MAPPING OF COSMO SKYMED SAR DATA BASED ON FALSE COLOR COMPOSITE IMAGE

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Abstract
A novel supervised classification approach is proposed for high-resolution dual-polarization (dual-pol) amplitude COSMO Skymed images. Coherence, mean backscattering coefficient and backscatter difference images are generated, from which the False Color composite (FCC) image is formed. From the FCC image the river, vegetation and the urban areas of Jharia, located in the state of Jharkhand in India, which is mapped to the GOOGLE EARTH accuraetly using the softwares MATLAB 7.6 and ENVI 4.7.
Keywords: COSMO Skymed data, land cover classification, Coherence image, mean backscattering coefficient, False color composite image.

I. INTRODUCTION

The mapping of land cover and the monitoring of spatial and temporal variability of land surface parameters are important issues in the management of land and water resources. The improved spatial resolution and the reduced revisiting time of the new generation of spaceborne SAR systems, such as Cosmo-SkyMed, aroused an increasing interest in SAR data for land cover classification.

The Cosmo/SkyMed SAR constellation is currently operating with two spacecrafts and allows daily acquisition of the same area with a spatial resolution from 1 m to 20 m. The possibility to operate a SAR sensor allows obtaining information on the ground in all weather conditions in spite of severe cloud covers. In this logic, Cosmo/SkyMed could be an important tool to verify the reliability of land cover information provided that the nature of the remotely sensed signal in the microwave range at such a high resolution is investigated and understood in terms echoes reflected by surface targets [1].

The COSMO Skymed data used here for analysis is an Interferometric Synthetic Aperture Radar (InSAR) image of processing level, level-1A operating in the Stripmap (PING PONG) acquisition mode. The data captured is of cross polarized ie. (HH/HV) horizontal polarization. The images were captured with a time interval of one day in the month of june, 2011 over the area of Jharia, located in the state of Jharkhand in India, with the geographical co-ordinates whose LL ranging from $23^{o}44'33.62''$N to $23^{o}35'9.46''$N, and $86^{o}19'31.04''$E and $86^{o}31'57.22''$ E.

The false color composite image delineates the land cover classes such as river, vegetation and urban areas. ENVI 4.7 and MATLAB 7.6 are used for the image processing.

II. METHODOLOGY

Complex images of the acquired consecutive pair were initially geometrically corrected and coregistered by taking image captured on 12th June 2011 as the master image and image captured on 11th june 2011 as the slave image. The same geometrical image is further processed to generate coherence image and the backscatter image.

A. Coherence Image generation

Coherence can be calculated using the equation below,

$$\gamma_{hv} = \frac{<m_{hv}.s_{hv}^{*}>}{\sqrt{<m_{hv}.m_{hv}^{*}><s_{hv}.s_{hv}^{*}>}}, \quad -(1)$$

Where, γ_{hv} is the coherence of HV polarized image, m denotes the master image and s denotes the slave image of HV polarized image. Similarly, γ_{hh} is calculated for HH polarized image.

The coherence should be estimated by ensemble average [3-6]. That means the expectation values should be obtained by using a suite of observations for every single pixel. Thus, according to the equation (1), coherence image, as shown in the figure.1, is generated from the complex co-registered images using a 3x3 window in MATAB.

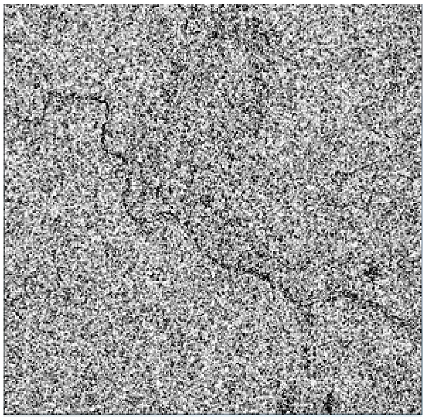

Figure 1. Coherence image

B. Backscattering coefficient of COSMO Skymed data

Many researchers have observed important effects of structures like water body, on radar backscattering. For example, the polarization ratio of the average HH power to the average HV power is related to the shape and orientation of scatterers. The effects of scatterer orientation are reduced, by the like-polarization magnitude, the average of the backscattering coefficients for HH and HV may be used in image interpretations, or the normalized difference between HH and HV backscattering can be used as an index of stem-angle related canopy structure. The backscattering coefficient, σ^o of HH & HV polarized complex images are evaluated using a 3x3 window in MATLAB.

Steps involved in calculating backscattering coefficient:

1. *Power image P(i, j),* evaluation of *input image, img(i,j),*

$$P(i,j) = |img(i,j)|^2$$

2. Remove the *Reference Slant Range* R_{ref}, *Range Spreading Loss Compensation Geometry,*

$$Fact = R_{ref}^{\,2*R_{exp}}, \text{ if } R_{slflag} \neq none$$

3. Remove the *Reference Incidence Angle* α_{ref}, *Incidence Angle Compensation Geometry ,*

$$Fact' = Fact * \sin(\alpha_{ref}), \text{ if } Inc_{flag} \neq none$$

4. Remove the *Rescaling Factor, F,*

$$Fact'' = Fact' \cdot \frac{1}{F^2}$$

5. Apply the *Calibration Factor* with the condition,
Calibration Constant Compensation Flag, $K_{flag} = 0$,

$$F_{tot} = Fact'' \cdot \frac{1}{K}$$

6. Apply the *total scaling factor,*

$$\sigma^o(i, j) = P(i, j) * F_{tot}$$

To get back scattering coefficient, σ^o *in dB,*

$$\sigma^o(r, c)\ 10*\log_{10}(\sigma^o(i,j)) \qquad (8)$$

The parameters involved in the above equations are obtained from the metadata of the image which are given as the calibration factors. Eqn. 8 gives the resulting backscattering coefficient image, from which mean backscatter and backscatter difference images for the master and the slave images are generated. The mean backscatter image is s shown in the figure 2.

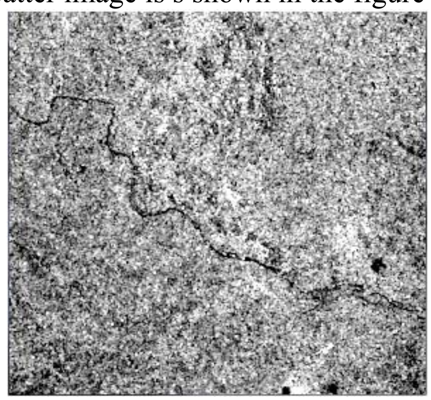

Figure.2 Mean Backscatter image

C. False Color Composite Image

The display color assignment for any band of multispectral image can be done in an entirely arbitrary manner. In this case, the color of a target in the displayed image does not have any resemblance to its actual color. The resulting product is known as a **false color composite** image [2]. There are many possible schemes of producing false color composite images. However, some scheme may be more suitable for detecting certain objects in the image. Here the coherence image, mean backscattering image and the backscatter difference image are layer stacked in ENVI to form a multispectral image, which results in the False Color Composite image shown in figure.3.

III. RESULT

The Figure 3 shows the FCC image, formed of coherence, mean backscattering coefficient and backscatter difference images. Because of the coherence and the backscattering coefficient values, the combination of both the values has the best efficiency to classify the pixels. Low coherence and low backscattering coefficient separates the water body from the vegetation and the urban areas. Therefore, the water body appears dark due to low coherence values and the vegetation and urban regions appears in purple and cyan due to the moderate and highest coherence values respectively. Here the image of size 670x940 was chosen from HH and HV polarized image and processed using ENVI and MATLAB 7.6. Coherence and the backscattering coefficients calculations were done programmatically in MATLAB and the FCC image is generated using ENVI 4.7.

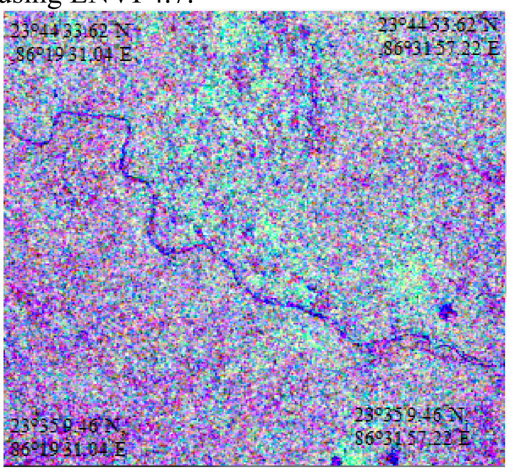

Figure 3. False Color Composite image

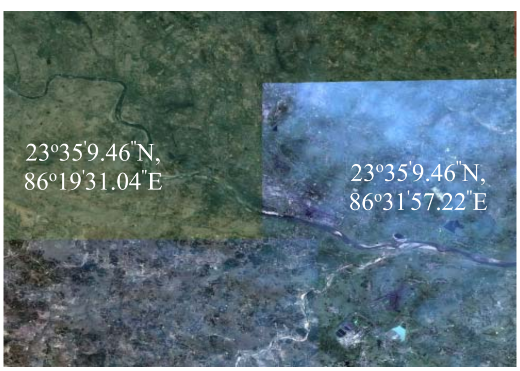

Figure 4. Google Earth image of the jharia region for the same location

The resulting FCC image is mapped with the Google Earth image of jharia region for the same locations shown in the figure.4, and the river region was accurately mapped.

IV. CONCLUSION AND REMARKS

The mapping methodology implemented in this paper results in delineating the land cover classes such as the water body, vegetation and the urban areas in better way. The high-resolution COSMO SkyMed data gives a accurate mapping of river body when mapped with the Google earth image as a result of the methodology discussed here due to the accurate evaluation of coherence and the backscattering coefficients.

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