image by discarding the LL band from original LR image. Then, this difference image is then added to the higher band components of the image. Thus finally IDWT is used to combine the estimated high resolution images with input images to get the original HR image. The DWT technique is shown in the figure.

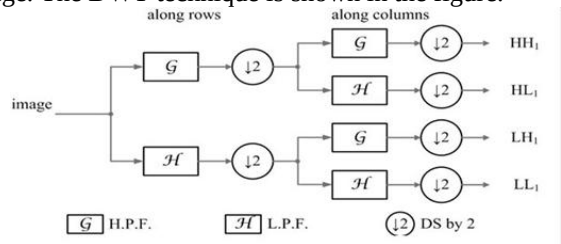

Fig 4: Discrete Wavelength Transform

E. Image Quality Evaluation [2]:

The result or output image can be evaluated with two characteristics, parameters, distortion & sharpness. Adjusting errors are calculated by computing MSE (Mean Squared Error) according to the distortion evaluation. The quality of image is based on the parameter PSNR (Peak Signal to Noise ratio). Higher the PSNR, better the image quality. The formulas for MSE and PSNR are given below.

$$PSNR=10\log\left(\frac{R^2}{MSE}\right)$$

$$MSE=\frac{\sum_{i,j}(I_{in}(i,j)-I_{org}(i,j))^2}{M\times N}$$

III. Conclusion

From this survey paper we can get the idea and comparison about different image enhancement techniques using wavelet transform. Also, the resolution enhancement that is not wavelet based can have disadvantage of losing high frequency. From the study we also come to know that the DWT is most efficient of all four given techniques. For future work, Multi Wavelet Transform can be obtained for fewer artifacts compared to other techniques.

References

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