Mapping Matters

Your Questions Answered

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

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

Question: What is the correlation between pixel size of the current mapping cameras in use and the mapping accuracy achievable for a given pixel size? e.g. for data collected at a 30 cm GSD what would be the best mapping horizontal accuracy achievable?

Dr. Abdullah: Unlike film-based imagery, digital imagery produced by the new aerial sensors is not referred to by its scale as the scale of digital imagery is difficult to characterize and is not standardized. Digital sensors with different lenses and sizes of the Charge Coupled Device (CCD) can produce imagery from different altitudes with different image scales, but with the same ground pixel resolution. In addition, the small size of the CCD array of the digital sensors results in very small scale as compared to the film of the film-based cameras. This latter fact has made it difficult to relate the image scale to map scale through a reasonable enlargement ratio as is the case with film-based photography. As an example, the physical dimension of the individual CCD on the ADS40 push broom sensor is 6.5 um; therefore for imagery collected with a Ground Sampling Distance (GSD) of 0.30 m, the image scale is equal to (6.5/0.30x1000000) or 1:46,154. Such small scale can not be compared to the scale of the equivalent film imagery or 1:14,400 which is suitable to produce maps with a scale of 1:2,400 or 1"=200'. Here, the conventional wisdom in relating the negative scale to map scale, which has been practiced for the last few decades is lost, perhaps forever. Traditionally in aerial mapping, the film is enlarged 6 times to produce the suitable map or ortho photo products. This enlargement ratio is too small to be used with the imagery of the new digital sensors if we equate the CCD array to the film of the film-based aerial camera. Imagery from the ADS40 sensor as it is used today has an enlargement ratio of 19! Traditionally, aerial film is scanned at 21 um resolution and Table 1 lists the different film scales, the resulting GSD, and the supported map scale based on an enlargement ratio of 6.

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Similar measures have been adopted for the new digital cameras as data providers and clients alike are familiar and comfortable with the values given in Table 1. Determining the vertical accuracy from digital sensors is no different from the horizontal accuracy as we adopted the same measure we used for film cameras to the new sensors. As it is given in Table 2, digital imagery collected at nominal GSD of 0.15 m is considered to support 0.60 m (2 foot) contours interval accuracy or an RMSE of 0.20 m according to the ASPRS map accuracy standard. This has been practiced despite the fact that the two-foot contours support was determined in the past based on the c-factor limitation of the stereo plotters used at that time. Table 2 provides the supported map products from digital sensors collected with different ground resolutions as practiced today.

Users of digital cameras are experiencing improved map quality and accuracies that exceed those given in Table 2. In other words, imagery from a good digital sensor with a GSD of 0.15 m may be suitable for map scale larger than 1:1,200, and in the future we may need a new standard for the digital camera products that reflects the improved quality and stability of these digital sensors.

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Table 1. Film-based mapping scale

Film Scale	Scanning Resolution	Resulting GSD (m)	Supported Map Scale	Supported Contour Interval (m)
1:7,200	21 um	0.15	1:1,200	0.60
1:14,400	21 um	0.30	1:2,400	1.50
1:28,800	21 um	0.60	1:4,800	3.00

Table 2. Digital Camera-based mapping scale

Image GSD (m)	Ortho GSD (m)	Supported Map Scale	Supported Contour Interval (m)
0.15	0.15	1:1,200	0.60
0.30	0.30	1:2,400	1.50
0.60	0.60	1:4,800	3.00