

Remote Sensing Laboratory
Lab Assignment # 6
Math Operation

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1. Objective

The main objective of this exercise is to familiarize with Math operation of image processing such a Logical Operation, NDVI and PCA (Principal Component Analysis) calculation

2. Data provided

The data used in this session is an image from Landsat 7 ETM+ sensor. Spatially it covers the area around Pathumthani province of Thailand (Upper Left Coordinates are 100° 26' 13.88"E, 14° 3' 14.38" N). The image contains six bands of Landsat having spatial resolution of 30 m (excluding the panchromatic and thermal bands having different resolution).

3. Methodology

3.1 Subset of the Image

1. Start image processing software ENVI 4.2
2. Open image file and consider to subset image to size 1000x1000 pixels but this image size 500x500 pixels then should to use this image size.

Note: All the Math operations are carried out on this subset, to reduce the computation time and storage required for the resultant images.

3.2 Band Math Operations

1. Click Basic Tools Menu and select the Band Math

Calculation of NDVI:

Normalized Difference Vegetation Index is the most widely used vegetation index to relate the remotely sensed signals with the ground features like vegetation, health of vegetation, bare soil, snow, irrigated land and droughts. It can be calculated using following equation.

Note that the MIN and Max keywords are required in the function call to BYTSCAL to ensure that the same minimum and maximum values are used for scaling all ties as tiled image.

$$NDVI = \tan \alpha = \frac{NIR - RED}{NIR + RED} \quad (1)$$

when $-1 \leq NDVI \leq 1$

Providing the result of NDVI in term of floating value then Band Math should be rewriting equation 1 by the following expression in Band Math window; (see equation

2) and in ENVI math window used b1 for NIR and b2 for Visible RED the result as equation 3.(see figure 1).

$$NDVI_{float} = \frac{float(NIR) - RED}{float(NIR) + RED} \quad (2)$$

$$NDVI_{float} = \frac{float(b1) - b2}{float(b1) + b2} \quad (3)$$

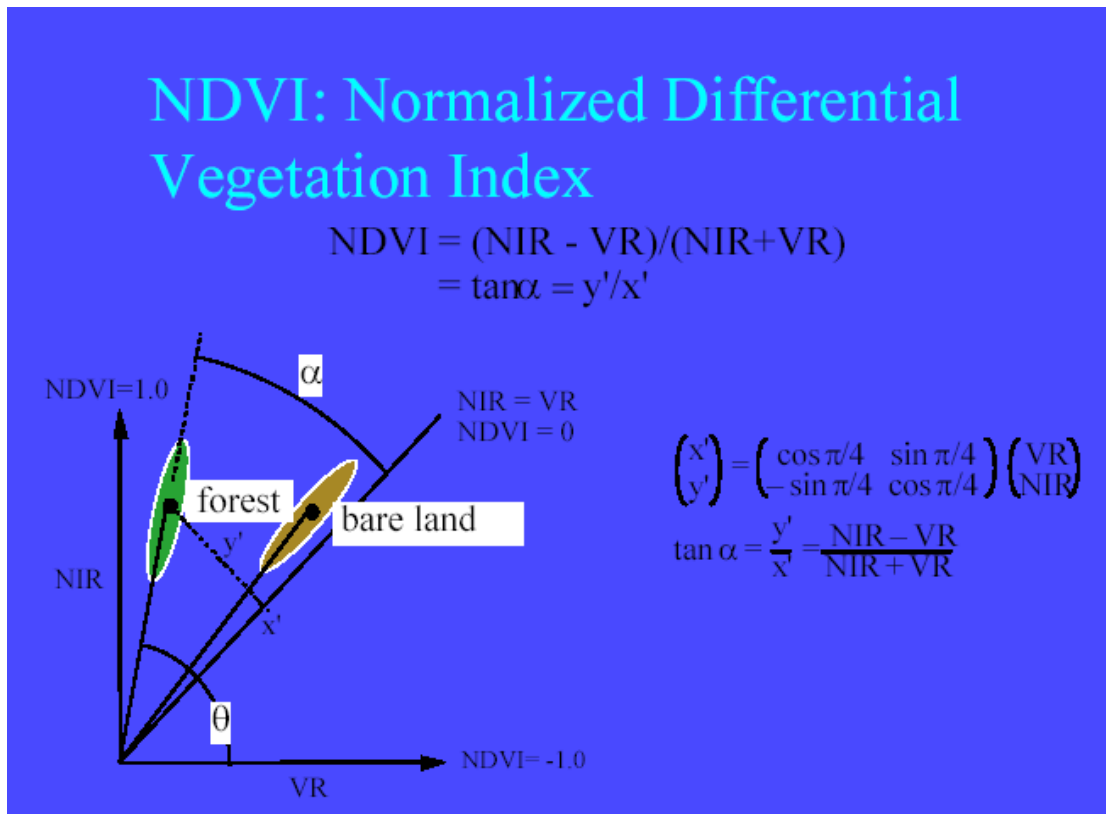


Figure1. Graphic Transformation of NDVI. [Ref 1.]

After entering this equation, ENVI will ask which band of the image should be used as b1 and which one to be used as b2. The band 3 (red) & band 4 (NIR) of the Landsat should be specified respectively as b2 and b1 (figure 2). The resulting image can be seen in figure 3. The inset of the image clearly shows that the data is in floating mode.

After the NDVI is calculated the resultant image can be viewed in gray shade. The values in this image vary from -1 to +1. Therefore it is customary to convert the floating point NDVI to Integer NDVI, with integer values of the range of 0-255. For this the Interactive Data Language (IDL) function BYTSCL is used as under (eq.4);

$$BYTSCL(b1, min = -1.0, max = 1.0) \quad (4)$$

After that, assign b1 should be linked with the floating NDVI band. The output file so generated will contain the integer values ranging from 0 to

255. The dialogue box for specifying the input and output files and the syntax of the formulae can be seen in figure 3 . The image result can be seen in figure 4. Band Math can also be used for hundred of other purposes like adding the bands, averaging the bands, removal of atmospheric errors, calculation of slope etc.

3.3 Principle Component Analysis (PCA) Calculation:

Use Principle component to procedure uncorrelated output bands, to segregate noise components, and to reduce the dimensionality of data sets. Because multi-spectral data bands are often highly correlated, the Principle Component (PC) Transformation is used to produce uncorrelated output bands. This is done by finding a new set of orthogonal axes that have their origin at the data mean and that are rotated so that the data variance is maximized.

Click Transform> Principle Component> Forward PC Rotation> Compute New Statistics & Rotate. It will open a menu to select the source file. Select the subset file. It will result into forward PC Rotation parameter dialogue .Specify 0.1 for Stats X Resize Factor & Stats Y Resize Factor in order to reduce the number of statistical calculations. Choose the statistics file name and output file name. Set the parameter 'Select the subset from Eigenvalue' to 'Yes' and then press OK. It will open a form showing eigenvalues of rotated bands (figure 5). Depending upon the user requirement select the number of bands with high values of eigenvalue (e.g. we have selected top 3 rotated bands). It will create a new image file with the no of bands as selected by the user in PCA. The new file can be used for image classification and for other purposes without losing amount of information too much extent. The six bands after PCA are shown as composite image in figure 6.

3.4 Logical Operation:

The NDVI product will use to mark PC1 image to show only vegetation are by the criteria that NDVI value is less than zero will as -999 values for non-vegetation area.

1. Select basic tools> band math form main menu bar.
2. enter equation (5) in expression text box.

$$(b1 \text{ lt } 0) * (-999) + (b1 \text{ ge } 0) * b2 \quad (5)$$

3. assign a b1 variable by NDVI band from last operation. And assign b2 variable for PC 1 band.

4. select result to file and enter the filename then click ok.

Note

lt = lesser than	le = lesser or equal than	eq =equal
gt=greater than	ge= greater or equal than	And ,or

4. Result

- 4.1 Band Math Operations NDVI
- 4.2 PCA Calculation:
- 4.3 The color table of Pseudo color by using NDVI mark on PC1

5. Conclusion.

6. Reference: