LEICA ADS40 SENSOR FOR COASTAL MULTISPECTRAL IMAGING

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Introduction

- Impervious surface is the total area of ground covered by pavement or other surfaces that prevent water infiltration.
- It is an important indicator of urbanization or development.
- It is used as a parameter for hydrological models that estimate storm water runoff.
Introduction

- The project area covered 55 3.75 minute quarter quad image tiles along the coast of Brevard, Indian River and St Lucie counties in Florida (over 2000 sq. Km.)
- Surface water features include Atlantic Ocean, Indian River Lagoon, canals, ponds, marshes and drainage ditches.
- Impervious surface features include paved areas (roads and parking lots) and building roofs.
Introduction

Project Area

Cape Canaveral

Indian River Lagoon

Vero Beach
Project Area Overview

IR, R, G Mosaic

R, G, B Mosaic
Leica ADS40 Sensor

- Panchromatic lines oriented 28° forward, nadir and 14° back for 200% stereo overlap
- R,G,B lines optically co-registered
- Infrared line co-registered by ortho-rectification
Focal Plate Arrangements

- **Image size** – 12,000 pixels by the length of the flight line
- **Alternating readout of the A and B lines** allows a 24,000 pixel swath in PAN bands
- **Linear CCDs contain no dead pixels.**
Focal Plate Arrangements

- Staggered panchromatic line in Nadir
- Excellent digital surface models
- Most sold solution

- Panchromatic Nadir line is substituted by Green line
- RGB in Nadir is perfect for true orthos
- Co-registered false color bands
Trichroid Filter

- Optical RGB co-registration device
- Cascaded dichroitic beam splitters
- Energy conserved due to spectral light splitting
- Metal interference filters between prisms and CCDs
Gradient Correction

• The Gradient Correction algorithm as implemented in Leica GPro 2.1 software is a dark pixel subtraction method.
• Image statistics are calculated on segments of the flight line (default 100 pixels) and cross track variation is analyzed to determine correction parameters.
• Each band is analyzed independently, but generally only the blue and green bands are corrected.
Image Acquisition

- Imagery was collected in Jan-March 2004 with the Leica ADS40 sensor.
- Flying height of 20,000 ft AGL, produced native pixels of approximately 0.62 meters.
- Orthorectified, with 1 meter pixel output.
- 12-bit dynamic range scaled to 16-bit, with “gradient correction” algorithm to reduce bidirectional reflectance and atmospheric effects.
Remote Sensing and ADS40

• **12-Bit Dynamic Range**
• **All Bands are Captured in Native Pixel Resolution**
• **Spectral Range (nanometers)**
  – Panchromatic 465 – 680
  – Red 610 – 660
  – Green 535 – 585
  – Blue 430 – 490
  – Near IR 835 – 885
## Band Comparisons of Satellite and Airborne Sensors

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<th>Pan</th>
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Data Pre-processing

- **Stack B, G, R, NIR images to create 4-band 16-bit images.**
- **Normalize Imagery brightness values per band to equalize across image swaths and ensure “typical” vegetation and water reflectance signatures**
Impervious Surface Extraction

- **Extract Land/Water Interface (Surface Water)** is extracted by using an normalized ratio of Blue to Near Infrared bands \((B-NIR)/(B+NIR)\),
- **Speckle caused by specular refection from ripples or band misalignment where movement occurs is removed by morphological filtering (Erode/Dilate/Open/Close)**
Impervious Surface Extraction

- Extract vegetated areas by using NDVI \((\text{NIR}-R)/(\text{NIR}+R)\), and determining a threshold value to create vegetation mask.
- Areas that are not vegetated and not water may be impervious.
- Run multispectral supervised classification of these areas to distinguish land cover types and reduce error.
- Create Impervious Surface Layer.
Impervious Surface Details

Impervious

Color Infrared Image

Surface Water
<table>
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<th>Impervious</th>
<th>Color Infrared Image</th>
<th>Surface Water</th>
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</thead>
<tbody>
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<td>[Impervious Surface Details Image]</td>
<td>[Color Infrared Image]</td>
<td>[Surface Water Image]</td>
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</table>
Impervious Surface Details

Impervious | Color Infrared Image | Surface Water
Impervious Surface Details

- Impervious
- Color Infrared Image
- Surface Water
Conclusions

- **Visual inspection of the impervious surface layer and the source imagery indicates that over 90% of asphalt and concrete surfaces were correctly identified as impervious.**
- **Exceptions include freshly laid asphalt (very black).**
Conclusions

- **Building roofs are more difficult to uniformly identify, as they are made of many different materials, but at least 80% of roof area is correctly identified.**
- **Most areas of open sand are classified as impervious, due to their similarity to concrete.**
- **This can lead to a substantial of error of commission, unless the sand can be masked out by overlaying previously identified areas of sand.**
Conclusions

• *This study has shown the feasibility of performing automated classification of surface water, vegetated surface, and non-vegetated land area.*

• *To the extent that open sand can be excluded from the non-vegetated land by using a priori land cover or land use information, a successful impervious surface layer can be efficiently extracted.*
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