Trends for Digital Aerial Mapping Cameras

Paper by
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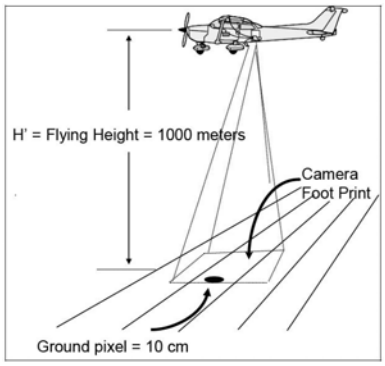
Analog Camera Parameters

- Standard square format (9" x 9" or 230 mm x 230 mm)
- Most common focal lengths: 150 mm (wide angle) and 300 mm (normal angle)
- Square format: field of view same in flight direction & across flight line
- Optical system has very high resolution
  - Good cameras: 100 line pairs/mm
  - Film for color images, only 40-50 lp/mm possible on average – based on
    - Film type
    - Atmospheric effects (dust & haze)
    - Film development

Analog Camera Parameters

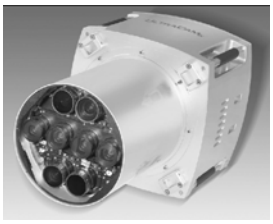


- Photo scale: $S_p = f/H'$
  - Where H' = flying height above ground

    f = focal length
- Most cases, images scanned
  - 12.5 μm – 12 μm most common scan resolutions
  - Can compute ground sampling distance (GSD)

$$GSD = S_p \times \text{scanning resolution}$$

Digital Camera Parameters



- No standard sensor format
- Most cameras have rectangular image format
  - Larger dimension across-flight direction to minimize no. of flight lines
- Focal lengths from 62 mm – 120 mm
- Because of rectangular format – field of view different in flight direction and across the flight line

Digital Camera Parameters

- Pixel size of CCD must be considered
  - Size varied from 7 μm – 12 μm
- Combination of focal length and pixel size determines operation profile
- Mission parameters – requiring GSD
  - For digital camera:

$$GSD = \frac{H'}{f} \times CCD \quad pixel\ size$$

  - For DMC, ground sample distance found by dividing H' by 10,000 (DMC has f = 120 mm and 12 micron CCD pixel size)

Challenges for Photo Flight Contracting Authorities

- Some parameters not directly transferred from analog to digital
  - Resolving power of 100 lp/mm required
  - Value cannot be used for digital sensors

- Essential for sensor design to adapt optical resolving power with pixel size of CCD
- If resolving power too high: artifacts (image aliasing) can be introduced
- Camera with 12 μm CCD pixel size requires optical design with approx 50 lp/mm optical resolution

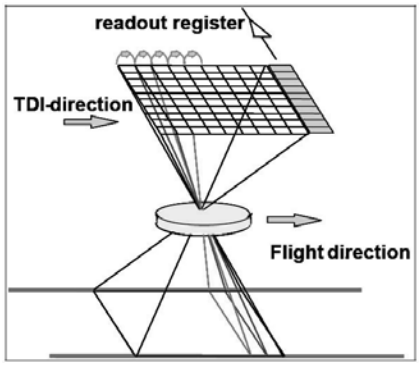
Challenges for Photo Flight Contracting Authorities

- Cameras with small pixel size cannot produce images at higher resolution than cameras with a larger pixel size
  - Ground resolution determined by
    - Flying height
    - Focal length
    - CCD pixel size
  - CCD pixel size specification makes no sense

Important Parameters for Photo Flight RFP Specifications

- GSD has to be specified
  - If too high
    - Means small pixel size on ground
    - More flight lines required
    - Amount of data per area increases
  - Recommend: specify both target GSD and minimum GSD
    - Allows flexibility due to terrain variability

Forward Motion Compensation for Digital Cameras



- Use TDI Time Delay Integration
- Only implemented on digital cameras based on frame sensors – not line sensors
- Cannot be used with cameras using CCDs with Bayer micro color filters