Mapping Matters

By Qassim A. Abdullah, Ph.D., PLS, CP

Your Questions Answered

The layman's perspective on technical theory and practical applications of mapping and GIS

Q: In your article in the February 2007 issue of the PE&RS on recent technologies of digital aerial sensors you hinted at two different designs based on "push-broom" and the "framing" concepts. Could you please elaborate more on these two concepts?

Anonymous, Frederick, MD

Answer: As for the first design, the term "push-broom" was the right choice of words to describe this type of imaging or scanning technologies. It simply implies the sweeping of a segment of the ground along the flight path of an airborne or space vehicle. The resulting image could be as long as the flight line of the airborne vehicle or the orbital distance the space vehicle travels. On board storage or size limitation of a certain raster file format are the only limitations on how long of an area on the ground a single image can cover.

The Charged Couple Device (CCD) array used for the "push-broom" sensor is a "linear array" of typically one pixel along the flight direction and several thousand pixels across the flight direction. The reflected light energy from the ground underneath or around the airborne or space vehicle passes through a slit at the bottom of the sensor and through a lens before it hits and exposes the CCD of the linear array. Here it is worth mentioning that there is no shutter mechanism or any moving parts involved in the build of this type of sensor. Depending on the sensor integration time and aircraft speed, a slice of the ground that is one GSD wide along the flight direction and several thousand GSD across the flight direction will be recorded and the cycle will be repeated for the next slice while the aircraft is moving forward. Those added image slices form the long image of that flight line. One of these long images can cover hundreds of miles along the flight direction.

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On the other hand, the "framing concept" implies the formation of a square or a rectangular image that is formed when a square or a rectangular CCD array is exposed simultaneously during the opening of the shutter at certain intervals, similar to the concept of the aerial film camera.

The two concepts were adopted in order to replace the film as recording media with digital recording technologies. However, film cameras offered wide area ground coverage that is unmatched by any single "area array" of CCD existing in the market today, therefore, alternative designs were needed to overcome the limitation in the size of a single CCD array. Manufacturers of the new digital "framing" sensors adopted multiple smaller sensor heads (cameras) that are configured in such a way that the merging of these overlapping smaller images forms a larger image in order to overcome this limitation. As for the "push-broom" sensors, a single "linear array" of 1 pixel wide and 12,000 pixels long, which is readily available in the market, was utilized to provide wide imagery coverage.

Whether it is based on push-broom or framing designs, both types of sensors are operational and are used today to replace film cameras. In addition, both types of these digital sensors are proven to have solid geometrical and radiometric qualities that in some cases surpass the quality of film-derived imagery. Accurate imagery with ground sampling distance (GSD) of 5 cm or smaller is attainable and proven useful for map making to meet all accuracy standards.

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One main difference remaining between the two approaches is the nature of the natural color and colored infrared image formation. While the push-broom sensor collects all bands (panchromatic, red, green, blue, and near-infrared) with the same project-specific required GSD, the framing camera collects only the panchromatic band with project-specific resolution, while it collects the colored bands with coarser resolution. The natural color imagery in the project-specific resolution is obtained through a process that many of us referr to as the "pan-sharpening" process in which some of the color contents of the coarser resolution color pixels is fused into the same contents of the panchromatic genuine resolution resulting in a colored pixel possessing the project-specific required GSD. The pan-sharpening technique has been used for a long time to produce color imagery from satellite sensors and it produces reliable and accurate natural color and colored infrared imagery. However, the remote sensing community still needs to examine and address some concerns as to whether the pan-sharpening process has any effect on the quality of the digital image processing and multi-spectral classification processes.

Please send your question to Mapping_Matters@asprs.org and indicate whether you want your name to be blocked from publishing.

Answers for all questions that are not published in *PE&RS* can be found on line at www.asprs.org/Mapping Matters.

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