COMBINING IMAGING STATISTICS AND SIDE SLITHER IMAGERY TO ESTIMATE RELATIVE DETECTOR GAINS

Cody Anderson, Dr. Andreas Brunn, Michael Thiele

anderson@rapideye.com, brunn@rapideye.com, thiele@rapideye.com

Calcon

August 27, 2012
BACKGROUND
RapidEye operates a constellation of 5 optical satellites.

- 5 spectral bands Blue (440-510 nm), Green (520-590), Red (630-685), Red-Edge (690-730), NIR (760-850).
- 6.5 m GSD, 77km swath-width.
- >5 million sq km/day imaging capacity.
- Daily revisit of any target possible!
RELATIVE GAINS

Raw Image

Relative Gains

Corrected Image

Relative Gains

Detector

Gain
PROBLEM DEFINITION

• A group of detectors can lose sensitivity fairly suddenly resulting in visible banding.

• Customer order deadlines don’t always allow for adequate statistics to be collected.

• A side slither maneuver can take away from customer collects and may take multiple days to pass over the site.

• A method to quickly and accurately correct new banding is needed.
SIDE SLITHER MANEUVER

• The side slither maneuver (SSM) involves yawing the satellite 90°.
• The focal plane is aligned with the flight direction.
• Each detector views the same location on the ground.
PROCEDURE
PROCEDURE

Collect Image Means
PROCEDURE

Collect Image Means → Compare to Previous Side Slither
PROCEDURE

Collect Image Means

Compare to Previous Side Slither

Locate New Banding
PROCEDURE

1. Collect Image Means
2. Compare to Previous Side Slither
3. Locate New Banding
4. Shift and Blend
PROCEDURE

- Collect
- Locate New Banding
- Shift and Blend
- Final
PROCEDURE DETAIL
LOCATE NEW BANDING
MEDIAN/MEAN FILTER FIT

Previous Side Slither Gains
Stat Mean Gains

Side Slither Gains Compared to Stat Mean Gains

Median/Mean Fit

Side Slither Gains Compared to Stat Gains with Filtered Fits

Side Slither Gains Fit
Stat Mean Gains Fit
PROCEDURE DETAIL
LOCATE NEW BANDING
CONTINUUM FIT

SIDE SLITHER GAINS FIT
STAT MEAN GAINS FIT

SIDE SLITHER CONTINUUM FIT
STAT MEAN CONTINUUM FIT
PROCEDURE DETAIL
LOCATE NEW BANDING
CONTINUUM REMOVAL

Remove Continuum

Side Slither Gains Fit
Stat Mean Gains Fit
Side Slither Continuum Fit
Stat Mean Continuum Fit
PROCEDURE DETAIL
LOCATE NEW BANDING

DIFFERENCE BETWEEN SSM AND STAT

Continuum Removed Side
Slither Gains Fit
Continuum Removed Stat
Gains Fit

SSM-STAT

Continuum Removed Side
Slither Gains Fit –
Continuum Removed Stat
Gains Fit
PROCEDURE DETAIL
LOCATE NEW BANDING
BAND LOCATIONS

Band Locations are greater than 1 standard deviation of the Continuum Removed Side Slither Gains Fit.

Band Starting and Ending Points are near (Threshold 0.005) a zero difference between the SSM and STAT continuum removed fits.
If an End and Start point are within 1000 detectors of each other, it is considered one single band.
PROCEDURE DETAIL
SHIFTING AND BLENDING

• The statistically derived relative gains at the new band location must be shifted and blended into the previous side slither gains.
• 500 detectors are used to blend the two sets of gains.
• 1000 detectors are used to shift the statistic relative gains.
PROCEDURE DETAIL
SHifting AND BLENDING

SHIFTING

Mean of 1000 SSM
Shifting Detectors

Mean of 1000 STAT
Shifting Detectors

Shifted Statistics Filtered Fit

Stat Fit
Level Shift
Shifted Stat Fit

Side Slither Rel Gain Fit
Statistic Rel Gain Fit
Shifted Stat Rel Gain Fit
PROCEDURE DETAIL
SHIFTING AND BLENDING

BLENDING

- A weighted average between the statistic and side slither individual gains is used to blend to two sets of gains.

- The detector closest to the band location is 499 parts Stat and 1 part Side Slither, the next is 498 parts Stat and 2 parts Side Slither, and so on.

- Finally, the rest of the Side Slither Gains are used for all other detectors.
RESULTS
SAUDI ARABIA (02/20/2012)

Previous SSM
Acquired on 01/20/12

Statistics
Stats gathered between 02/16/12 - 03/08/12

Combination of Stats and Previous SSM

New SSM
Acquired on 03/08/12
Absolute Difference Images

SSM-Stat  SSM-Comb

Detector Means

W/(sr*m²)

Radiance

Detector
BRAZIL (02/18/2012)

Previous SSM
Acquired on 01/20/12

Statistics
Stats gathered between 02/16/12 - 03/08/12

Combination of Stats and Previous SSM

New SSM
Acquired on 03/08/12
Absolute Difference Images

SSM-Stat  SSM-Comb

Detector Means
CONCLUSIONS

• Clearly Side Slither is still the best method.

• The amount of visual banding in the Combination method is better than the STAT method.

• The main difference between the STAT and Combination methods is what happens to underlying gradient structure in the images.
  • The STAT method changes the gradient significantly while the Combination method preserves it.