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THERMAL HYPERSPECTRAL SENSOR TECHNOLOGY COMPARISON:
Push-broom AisaOWL – Imaging FTIR Telops Hypercam

- Chapter 4 – Blinking pixels -

4. BAD AND BLINKING PIXELS

Currently MCT is the most sensitive commercial LWIR detector technology. Both AisaOWL and Hypercam employ it. Any LWIR MCT detector array, independent of the array manufacturer, includes both actual bad pixels and blinking (flickering) pixels, which influence the data quality and require specific corrections in data processing.

Bad pixels are pixels which do not react properly to light, i.e. they stay dark or bright (saturated). The number of bad pixels is typically 1 % of the pixels.

Blinking pixels react properly to light. Blinking is caused by randomly varying dark current in these pixels. Typically dark current varies (jumps) between 2 or 3 levels (states). The number of blinking pixels in a LWIR MCT detector array is significantly higher than that of the bad pixels, from 5 to 9% depending on the set criteria for the signal variation. Thus proper handling of the blinking pixels is in fact more relevant for the data quality and information retrieval from the data. Handling of the blinking pixels is challenging due to following random-type characteristics in the blinking phenomenon:

- Blinking frequency typical varies from pixel to another, in the range of approx 50 Hz to 0.01 Hz.
- Even though the entire map of blinking pixels remains fairly constant, there may be large variations in the map of the pixels that actually blink after each power-up of the detector.

Due to the varying appearance of the blinking pixels, a fixed blinking pixel map is not relevant. SPECIM has chosen an approach to map the blinking pixels for each flight line as part of the data processing. It takes place by collecting a number of image frames (typically 1024 frames) from an internal shutter (= a uniform target) in the AisaOWL sensor at the end of each flight line. After radiometric processing of the data, blinking pixels are detected from the shutter data as pixels that have standard deviation in their radiance signal larger than a set threshold (like 1.5 %). In the actual flight line data, these pixels are then replaced by the value of each blinking pixel's neighboring **spectral** pixel.

Figure 7a and 7b show an example of actual blinking pixel map from two different flights (a day and night flight line from the data collections with SPECIM **demo sensor** in Israel in 2013), determined with >1% standard deviation threshold in signal variation. Also a difference map between the two maps is presented (Figure 7c), demonstrating significant difference in the appearance of the blinking pixels.

A note regarding the demo sensor used in 2013 data collection:
At the time of building that demo sensor, SPECIM did not have a detector array with full specifications available for the demo instrument, and it was built by using a detector array which had more clustered bad and blinking pixels than there is in a typical production unit. Figure 7d shows a typical blinking pixel map from a standard AisaOWL instrument, with mainly single individual blinking pixels.

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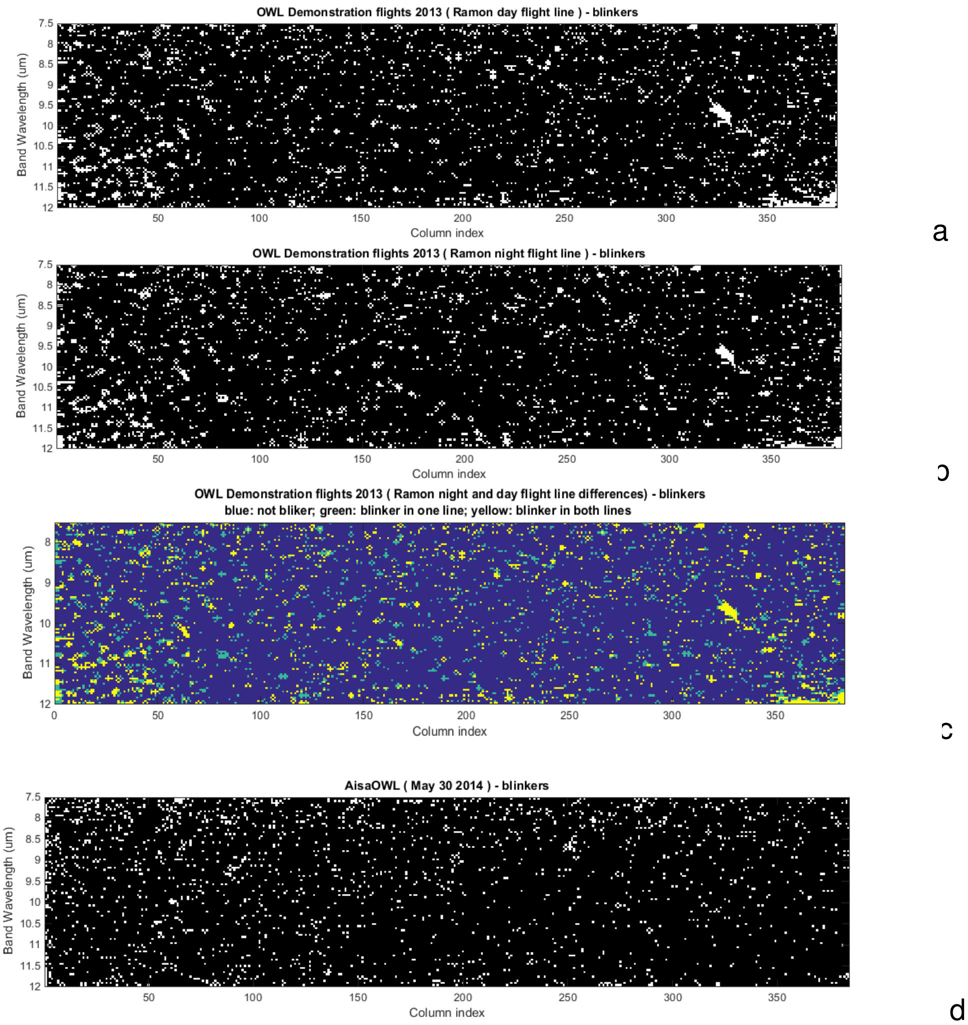

Figure 7.

4.1. Appearance of blinking pixels in push-broom data - AisaOWL

Majority of blinking pixels are single individual pixels, and appear as single pixel peaks in the push-broom spectral data, as shown in the red spectrum (at the green pointer line) in Figure 8. Spatially, blinking pixels appear as dotted stripes in the push-broom image. As the optics in AisaOWL is designed to meet the sampling theory, the optical spot size is approx 2 times the pixel size. Thus a single peak in the spectral data can always be considered as an artifact, and correcting the peak by replacing it by a neighboring **spectral** value does not deteriorate the actual information in the push-broom data.

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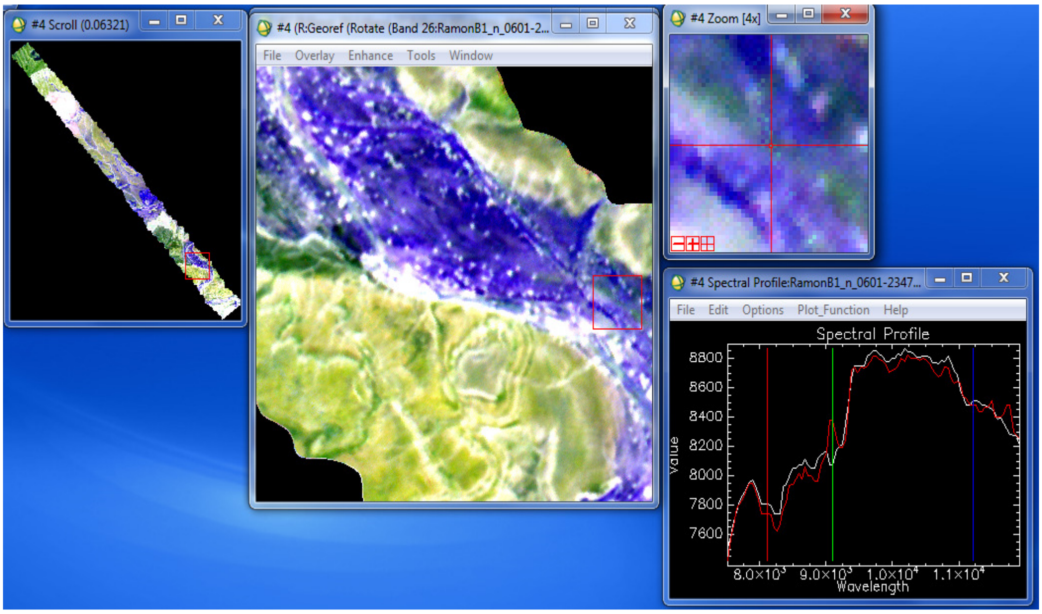

Figure 8. Blinking pixel appearance in push-broom data (AisaOWL).

4.2. Appearance of blinking pixels in imaging FTIR data - Hypercam

In the FTIR, pixel blinking causes variation(s) in the signal level during the acquisition of the interferogram. Through the Fourier Transform, these signal variations in the interferogram create error frequencies in the spectrum, which appear as noise **in the entire spectrum** (see Figure 8b), and thus spoil the entire spectral data in that spatial point in the image.

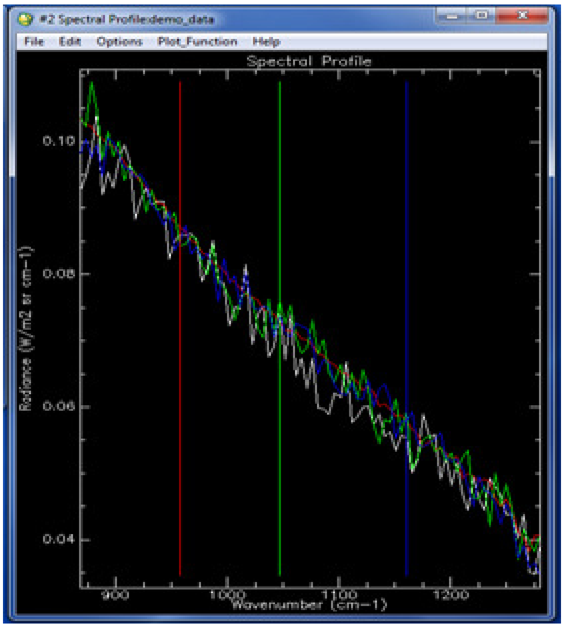

Figure 8b. Blinking pixel appearance in imaging FTIR data. Red curve is un-disturbed spectrum while white and green curve show disturbances caused by blinking of pixels.

In fact, these spectral errors caused by pixel blinking are similar to the errors caused by pixel misregistration over a contrast edge during the image acquisition (see chapter 1).