Tiled Image Archival and Distribution for Seafloor and Terrestrial Imagery

E. Ioup, J. Sample, and F. McCreedy
Marine Geosciences Division

Introduction: The Navy and other Department of Defense activities collect and archive large amounts of imagery of the Earth's seafloor and terrestrial surfaces for distribution to users in the tactical, intelligence, or scientific communities. This imagery is high resolution and collections can be quite large; the compressed 1 meter per pixel imagery of the U.S. is approximately 3 terabytes. Storing the high-resolution imagery as flat files on a hard drive or in a database is problematic because the system must perform time-consuming loading, decoding, and post-processing of large numbers of images for every request by a user. The tile archival and distribution system developed by the Naval Research Laboratory's Mapping, Charting, and Geodesy Branch of its Marine Geosciences Division solves these problems and provides a sophisticated and comprehensive method of imagery management.

Tile Organization and Creation: The tile archival and distribution system works by preprocessing imagery once before it is used. Our system stores all imagery as fixed size image tiles at a number of predefined map scales. The lowest map scale partitions the world into two tiles: a tile matrix of one row and two columns. All consecutive scales have double the number of rows and columns as the previous scale. Figure 4 shows the Western Hemisphere divided by several scales of tiles. This system allows for arbitrarily high map scale, although it is rarely necessary to have more than 20 scales. An image tile may be any size but we chose to use 512 × 512 images. A 512 × 512 image tile provides a compromise between limiting image size and limiting the number of images required to fill a user's map.

The process of tile creation involves a few basic steps. First, the image is decoded from its original image file format and, if necessary, reprojected into a geodetic projection. Our reprojection algorithm performs a pixel-by-pixel reprojection to ensure that tiles align on the edges, but improves performance by creating a matrix of conversions and linearly interpolating between values. (This algorithm is the subject of an NRL patent application filed in 2007.[1]) Next, the image is resized to the closest native tile scale and pasted into the appropriate tiles. When all original images have been processed, the highest scale is used to create the lower scales. Each tile in the lower scale can be created by resizing and combining tiles in the higher scale. Data updates are performed by using new data to create tiles to replace old tiles and recreating the lower scales in areas that changed.

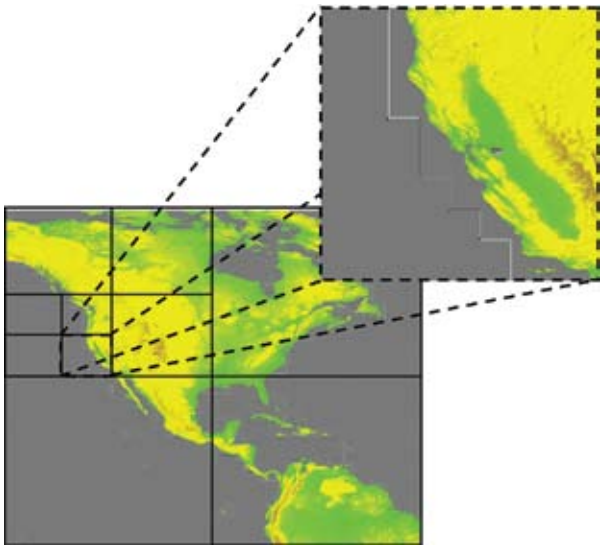

FIGURE 4
An example world image broken into successively higher resolution tiles. Higher resolution tiles cover the same geographic area, but contain more highly detailed imagery.

Tile Image Distribution: The tile archival and distribution system is especially well suited to online distribution of imagery. We have created a tile server to provide direct access to tiled imagery over the Internet. Each image tile is accessible from the tile server via a unique URL containing the scale, row, and column of the tile. This URL allows both Web browser clients and standalone clients to access tiles quickly and easily. These clients will retrieve tiles from the tile server and manage the map view themselves. Clients determine which tiles are necessary for a particular geographic area desired by the user. These clients will only usually display the map scales natively supported by the tile server, thus no costly image processing must be performed on either the server or client. Google Earth and other tile-based clients are compatible with this methodology.

Our tile server also supports the Web Map Service (WMS), a standard and popular method of distributing imagery over the Internet. WMS allows users to request imagery of any size over any geographic area. To fulfill a WMS request, the tile server mosaics the tiles of the closest map scale to the request and rescales the result to match the desired image size. This method is superior to using the original imagery, which requires loading each high-resolution image file, constituting possibly terabytes of imagery for large areas, in order to fulfill a request.

Mobile and disconnected systems have limited resources available for imagery storage and processing,

both of which are taxed if required to handle high-resolution imagery. Deploying tiled data provides a number of advantages. We can deploy tiles covering limited areas and at lower resolution than the original imagery in order to save storage space. Our mobile applications require little processing power because no image processing is necessary to directly use tiles.

Conclusion: The NRL-developed tile archival and distribution system has provided significant advancements in how imagery of the Earth's surface and seafloor is currently used by a number of Department of Defense agencies, including the National Geospatial-Intelligence Agency, the Marine Corps System Command, Naval Explosive Ordnance Disposal, and NRL's Naval Center for Space Technology.

[Sponsored by NRL]

Reference

[1] E.Z. Ioup, H.C. Mesick, and J.T. Sample, "Method for Efficiently Transforming a Raster Image from One Map Projection to Another Map Projection," U.S. Patent Appl. 11/673,363, Feb. 2007.