DMC II Calibration
and
Geometric Sensor Accuracy

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DMC Ile 250 Camera

Camera Parameter

Panchromatic camera – reference camera:
Single CCD - array

- Nominal focal length 112.0000 mm
- Image format:
  - along FD: 14016 pixel * 5.6 μm = 78.4896mm
  - across FD: 16768 pixel * 5.6 μm = 93.9008mm
- Field of view:
  - along FD: 38.62°
  - across FD: 45.49°
- Base-height ratio at p=60%: 0.28
Calibration Procedure

3 Step Calibration method

„SILVER“ calibration

„GOLD“ calibration

„PLATINUM“ calibration
The “SILVER” geometric calibration takes place at Carl Zeiss Jena on a certified test stand. More than 800 “light targets”, projected on 28 lines that are distributed diagonally on the focal plane, are automatically measured by finding their centers light with a precision of less than 1/10 of a pixel. The light targets are projected from the “infinity” by using a collimator.
**GOLD** calibration

**Panchromatic camera – reference camera:**

- Focal length 112.0000 mm
- Full-calibration-frame image format:
  - along FD: 14656 pixel * 5.6 μm = 82.0736mm (14016 pixel * 5.6 μm = 78.4896mm)
  - across FD: 17216 pixel * 5.6 μm = 96.4096mm (16768 pixel * 5.6 μm = 93.9008mm)
„GOLD“ calibration procedure

Mission Plan:

- 8 x 8 flight lines
- N-S and E-W direction -> cross pattern
- 144 images
- GSD: 4.7 – 5.0cm
- End lap 67 – 71%
- Side lap 71 – 75%
- 54 GCPs -> SD X, Y = 3cm
  
  \[ Z = 4cm \]
- Flat area: 423 – 484m terrain height
GOLD calibration procedure

hg = 1000m AGL
Image footprint 733m x 861m

--- 3.5 km ---

--- 3.5 km ---

PFG 2011 / 2, 071 – 079, March 2011
Geometric Property of Large Format Digital Camera DMC II 140
KARSTEN JACOBSEN, Hannover

- when it has to be right
Run APM – Intergraph Image Station
AeroTriangulation was used

- 144 images
- 105 up to 353 points/image
- 266 points/image in average
- All image points overlayed to one image
“GOLD“ calibration procedure

- á priori STD for image measurements relaxed to 6-8μm
- GNSS INS EOs, misalignment and geodetic datum calibrated
- High accurate GCPs
  STD X,Y = 3cm  Z = 4cm
- Remove all image blunders and image points with σ₀ > 8μm
  ➢ Generate ISAT Grid Correction
  ➢ Focal Length and Principal Point of Auto Collimation pre estimation

✓ „GOLD“ Calibration
From „SILVER“ to „GOLD“

- Remaining non-linear systematic distortion in focal plane
- Cannot be absorbed by optimal selection of FL/PPAC only
  ➔ Scale and Bias correction only
From „SILVER“ to „GOLD“

- Distortion Grid Correction applied
- Rmax: 3.6955μm → 0.9094μm
- $\text{rmsX} = 1.1582\mu m \rightarrow 0.1826\mu m$
- $\text{rmsY} = 1.2564\mu m \rightarrow 0.1554\mu m$

- when it has to be right
From „GOLD“ to „PLATINUM“

Nominal Camera Parameter

Panchromatic camera – reference camera:

- along FD: 14016 pixel = 78.4896mm
- across FD: 16768 pixel = 93.9008mm
- Run APM with á priori STD for image measurements 3μm

Focal Length and Principal Point of Auto Collimation finally adjusted

Mission Plan:

- 8 x 8 flight lines
- N-S and E-W direction -> cross pattern
- 144 images
- GSD: 4.7 – 5.0cm
- End lap 67 – 71%
- Side lap 71 – 75%
- 54 GCPs -> SD X, Y = 3cm Z = 4cm
- Flat area: 423 – 484m terrain height

✓ „PLATINUM“ Calibration

- when it has to be right
Mission Plan:

- 4 + 2 flight lines
- 54 images
- End lap 60 – 65%
- Side lap 30 – 35%
- 5 Control Points
  -> SD X, Y = 3cm    Z = 4cm
- 39 Check Points
  -> SD X, Y = 3cm    Z = 4cm

- ≤ 0.5 * Pixel Size for X, Y
- ≤ 0.7 * Pixel Size for Z

- when it has to be right
GNSS/IMU Performance and Direct Georeferencing

DGNSS vs PPP solution

- DGNSS – Base Station required
- Final PPP – Satellite Ephemerides / Satellite & Station Clocks → 12-18 days
- Rapid PPP – Satellite Ephemerides / Satellite & Station Clocks → 17-41 hours
- UltraRapid PPP – Satellite Ephemerides / Satellite Clocks → 3-9 hours
GNSS/IMU Performance and Direct Georeferencing

NovAtel SPAN OEM638

Northrop Grumman LITEF GmbH
LCI-100C

NovAtel Inertial Explorer
GNSS-IMU Post processing Software
GNSS/IMU Performance and Direct Georeferencing

**Absolute Position RMS [Meter]**

- East [m]: 0.034, 0.032, 0.030, 0.029, 0.020, 0.000
- North [m]: 0.156, 0.049, 0.044, 0.046, 0.048, 0.049
- Height [m]: 1.386, 0.844, 0.563, 0.000

**Absolute Position Standard Deviation [Meter]**

- East [m]: 0.033, 0.039, 0.038, 0.042, 0.050, 0.013
- North [m]: 0.113, 0.043, 0.042, 0.035, 0.035, 0.043
- Height [m]: 0.551, 0.911, 0.164, 0.000

- when it has to be right
GNSS/IMU Performance and Direct Georeferencing

**Absolute Angular RMS [ArcSec]**

- **Omega [arcsec]**: 6.8, 6.7, 6.7, 6.7, 9.5
- **Phi [arcsec]**: 6.5, 6.4, 6.4, 6.4, 9.8
- **Kappa [arcsec]**: 4.4, 4.6, 4.6, 4.6, 29.2

AT vs DGNSS | AT vs Final PPP | AT vs Rapid PPP | AT vs UltraRapid PPP | AT vs RealTime

**Absolute Angular Standard Deviation [ArcSec]**

- **Omega [arcsec]**: 6.8, 6.7, 6.7, 6.7, 9.4
- **Phi [arcsec]**: 6.5, 6.4, 6.4, 6.4, 9.8
- **Kappa [arcsec]**: 4.4, 4.7, 4.7, 4.6, 29.3

AT vs DGNSS | AT vs Final PPP | AT vs Rapid PPP | AT vs UltraRapid PPP | AT vs RealTime

- when it has to be right
Thank you!

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