Airborne Sensors from Hexagon

Klaus Neumann  Product Management
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... the most complete professional airborne sensor portfolio

- Z/I DMC II Frame Imaging
- Leica RCD Frame Imaging
- Leica ADS Pushbroom Imaging
- Leica ALS LIDAR
Target Markets for Airborne Products

Remote Sensing
- Leica ADS100

Regional Mapping
- Z/I DMC II
- Leica ADS100

Engineering
- Z/I DMC II
- Leica RCD30 UAV

3D & Smart City
- Mobile Mapping
- Leica RCD30 Oblique
- Small UAV
Atmosphere

“In most cases, the atmosphere is perceived as a hostile entity whose adverse impacts must be neutralized or eliminated before remotely sensed data can be properly analyzed.”
(Schott, Remote sensing. The image chain approach, 1997)
Radiometric Imaging Chain

**ADS XPro**

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**.raw/L0**  
System Corrected DN: Removal of system artifacts

**L1/L2**  
Radiance Calibration: At-sensor Radiances $[\text{W/m}^2\text{sr}/\mu\text{m}]$ by laboratory calibration

Atmospheric Correction: Removal of  
- Path radiance  
- Adjacency effect

Reflectance Calibration: Ground Reflectance  
Removal of the effects of solar Irradiance (with dark pixel observation)

BRDF Correction: Removal of reflectance anisotropy

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[1] DN
Image Block from an ADS Line Scanner (GSD 50 cm)

Raw Data:
South Texas 2009 (NAIP project)
  Brightness gradient
  - within block
  - along flight line
  - across flight line
  Wrong colors due to different sensitivity from sensor to sensor
Radiometric Correction in Photogrammetry

Aim: Comparable data
  - within an image, from image to image, from day to day
  - from sensor head to sensor head
  Necessary for mosaicking, change detection, data fusion, etc.

Actions:
- Correction of environmental image artifacts due to
  - Diurnal illumination change
  - Atmospheric haze (e.g. blue hue towards the borders)
  - Bidirectional reflectance effects of the ground (e.g. hot spot)
- Compensation of different sensor sensitivities (absolute radiometric calibration)
Image Quality Improvements of the ADS100

- Radiometric
  - Better linearity at low light levels due to look-up table correction.
  - Higher sensitivity due to new beam splitter and TDI.
  - Higher dynamic range due to smaller minimum cycle time.

- Geometric
  - Improved image sharpness due to new beam splitter design.
  - Higher spatial resolution due to 5 nm pixel size and high performance lens.
  - Reduced image blur due to new PAV100 gyro-stabilized mount with adaptive control.
  - Resolution enhancement due to the staggering option.

- Spectral
  - Increased stereo capability due to additional RGBNIR beam splitter in forward direction.
ADS Image Block South Texas 2009

Before

After

Atmospheric correction, reflectance calibration & BRDF correction
References


Validation of the Image Quality:
EuroSDR project for geometric calibration (Vaihingen/Enz 2008)
Validation: Ground data set

Ground spectra:
Asphalt road (1)
Grass (2)
Color Tarps: White (3), blue (6), green (5), red (4)
Image ROIs: (1) – (14)
Validation: Asphalt spectra

North-South strip H6: no BRDF effect but cloud shadows

East-West strip L4: BRDF effect
Validation of the Image Quality

The New Leica ADS100
Digital Airborne Sensor
The All New Leica ADS100 Airborne Digital Sensor
Key Features Sensor Head SH100

- **Focal Plate (FPM)**
  - Total of 13 CCD lines with 20000 pixels each in three line groups (Forward, Nadir, Backward)
  - Pixel size 5um
  - TDI stages selectable 1, 2, 4, 8, 15 (1/2, ¼, 1/8, 1/16 @ Cycle time >1ms)
- **Two Tetrachroid beamsplitters in**
  - Forward (25.6°) - full color RGBN –
  - Backward (17.7°) - full color RGBN
- **One bi-Tetrachroid in**
  - Nadir - full color RGGBN
- **Dynamic Range of CCD**
  - 72dB
- **Resolution A/D converter**
  - 14-bit
- **Data Compression**
  - Lossless 14-bit
- **Recording Interval per Line (Cycle Time)**
  - >0.5ms
- **Spectral Bands**
  - Red: 619-651nm
  - Green: 525-585nm
  - Blue: 435-495nm
  - NIR: 808-882nm
Key Features Sensor Head SH100

- **Field of View (FoV)**
  - Forward 65.2° across track
  - Nadir 77.3° across track
  - Backward 72.5° across track
- **Focal Length**
  - 62.5mm
- **F-number**
  - 4
- **Spectral Range**
  - 420-900nm
- **Registration Accuracy**
  - 1um
- **Lens Design**
  - Telecentric lens design.
  - Maintains position & width of filter edges over whole FoV
  - Thermic and pressure compensation for high accuracy.
- **Flying Height Multiplier**
  - 12.500:1
  - 10cm GSD = 1250m AGL
- **Sensor Head SH100**
  - Weight ~50 kg with CUS6 IMU
  - Height 65 cm
  - Diameter 39cm
- **IMU integrated in Sensor Head**
  - Leica IPAS20-CUS6 IMU integrated

ADS100 10cm GSD, 2000m Swath, 1254m AGL
Performance Indicators

Inflight QC Options
- **Video Camera**
  - Oblique View 17° forward
  - Swath width 55° along x 77° across track

- **Waterfall Images**
  - Waterfall images during flight available for RGB Nadir

- **Leica FlightPro**
  - Full control of data acquisition parameters

Data Recording Performance
- **Capacity of Mass Memory (Pair)**
  - Selectable single, joint or backup mode possible
  - Joint mode of 2.4 TB, recording time depends on configurations of data acquisition
  - Hot swappable in-air

- **Firmware & Software**
  - Leica FlightPro Flight Management Software

- **Average Ground Speed (GS) for various GSD @ 0.5ms CT**
  - GS = 120 kts for GSD of 1.2” / 3cm
  - GS = 190 kts for GSD of 2” / 5cm
  - GS = 290 kts for GSD 3” / 7.5cm
  - GS = >350 kts for GSD 4” / 10cm
Key Performance Summary

- Full multispectral color swath width of 20000 pixels in RGBN for highest data acquisition efficiency
- Selectable TDI stages for improved sensitivity and expanded operational envelope
- Improved cycle time to acquire smaller GSDs at faster speed
- Full color RGBN in forward, nadir and backward for more flexible stereo interpretation
- Improved Leica PAV100 gyrostabilized mount with adaptive control for improved image quality
- Embedded Novatel SPAN GNSS/IMU with tightly coupled processing to reduce fuel consumption
- End-to-end workflow from mission planning with Leica MissionPro to orthophoto and point cloud generation with LeicaXPro
Leica RCD30 General Description and Specifications
Medium format for photogrammetry

- Multispectral, coregistered RGB and IR
- Mechanical motion compensation, 2 axes
- >1 second frame rate
- 50 mm and 80 mm focal length
- Stabilized lens system
- High accuracy mapping range
- Exchangeable central shutter
- B/H ratio of 0.32 @ 60% overlap (50mm)
- 2 x 60MP, 6um CCD for RGB and NIR
- CC3x can control up to five CH6x
- Image size single head 8956 x 6708
- Image size dual head 13216 x 8956
- 15cm GSD @ 3780ft flying height (50mm)
- Weight CH6x 4 kg, CC3x 6kg
RCD30 Standalone
RCD30 Uno/Duo Pod

Uses Leica PAV80 for RCD30

Height  485 mm
Diameter  390 mm
Weight (incl IMU)  17.5 kg
RCD30 Standalone
RCD30 Uno Pod

Height  485 mm
Diameter  390 mm
Weight (incl IMU)  17.5 kg
Leica RCD30 for ALS and 3rd party
Installation with Leica ALS

Uses Leica PAV80 Heavy Load

Or installation without mount
RCD30 Oblique
RCD30 Penta Pod

Height  485 mm
Diameter  390 mm
Weight (incl IMU)  18 kg
RCD30 Oblique
RCD30 Trio Configuration
RCD30 Oblique
RCD30 Penta Configuration
Z/I DMC II Large Format Frame Sensor
DMC II Camera System
DMC II Camera Design
DMC II Sensor Design

R B G NIR

PAN

B NIR
DMC II Camera Family

- Multi spectral sensor, RGB and IR
- 2:1 pan-sharpened color resolution
- FMC forward motion compensation
- 2.2 second frame rate
- 92 mm focal length
- B/H ratio of 0.36 @ 60% overlap
- 4x42 MPixel, 7.2 um MS CCD
- 1x140 MPixel, 7.2um PAN CCD
- Finished Image Size: 12,096 x 11,200
- 15cm GSD @ 6288 ft flying height
DMC II Camera Family

- Multi spectral sensor, RGB and IR
- 2.5:1 pan-sharpened color resolution
- FMC forward motion compensation
- 2.3 second frame rate
- 92 mm focal length
- B/H ratio of 0.35 @ 60% overlap
- 4x42 MPixel, 7.2um MS CCD
- 1x230 MPixel, 5.6um PAN CCD
- Finished Image Size: 15,552 x 14,144
- 15cm GSD @ 8085ft flying height
DMC II Camera Family

DMC II 250
A Product of Z/I Imaging

- Multi spectral sensor, RGB and IR
- 3.2:1 pan-sharpened color resolution
- FMC forward motion compensation
- 1.8 second frame rate
- 112 mm focal length
- B/H ratio of 0.28 @ 60% overlap
- 4x42 MPixel, 7.2um MS CCD
- 1x250 MPixel, 5.6um PAN CCD
- Finished Image Size: 16768 x 14,016
- 15cm GSD @ 9843ft flying height
DMC II Footprint & AGL

DMC II_{140}  

DMC II_{230}  

DMC II_{250}  

AGL for 10cm GSD

4192ft  5390ft  6561ft
Towards Unified Aircraft Installation - 2013

- Leica MissionPro
- Leica FlightPro
- Novatel SPAN
- Leica PAV100
- Controller CC33
- OC60 and PD60
- ADS100
- RCD30
- RCD30 Oblique
- Z/I DMCII
- ALS70
- OC60 and PD60
- Controller CC33
- Leica PAV100
- ADS100
- RCD30
- RCD30 Oblique
- Z/I DMCII
- ALS70
Post Processing Workflow
Leica ADS100 Workflow

Leica Xpro 6.0
- Radiometry
- Direct Georeferencing
- Atmosphere
- Bundle Adjustment

SGM
Orthophoto

3DCon

Intergraph
Total Geospatial Solutions
Leica ADS and Leica XPro
Z/I DMC II Workflow

- Leica Mission Pro
- Leica Flight Pro
- Novatel IE

Z/I PPS 6.6
- PureColor Technology
- Radiometry
- Atmosphere

- Intergraph
- Bundle Adjustment
- Orthophoto
- 3DCon
- SGM
Info-Clouds from Frame Camera

City of Lindau
5cm GSD
DMC II 140
tridicon® 3D: Source data parameters

Stereo Aerial Images:
- Camera: **Leica RCD 30 Oblique**
- 1x Nadir, 4x oblique
- vertical / horizontal overlap: 60% / 35%
- ground sample distance (GSD): 4 cm
- camera file and orientation data
tridicon®: Automatic Building Reconstruction (3D BuildingFinder)
tridicon®: Automatic Texturing
Thank you!
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