Flight planning for city acquisition at high resolution

EuroSDR Workshop
*Oblique Cameras & Dense Image Matching*
Southampton, 19th of October 2015
Konrad Wenzel - nFrames
DSM & automatic True Orthophoto
True Orthophotos with sharp edges
Dense 3D Point Clouds

Dortmund, 10cm oblique imagery - IGI DigCAM Penta imagery - courtesy of Aerowest GmbH - Scales to large dataset
Flight planning for city acquisition at high resolution

Best practice?
Flight planning - objective

**Quality**
- Precise results
  - Sharp geometry and texture

**Productivity**
- Efficient acquisition
  - Minimal amount of flight lines
- Efficient processing
  - As less manual editing as possible
Nadir imaging – typical flight planning

» Based on DTM projections
» Definition of ground sampling distance
» In & across strip overlap
  • Formerly 60/30% – minimum number of images
  • Now typically 80% forward overlap
Oblique imaging

» Medium frame camera systems
  • Typically Maltese Cross configuration
  • >= 5 camera heads
  • Different camera tilts – 30° vs. 45°
  • Current examples:
    • Leica RCD 30
    • IGI PentaCam,
    • Microsoft Osprey
    • Track’Air MIDAS systems
        ...  

» Small frame camera systems
  • Rigs of large amounts of cameras
  • Sweeping systems, such as the VisionMap A3
Oblique imaging – typical flight planning

» Lead parameter:
  GSD and Overlap in Nadir frame

» Oblique GSD defined in image center

» Oblique overlap defined along center line in flight direction
Oblique imaging – results from the FBK study

Ewelina Rupnik, Francesco Nex, Isabella Toschi, Fabio Remondino, 2015
Aerial multi-camera systems: Accuracy and block triangulation issues.

» Simulated and real case studies for several oblique setups

➔ Oblique images
  • *increase 3D precision* and accuracy through redundancy
  • *increase block stability*

➔ 80/60 can be a compromise between data quality and flight productivity
  • More should be considered for urban complex scenes
Oblique imaging – camera tilt

» 45 degrees versus 30 degrees tilt angle
» Intersection geometry & façade visibility versus homogeneous coverage

⇒ terrain should be taken into account for flight planning

Rupnik et al, 2015
City acquisition at high resolution – nadir example at 5cm GSD
True Orthophoto – ground level
Colorized DSM – ground level

Filtering moving objects
Dense Image Matching
Pixel correspondence search for depth estimation

1) Correspondence search
2) Disparity image
3) 3D Pointcloud

➡ Relies on image similarity
Occlusions and building lean
Occlusions and building lean
Occlusions and building lean
Oclusions and building lean
10cm GSD vs. 5cm GSD – lean displacement

» Linear relation
Strong displacements – perspective distortions
10cm GSD vs. 5cm GSD – loss of overlap

» Corresponds to displacement
Challenges from terrain displacement

» Pixel shifts untreated in the traditional flight planning
  • Occlusions
  • Perspective distortions
  • Insufficient overlap
Solutions

1) Carry out flight planning at two levels
   • Minimum (1) and maximum (2) ground level
   • Overlap !>= 75%

2) Consider building lean
   • As angle and effective pixels
Conclusions and Outlook

» Dense matching products benefit from
  • High image similarity
  • Low amount of occlusions

  ➔ Automatic True Ortho, Point Clouds and Meshes

» Needs to be considered in Nadir flight planning

» Oblique images
  • Help to resolve occlusions – but not image similarity requirement
  • Oblique overlap should be > 75%
  • Oblique tilt should be chosen according to flight altitude
Conclusions and Outlook

» Flight planning needs **attention on terrain** – in particular for either case

  High resolution: <8cm GSD  **OR**  High ground undulation / narrow streets

» Longer focal lengths should be preferred for city acquisition

» **80/60** in Nadir should be ensured

» **80/80** needed for low flying altitude or large buildings

  ➔ Productivity through automatic processing