Environmental Remote Sensing
GEOG 2021

Lecture 2

Image display and enhancement
Image Display and Enhancement

Purpose

• visual enhancement to aid interpretation
• enhancement for improvement of information extraction techniques
Topics

• **Display**
  – Colour composites
  – Greyscale Display
  – Pseudocoulor

• **Image arithmetic**
  – + - × ÷

• **Histogram Manipulation**
  – Properties
  – Transformations
  – Density slicing
Colour Composites

‘Real Colour’ composite

red band on red
green band on green
blue band on blue

Swanley, Landsat TM
1988
Colour Composites

‘Real Colour’ composite
red band on red
Colour Composites

‘Real Colour’ composite

red band on red
green band on green
Colour Composites

‘Real Colour’ composite
red band on red
green band on green
blue band on blue

approximation to ‘real colour’...
Colour Composites

‘False Colour’ composite

NIR band on red
red band on green
green band on blue
Colour Composites

‘False Colour’ composite

NIR band on red
red band on green
green band on blue
Colour Composites

‘False Colour’ composite

- many channel data, much not comparable to RGB (visible)
  - e.g. Multi-polarisation SAR

Fig. 3 L-band Pi-SAR image of sea ice in southern part of the Sea of Okhotsk, February 23, 1999

HH: Horizontal transmitted polarization and Horizontal received polarization
VV: Vertical transmitted polarization and Vertical received polarization
HV: Horizontal transmitted polarization and Vertical received polarization
Colour Composites

‘False Colour’ composite
- many channel data, much not comparable to RGB (visible)
  - e.g. Multi-temporal data
  - AVHRR MVC 1995

April
August
September
Greyscale Display

Put same information on R,G,B:

August 1995
August 1995
August 1995
Pseudocolour

- use colour to enhance features in a single band
  - each DN assigned a different 'colour' in the image display
Image Arithmetic

- Combine multiple channels of information to enhance features

  - e.g. NDVI
    \[(\text{NIR} - \text{R})/ (\text{NIR} + \text{R})\]
Image Arithmetic

• Combine multiple channels of information to enhance features

• e.g. NDVI
  $$(\text{NIR}-\text{R})/(\text{NIR}+\text{R})$$
• Common operators: Ratio

Landsat TM 1992

Southern Vietnam: green band

what is the ‘shading’?
Image Arithmetic

• Common operators:
  
  Ratio

  topographic effects
  visible in all bands

  FCC
• Common operators: \[ \text{Ratio (} \frac{c_{\text{a}}}{c_{\text{b}}} \text{)} \]

apply band ratio

= NIR/red

what effect has it had?
• Common operators: Ratio ($c_h^a/c_h^b$)

• Reduces topographic effects

• Enhance/reduce spectral features
  • e.g. ratio vegetation indices (SAVI, NDVI++)
• Common operators:
• **Subtraction**

_MODIS NIR: Botswana Oct 2000_

_Predicted Reflectance_

Based on tracking reflectance for previous period

• examine **CHANGE**
Measured reflectance
Difference (Z score)

*measured minus predicted* noise
• Common operators: Addition

- Reduce noise (increase SNR)
  - averaging, smoothing ...
- Normalisation (as in NDVI)

=
• Common operators: Multiplication
• rarely used per se: logical operations?
  – land/sea mask
• WHAT IS A HISTOGRAM?
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Frequency of occurrence (of specific DN)
Density Slicing
Density Slicing
Density Slicing

Don’t always want to use full dynamic range of display

Density slicing:
• a crude form of classification
Density Slicing

Or use single cutoff

= Thresholding
• Analysis of histogram
  – information on the dynamic range and distribution of DN
    • attempts at visual enhancement
    • also useful for analysis, e.g. when a multimodal distribution is observed
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  – information on the dynamic range and distribution of DN
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Typical histogram manipulation algorithms:

Linear Transformation
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**Linear Transformation**
Typical histogram manipulation algorithms:

**Linear Transformation**

- Can automatically scale between upper and lower limits
  - or apply manual limits
  - or apply piecewise operator

But automatic not always useful ...
Typical histogram manipulation algorithms:

**Histogram Equalisation**

Attempt is made to ‘equalise’ the frequency distribution across the full DN range
Typical histogram manipulation algorithms:

**Histogram Equalisation**

Attempt to split the histogram into ‘equal areas’
Typical histogram manipulation algorithms:

**Histogram Equalisation**

Resultant histogram uses DN range in proportion to frequency of occurrence
Typical histogram manipulation algorithms:

**Histogram Equalisation**

- Useful ‘automatic’ operation, attempting to produce ‘flat’ histogram
- Doesn’t suffer from ‘tail’ problems of linear transformation
- Like all these transforms, not always successful

**Histogram Normalisation** is similar idea

- Attempts to produce ‘normal’ distribution in output histogram

  - both useful when a distribution is very skewed or multimodal skewed
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Summary

• **Followup:**
  – web material
    • http://www.geog.ucl.ac.uk/~plewis/geog2021
    • Mather chapters
    • Follow up material on web and other RS texts
    • Access Journals