A Preliminary Study on Imaging Time Difference Among Bands of Worldview-2 and Its Potential Applications

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Joint Agency Commercial Imagery Evaluation
Civil Commercial Imagery Evaluation Workshop
Boulder, Colorado
March 30, 2011
Worldview-2

Launch Date: October 8, 2009, from Vandenberg AFB
Orbit: circular sun-synchronous orbit 100.2 minutes, 770 km
   a descending nodal crossing time of approximately 10:30 a.m.
Bands: 11-bit data in 9 bands: panchromatic, coastal, blue, green, yellow,
   red, red edge, NIR1, and NIR2.
GSD: nominal GSD 0.46 m (panchromatic) 1.84 m (multispectral)
Swath: The nominal swath 16.4 km.
An Airplane’s Image
An Airplane’s Image

Coastal Blue
B2

Yellow
B3

Red-Edge
B5

NIR2
B7

Blue

Green

Red

NIR1

Panchromatic
Different bands have different imaging time for the same point on the earth surface.

Moving objects have different image in the same set of satellite image.

$$\Delta t = \frac{D \times H}{f \times GSD \times LR}$$

LR is the line rate
Worldview-2 Focal Plane Layout

From “Radiometric Use of WorldView-2 Imagery (DigitalGlobe )”
Time difference?

For Quickbird L1B data, D, H, f, GSD, LR are all ready in Geo and other files
For Worldview-2 L1B data, H, f, GSD, LR are ready, but D is zero in Geo file. We have to estimate the imaging time difference of different bands.

Method1: Using the landing airplane near Hongqiao Airport
If we know the speed of the plane, and the moving distance between bands, the time difference can be estimated.
Method2: Supposing D of Worldview-2 to be the same of Quickbird
Airplane model recognition:
   Measuring the dimensions of the airplane, comparing to all models from Boeing and Airbus.
   It is a Boeing 737-400

Landing speed estimation:
   From flight manual, the land speed at this place: 145-165 knots, about 75-85 m/s
Time difference estimation

Method 1

Moving distance measuring:
- NIR2 – PAN : 9m
- PAN – NIR1 : 9m
- NIR2 – NIR1 : 17.5m

Time Difference: 17.5/80 = 0.22s for NIR1 – NIR2
Time difference estimation

Method 2

For worldview-2:
   \( f = 13.3m, \ H = 770km, \ GSD = 1.84m \) (MS), \( LR = 5000 \)
   if we suppose \( D \) of two groups of MS bands is the same of Quickbird, that is 35.14mm, then the time difference between two groups of MS bands:

   \[ \Delta t = \frac{D \times H}{f \times GSD \times LR} = \frac{35.14 \times 770000000}{13300 \times 1840 \times 5000} = 0.2211s \]

Of course, \( \Delta t \) varies according to the actual position and attitude of the satellite, this is only a rough value. But it is quite in accordance with the value we estimated by using method 1.
Applications:
1. Speed estimation
Application: Speed estimation

Part of the same image
Vehicles in Express highway
## Application: Speed estimation

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### Vehicles’ speed table
Applications:

2. Instant Traffic Animation

Three Bands play one by one in short time

Instant traffic Animation
Applications:

3. Tracking

Usually It’s Impossible to verify if it is the same vehicle
Applications: Tracking

Instant Speed Estimation
Travel Distance Estimation

Speed Estimation: 12.2 m/s

Travel Distance in 32s
Estimation: 390 m
Applications: Tracking

Size Comparison between the original bus & car and buses & car around the endpoint (Exclude opposite buses & cars)

Size Comparison Around Endpoint
Applications: Tracking

Conclusion: Yes, the same bus and the same car