

Is the world flat?

—by Dave Knopp and Harold Schuch

Currently, several new developments are allowing the processing of large photogrammetric blocks. They are:

- Cameras have become much more precise;*
- Lens distortion has become smaller than image measurement resolution;*
- Model and strip connections are strengthened through the use of much larger number of points (autocorrelation);
- AT and orthorectification software can handle much larger data sets;
- Disk memory has become less expensive; and
- Computers are much faster; and

As a consequence, it has become possible to process much larger image blocks without breaking blocks up into sub-blocks.

Blocks and Earth curvature

If one analyzes the mathematical models normally applied to build photogrammetric blocks through collinearity, it easily becomes evident that they contain no observation equation or condition components that twist the block into a plane feature set. Therefore, if one builds a photogrammetric block on the basis of pass/tie point connections alone (including perspective center points), this block will naturally assume the curved shape of Earth, as it was flown in 3D space.

Figure shows this in a much exaggerated manner to make the point. It shows a

photogrammetric block of two strips, in its natural relaxed state in space. The Earth's surface is curved—the flight follows that curvature—and once properly oriented relatively, each model holds a curved ground surface. Consequently, each strip is curved in all directions.

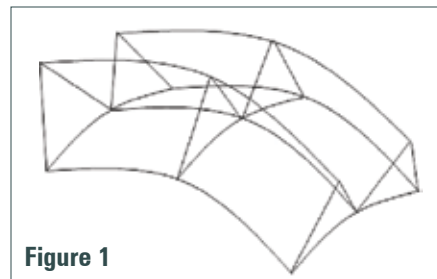


Figure 1

Ground control and Earth curvature

Alternatively, ground control as utilized nowadays consists of two parts: One horizontal component that normally is expressed in a State Plane Coordinate System (a Cartesian coordinate reference), and a vertical component that represents elevations above a Mean Sea Level of sorts. As implemented, these ground control systems (horizontal and vertical) are simply assumed to form one single Cartesian system (right-handed, orthogonal, and of equal scale in all axes). [See Figure 2.]

Unfortunately, this is not really so. Any horizontal coordinate system that is based on a projec-

* Conventional 9" x 9" frame cameras.

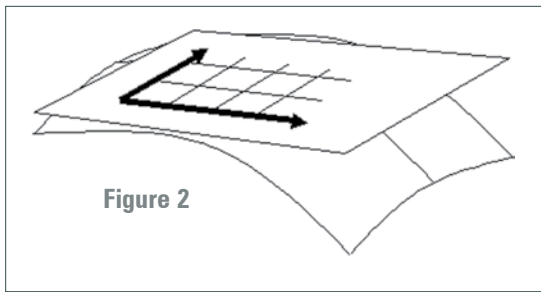


Figure 2

tion will be affected by scale factors that change continuously from one side of a projection zone to the other. These scale factors represent may be insignificant, but if precision in large projects are pursued, this can become relevant.

Vertical control is not parallel; it is really based on plumb lines that are roughly radiating out from the center of the Earth [if we ignore deflections of the vertical for now]. [See Figure 3.]

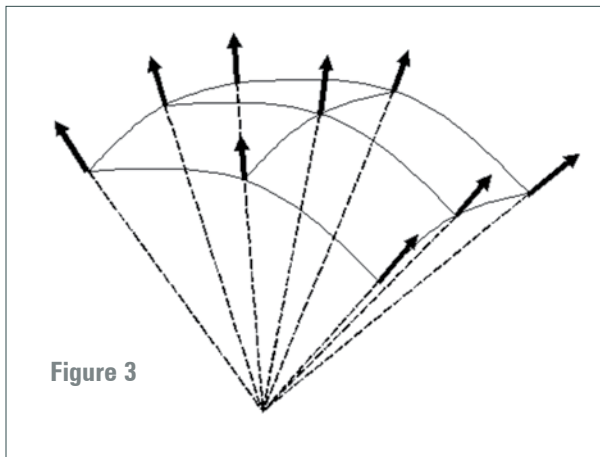


Figure 3

A blind combination of these two very dissimilar reference systems may not be ignored in larger projects. Modern block adjustment programs allow the introduction of an earth curvature correction factor (as with MATCH-AT). However, the application of this factor is systematic and usually not applied correctly.

Therefore, any large photogrammetric block should be fitted to a ground control system that reflects the natural shape of the block, and should not try to flatten the block through the use of a systematic and artificial factor. A method has to be introduced that takes the actual three-dimensional shape of a large photogrammetric block and references it in the correct three-dimensional (curved) control field.

Given that photogrammetric blocks naturally follow the earth's curvature, and analytical block formation tends to reconstruct that shape as a first and fundamental approach, it would make sense to work in 3D space as a better approach.

If one adds that GPS positions are by definition based on a geocentric and Cartesian coordinate system (X, Y, Z) that is natively cohesive and naturally capable of expressing 3D shapes, it make sense if one expresses control in that space before building the photogrammetric block (as shown in Figure 4).

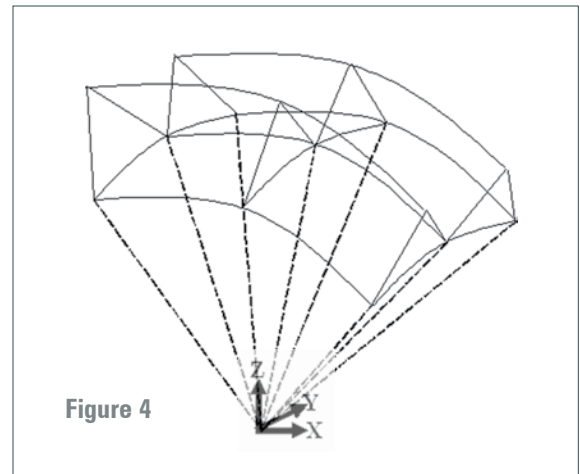


Figure 4

Once a large block has been referenced to a geocentric X-Y-Z system, all other data representations (spheroidal representations and various projections) become mere special and precise renditions of the geocentric data set.

The solution of large and precise photogrammetric blocks is made possible without changing the formulation of the Collinearity conditions. All it takes is to use geocentric coordinates (X-Y-Z) for each ground control point. Also, the coordinates for the perspective points (camera stations as observed through AGPS) would have to be expressed in geocentric coordinates as part of post processing.

In a sense, aerial mapping within large-area projects would become much more akin to close-range photogrammetry in formulation, and would reflect earth detail with any desired precision levels.

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