

Aerial Photography

Yosef Bodovski

Description and techniques

Since the 1940s, aerial photographs have been the primary source of data used by USGS (United States Geological Survey) and similar agencies to create and revise topographic maps. Before then, topographic maps were compiled in the field using magnetic compasses, tapes, plane tables (a drawing board mounted on a tripod, equipped with an leveling telescope like a transit), and even barometers to estimate elevation from changes in air pressure. Although field surveys continue to be important for establishing horizontal and vertical control, photogrammetry has greatly improved the efficiency and quality of topographic mapping.

A straight line between the center of a lens and the center of a visible scene is called an optical axis. A vertical aerial photograph is a picture of the Earth's surface taken from above with a camera oriented such that its optical axis is vertical. In other words, when a vertical aerial photograph is exposed to the light reflected from the Earth's surface, the sheet of photographic film is parallel to the ground. The nominal scale of a vertical air photo is equivalent to f / H , where f is the focal length of the camera (the distance between the camera lens and the film -- usually six inches), and H is the flying height of the aircraft above the ground. It is possible to produce a vertical air photo such that scale is consistent throughout the image. Unfortunately, this is only possible if the terrain in the scene is absolutely flat. In rare cases where that condition is met, topographic maps can be compiled directly from vertical aerial photographs. Most often however, air photos of variable terrain need to be transformed, or rectified, before they can be used as a source for topographic mapping.

To understand why topographic maps can't be traced directly off of most vertical aerial photographs, we first need to appreciate the difference between perspective and planimetry. In a perspective view, all light rays reflected from the Earth's surface pass through a single point at the center of the camera lens. A planimetric (plan) view, by contrast, looks as though every position on the ground is being viewed from directly above. Scale varies in perspective views. In plan views, scale is everywhere consistent (if we overlook variations in small-scale maps due to map projections). Topographic maps are plan views. Vertical aerial photographs are not, unless they happen to be taken over flat terrain. Aerial photographs need to be transformed from perspective views into plan views before they can be used to trace the features that appear on topographic maps.

The scale of an aerial photograph is partly a function of flying height. Thus, variations in elevation cause variations in scale on aerial photographs. Specifically, the higher the elevation of an object, the farther the object will be displaced from its actual position away from the principal point of the photograph (the point on the ground surface that is directly

below the camera lens). Conversely, the lower the elevation of an object, the more it will be displaced toward the principal point. This effect is called relief displacement.

It is possible to produce a single photographic image in which distortions caused by relief displacement have been removed. Such a photograph is called an orthophoto. Like any other plan view, an orthophoto depicts a scene as though every point is viewed from directly above. It can be created through a process called rectification. Before the computer software was developed enough photogrammetrists had to create very large map from multitude of aerial photos by fitting them together. It was very messy and not efficient process. Nowadays, digital aerial photographs can be rectified in an analogous way using specialized photogrammetric software. One of the most effective techniques is called stereoscopic, which briefly can be described as superimposition of two or more stereoscopic (3D) images of the same area.

Sources

One of the biggest manufactures of Aerial Photography is the [U.S. National Aerial Photography Program](http://edc.usgs.gov/products/aerial/napp.html) (<http://edc.usgs.gov/products/aerial/napp.html>) which is a part of United States Geological Survey (USGS). It sponsors vertical aerial photography of the entire lower 48 states every seven years or so at an altitude of 20,000 feet, suitable for producing topographic maps at scales as large as 1:5,000. The program provides a standardized set of cloud-free aerial photographs covering the conterminous U.S. over five-to-seven year cycles. The program began in 1987 and continues to be our most recent and consistent source of high-quality aerial photography. The High and Medium resolution photos are available for downloaded from web site or ordered on CD and DVD.

Another big source of aerial photos is [TerraServer](http://www.terraserver.com/) (<http://www.terraserver.com/>) imagery portal. Its catalog consists of recent true color, high-resolution aerial photography of many of the top cities in the USA. The pictures are available in different sizes, from small (500x500pixels) to 3XL (2500x2500pixels). The max resolution of the pictures is 0.1524 meter (6 inches). The site also has links to another providers of photo images such as Digital Globe or SPIN2.

[TerraFly](http://www.terrafly.com/) (<http://www.terrafly.com/>) offers aerial photo imagery derived from USGS Digital Orthophoto Quadrangles (DOQs). Imagery has been orthorectified, i.e. altered for precise mapping. Aerial photo imagery is available over almost any area of your choice within the continental United States at 1-meter resolution or better (at 1-meter resolution 1meter=1pixel). Some urban area available at 1-foot and better resolutions.

If you want to make to someone a special present or just enjoy nice aerial images, visit [SkyPic](http://www.skypic.com/index.html) web site (<http://www.skypic.com/index.html>). The gallery contains over 8000 images of New England coast, the Florida coast, national parks, California, Caribbean, Bahamas, Virgin Islands, colleges, ships lighthouses, stadiums, major cities, and ski areas. This is rich and very impressive collection.