Digital Image Processing
Image Enhancement. Part 2

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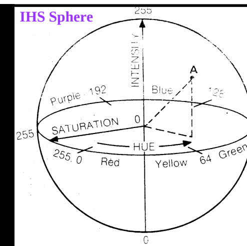
IHS Transformation

- IHS mimics the human eye system more closely in conceiving color
- IHS Sphere
  - Intensity axis represents variations in brightness (black-0 to white-255). No color.
  - Hue represents the dominant wavelength of color. (0 at mid point of red tones and increases anti clockwise to 255)
  - Saturation represents the purity of color and ranges from 0 at the center of the Sphere to 255 at the circumference.
  - A saturation of 0 represents a completely impure color, in which all wavelengths are equally represented (grey tones)

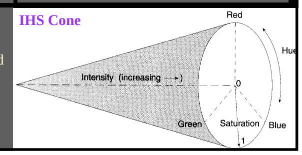
IHS Sphere



Intensity, Hue and Saturation color coordinate system. Color at point A has the following values: I = 195, H =75, S = 135

- IHS Cone
  - Intensity varies along main axis of cone
  - Hue is a measure of colour and is plotted on the circumference
  - Saturation is a measure of the colour purity and increases from the center to the perimeter.

IHS Cone



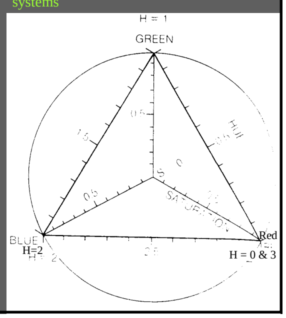
IHS Transformation

- Circle represents a horizontal section through the equatorial plane of the IHS sphere
- Corners of the equilateral triangle are located at the position of the red, green, and blue hue
- Hue changes in a counterclockwise direction around the triangle, from red (H=0), to green (H=1) to blue (H=2) and again to red (H=3)
- Values of saturation are 0 at the center of the triangle and increase to maximum of 1 at the corners
- IHS values can be derived from RGB values through the following transformations (Short and Stuart, 1982).

$$I = R + G + B$$
$$H = \frac{G - B}{I - 3B}$$
$$S = \frac{I - 3B}{I}$$

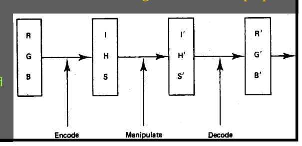
- These values can be mapped to 0-255 range
- Inverse equations may be used for IHS to RGB system

Relationship between RGB and IHS systems



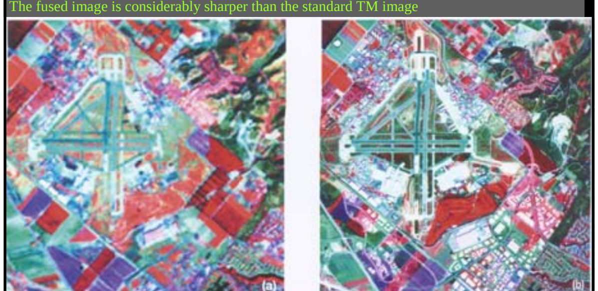
IHS Transformation

- When any three spectral bands of MSS data are combined in the RGB system, the resulting color images typically lack saturation, even though the bands have been contrast-stretched.
- Under saturation is due to the high degree of correlation between spectral bands. High reflectance values in the green band, for example, are accompanied by high values in the blue and red bands, so pure colors are not produced.
- To correct this problem, a method of enhancing saturation was developed that consists of the following steps:
  - Transform any three bands of data from the RGB system into the IHS system in which the three component images represent intensity, hue and saturation.
  - Typically intensity image is dominated by albedo and topography. Sunlit slopes have high intensity values (bright tones), and shadowed areas have low values (dark tones)
  - Saturation image will be dark because of the lack of saturation in the original data.
  - Apply a linear contrast stretch to the saturation image
  - Transform the intensity, hue and enhanced saturation images from the IHS system back into three images of the RGB system. These enhanced RGB images were used to prepare the new color composite image
- This approach is also used to merge data of different spectral resolution sensors after co-registration
  - PAN data merged with LISS data (substituted for the Intensity image)
  - TM data merged with SPOT PAN data
  - Radar data merged with IRS LISS data

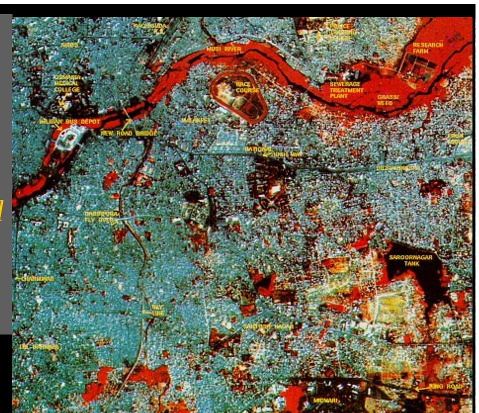


Synergetic Display

Comparison of
(a) TM image with (b) TM/SPOT fused data for an airport southeast of Los Angels
The fused image is considerably sharper than the standard TM image



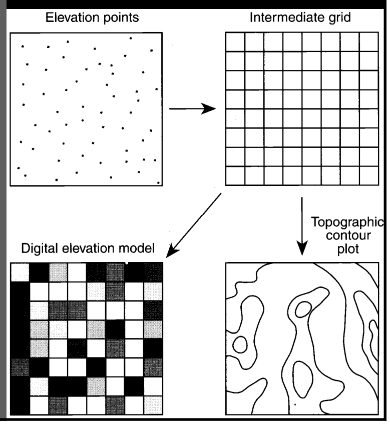
IRS LISS III and PAN merged and enhanced Image of Hydera-bad



IRS-1C(LISS III and PAN) digitally merged and enhanced image of Hyderabad city

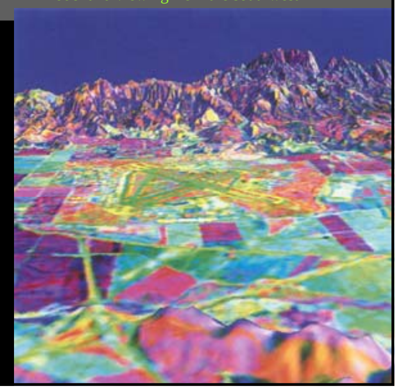
Synergetic Display

- Transfer data from different systems into a single dataset
- For this, it is important that separate bands are co-registered with each other and that they contain same number of rows and columns
- FCC can be produced by considering any three bands (may be of different spectral or spatial resolution)
- Non-remote sensing data such as topographic data, elevation information may also be merged through DEM
- Non-remote sensing data such as location names can also be merged



Synergetic Display

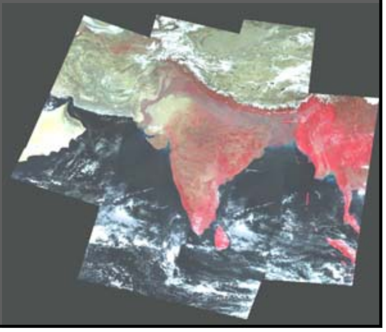
Perspective view southeast of Los Angeles produced by draping TM and radar data over a digital elevation model and viewing from the southwest



Making Digital Mosaics

- Mosaics are prepared by matching and splicing together individual images to get an entire image for any political, geological or hydrologic boundary by combining number of images
- Adjacent images are geometrically registered with the help of GCPs in the regions of overlap
- Eliminate duplicate pixels
- Contrast stretch the composite image to have uniform appearance

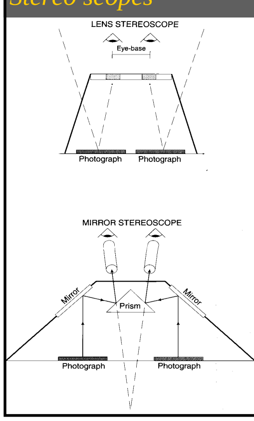
- Mosaic of images captured by the Ocean Colour Monitor (OCM) onboard the IRS-P4 (Oceansat) satellite

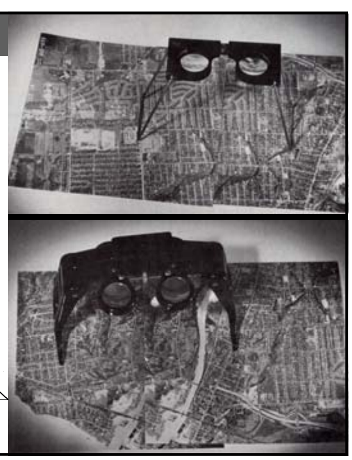


Producing Synthetic Stereo Images

- GCPs may be used to register satellite images to other digitized data sets such as topographic maps with elevation details
- This registration causes, elevation value to be associated with each image pixel (interpolation)
- Each pixel in a scan line can be displaced relative to the central pixel of that scan line
- Pixels to the west of the central pixel are displaced westward by an amount that is determined by the elevation of the pixel and by its distance from the central pixel. Same procedure determines eastward displacement of pixels east of the central pixel.
- Resulting image simulates the parallax of an aerial photograph
- Principal point is then shifted and a second image is generated with the parallax characteristics of the overlapping image of stereo pair
- This stereo pair can be viewed with a stereoscope to appreciate the three dimensional effect of vertical exaggeration.

Stereo scopes





Advantages of Synthetic Stereo Images

- Vertical exaggeration can be increased
- Entire image can be viewed stereoscopically (by shifting reference points)

Time Composite Images

- If an image contains cloud cover in a portion but that imagery can be acquired everyday like in the case of NOAA AVHRR a time composite imagery can be produced without cloud cover
- Co-register images acquired over number of days (say 15 days)
- Area with cloud cover is identified from the first imagery and is replaced by the next imagery of the same area.
- Cloud cover (if any) from this composite imagery is replaced with the third imagery.
- This procedure is repeated 15 times (say over 15 days imageries)
- Composite imagery is used for further analysis
- NRSC used such time composited imageries of NOAA AVHRR over 15 days for Agricultural drought assessment and analysis.