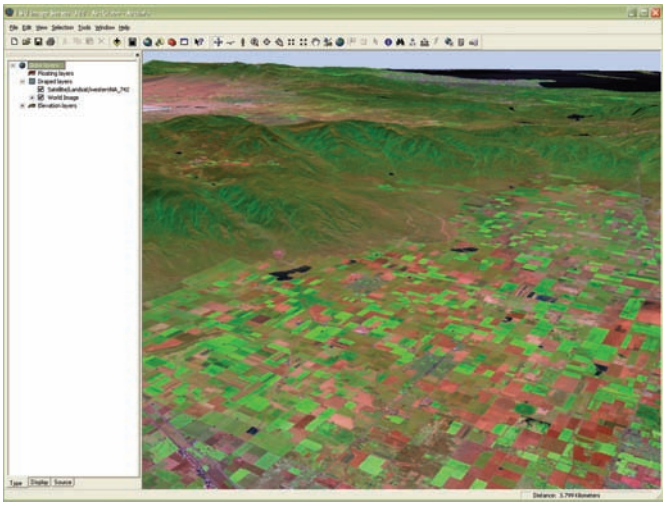
Access to Geospatial Imagery with ArcGIS Image Server

By Peter Becker

The volume of geospatial imagery in existence is huge and with the proliferation of new aerial and satellite sensors it is growing exponentially. With the advent of publicly accessible Web sites that provide fast access to consumer grade imagery, the demand for imagery both as a background in many applications, as well as for analysis and interpretation, has substantially increased. There are many users who are happy with the consumer grade imagery and interfaces that are freely available; however, there are many others, whose jobs, businesses and sometimes their lives rely on imagery requiring them to have access to the best imagery for their varied needs, and the important associated metadata.

Currently only a fraction of the acquired and available imagery is actually used. This use is also limited to only a small percentage of the users that could gain from accessing it. The key reason for this is not a lack of available imagery, but image access. The conventional workflow for making georeferenced imagery accessible to users does not scale to users' demands. Typically the time frames for creating the required image products are too long, the image products themselves are too large and the process of distributing the imagery is too cumbersome. As a result, the cost in both dollars and time to create a suitable image product is too high and the value of imagery becomes lost. Additionally the extensive preprocessing of imagery results in a loss of image depth in terms of the radiometric bit depth, number of radiometric bands, image overlap, quality and associated metadata.



In ArcGlobe, a Landsat image combining bands 7,4,2 is draped over 3D elevation data.

Manage, Process and Distribute Imagery

ArcGIS Image Server, a new product from Environmental Systems Research Institute (ESRI), redefines how imagery is managed, processed, and distributed. It provides fast enterprise-wide access to very large image datasets within GIS, CAD, imaging, and Web applications. Instead of the traditional process of attempting to take all imagery and mosaicking it into a single fixed image dataset, ArcGIS Image Server enables the data to remain in its native form as many individual images and then processes and mosaicks the imagery on demand. The imagery used by ArcGIS Image Server can be in different compressed or uncompressed formats stored as files or within a DBMS. Existing data can be used directly without expensive reformatting or loading. The imagery can be the preprocessed tiled and mosaicked imagery that has been traditionally delivered to organizations such as DOQQ, NAIP and SRTM. Such images have lost much of their original image depth. The imagery can also be large numbers of individual georeferenced yet overlapping frames, such as QuickBird Standard imagery, Landsat 1G or orthorectified image frames. Alternatively, the imagery can

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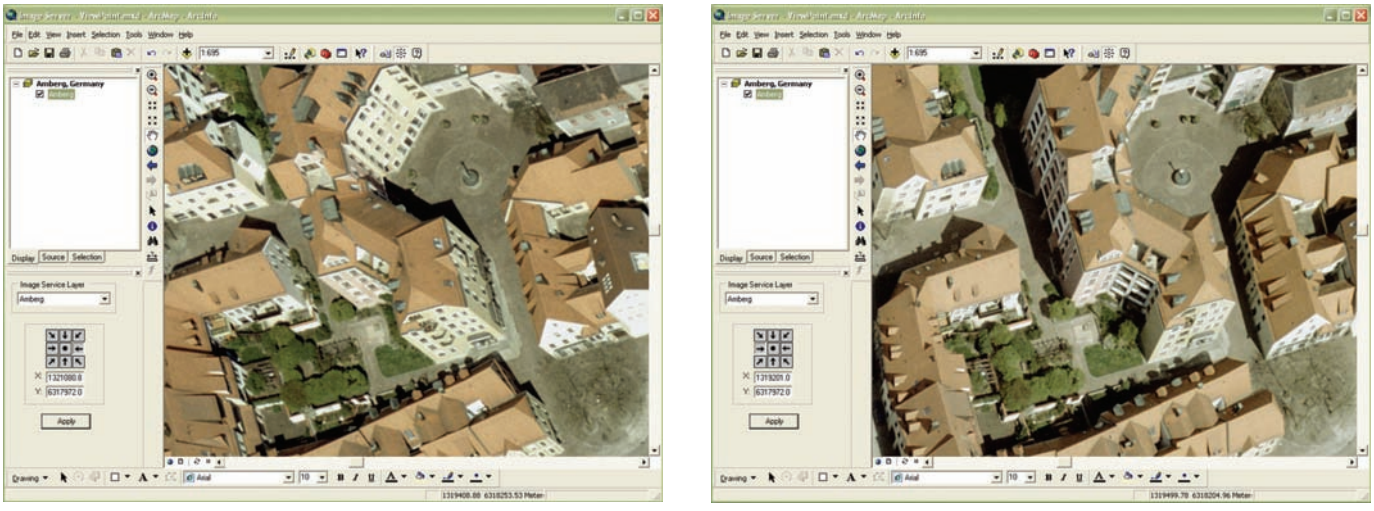

Effectively manage overlapping imagery by defining different mosaicking methods. The imagery can be ordered based on an attribute such as date, quality, or even viewpoint location, which enables the sides of buildings or an occluded feature to be visible – Amberg Germany is seen here from the east (left) and west (right).

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remain as nonrectified aerial frames from a digital mapping camera or satellite scenes such as QuickBird Basic imagery.

Easy Authoring of an Image Service

An image service is created using an authoring tool in ArcGIS Desktop that defines the properties of the image service and of each image, as well as any processing to be applied to the imagery, and the rules for the mosaicking. Each image service can include a large number of different images and each image can have different processes applied, be in different projections, have different resolutions, or be in different file formats. This provides great flexibility in the images that can be used. An image service is then published by the server component of ArcGIS Image Server, and client applications access the image service as a single virtual mosaic. As the client application pans or zooms around, the server extracts and processes the images covering the area of interest and provids a final mosaicked image to the client application. Both the image data access and processing is highly optimized such that the time from request to image display is near instantaneous.

Dynamic Image Processing

The image processing defined in an image service is referred to as a process chain. A process chain can include a range of different radiometric and geometric processes that are strung together to produce the required output. Radiometric processes can be used to enhance the imagery, pan-sharpen, or perform different types of image algebra, such as the NDVI (Normalized Difference Vegetation Index) used to determine biodiversity. Geometric processes are used to georeference, orthorectify, or clip imagery.
Image services can be dynamically updated by adding new imagery or changing the processing properties. The processing capability combined with the ability to directly read imagery in its native format, enables ArcGIS Image Server to substantially reduce the time or latency in making imagery accessible, thereby further increasing the value. Graded image services can also be created. Such services initially utilize preliminary georeferencing and radiometric processing parameters obtained from supporting sensor metadata. As revised parameters become available and are included in the image service, the grade of the image service increases without the need to reprocess or deliver new imagery.

With ArcGIS Image Server, end users (clients) have fast access to imagery; they can also interact with the image service to change some of the service properties. For example, they can change the compression of the transmitted imagery they view. The imagery on the server can be stored in multiple compressed and uncompressed forms. After processing a request, the server can compress the data for transmission. This compression can be changed by the client application. Users working across low band-width connections can set the compression high to access imagery quickly for purposes such as navigation. When these users find their area of interest, they can reduce or remove the compression to obtain the best quality imagery. Other properties that can be changed include the sampling and mosaic methods.

Different applications may require different sampling methods. For example, to obtain the highest radiometric accuracy the nearest neighbor sampling method is preferable, but for better feature definition the bilinear or cubic convolution sampling methods are preferred. ArcGIS Image Server applies only a single sampling of the image from source to screen, irrespective of the different processes, such as orthorectification or reprojection applied to the image. This results in higher quality imagery.

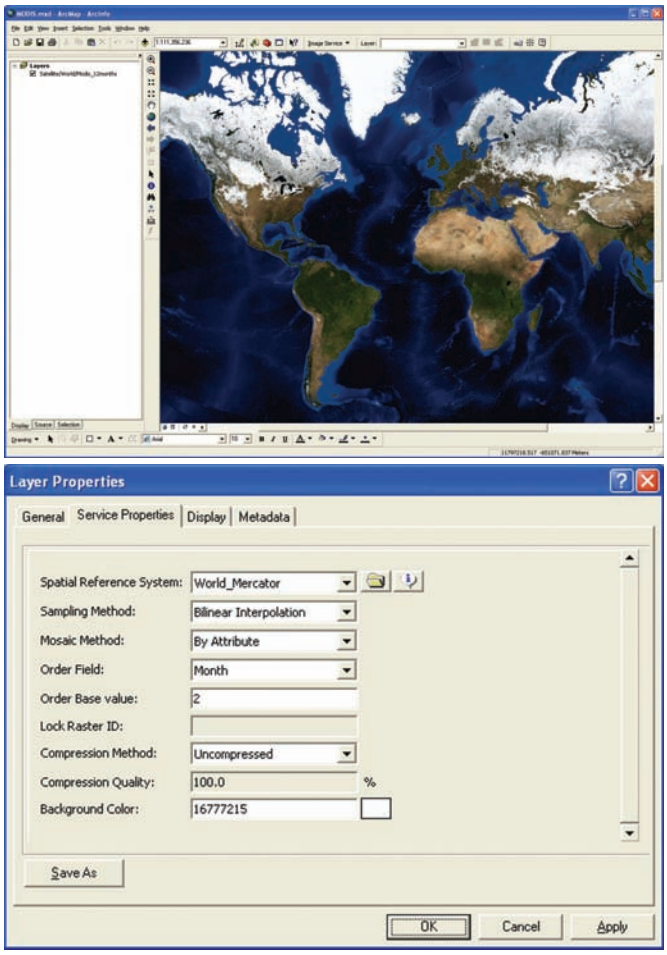

Figure 1. An example of MODIS imagery service properties. Image service administrators can edit properties and also control which properties clients can alter.

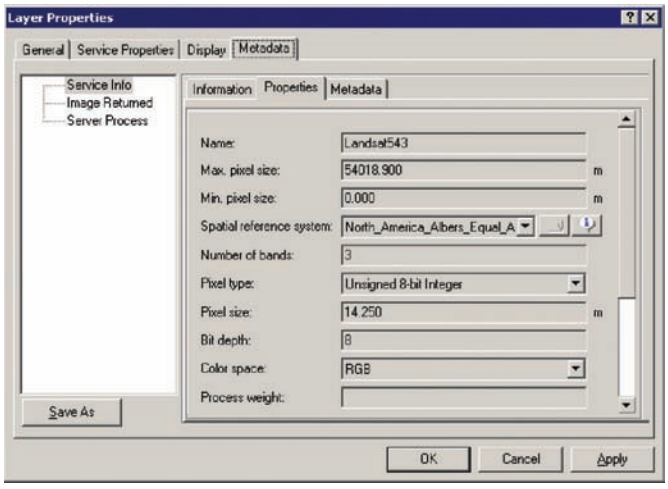

Figure 2. Service Information.

The changeable mosaic method enables the users to change how multiple overlapping images are ordered and fused together. Different methods enable users to order the imagery based on an attribute, such as the most recent imagery, imagery nearest a specific date, or imagery with the highest sun angle. Other mosaic methods enable the order of imagery to be set based on geometric attributes, such as relative viewing angle, or seamlessly mosaicked and blended along predefined seamlines. Again, such features maximize the depth of available imagery.

Metadata is important for nearly all applications and becomes apparent soon after a user accesses an image. For example when a user is viewing an image covering their town, nearly all of them will first zoom into the location of their home and comment on the imagery and then ask, "When was this image taken?" Metadata must be made available to give users confidence in the data. With ArcGIS Image Server, metadata related to the image service and each individual image contained in a view, is accessible to the client application.

Access by Different Clients

The image services can be accessed by multiple client applications. These clients include ESRI applications, such as ArcGIS Desktop, and third party applications, such as AutoCAD and MicroStation, thereby providing access to a wide variety of users. Imagery can also be made available through ArcGIS Server to Web applications including ESRI's Web Map Application, ArcGIS Explorer, and other Web clients that accept OGC WMS or KML services. Although publishing services through the open Web and Internet is increasingly popular, many organizations that invest in imagery have a requirement to publish imagery internally to their local or wide area networks within the confines of their firewalls. ArcGIS Image Server can publish services through local, wide area networks, or over the Internet.

Implementation Examples

MAPS Geosystems

The technology has been used by a number of companies, including MAPS geosystems in the United Arab Emirates, who use ArcGIS Image Server as a core component in their production work flow. They are able to quickly create image services from different imagery that becomes available or is acquired. For each imagery project the initial image services use orientation data captured from the sensor and existing terrain models for orthorectification. These services often do not have the final required accuracy; however, they are sufficient to check the overall image quality and that the imagery covers the project limits. As new images become available they are added to the image services. Different photogrammetric processes are then performed to update parameters such as revising the orientation parameters from aerial triangulation, updated terrain models for more accurate orthorectification, updating radiometric enhancement, and mosaic seamlines. The existing image services are updated with these parameters resulting in the grade of the services continually improving. At any stage quality control checks can be performed and the data made available to the client without the need to pre-process the data.

Most customers still require a mosaicked product as a deliverable, which is generated using the batch processing capabilities of the ArcGIS Image Server. The image products are often delivered along with the image services. For users that have ArcGIS Image Server, the image services can be directly loaded and immediately served to clients without any additional system loading. In many projects the raw raster data and associated service definitions are also delivered in addition to the mosaicked product, enabling the client to utilize the full depth of the imagery in terms of radiometry and overlap.

USDA Forest Service

The USDA Forest Service has also adopted ArcGIS Image Server. They are using it at one National Service Center located in Utah to maintain data for the entire continental U.S., Puerto Rico, and portions of Alaska. Using ArcGIS Image Server, they are able to easily provide image data for users in any office, nationwide. The five main image services they provide are the Best of the U.S. (BOTUS) high resolution color orthophotogrpahy from i-cubed (www.i3.com), ESAT 15 m Landsat TM imagery, NASA Blue Marble 1km MODIS, various eTOPO™ maps, and various shaded relief maps down to 10 meters. Their users are located across many of the lower 48 states, Puerto Rico, and Alaska, with varying network connections.

Their users have been pleased with the connection speeds, which is aided by the user-control for the compression for transmission setting in ArcGIS Image Server image services. But most importantly, their entire datasets are now available for the first time to all their users; therefore, their users are not having to piece together datasets to cover their areas of interest.

Conclusion

ArcGIS Image Server provides many new capabilities for managing, processing and distributing imagery. It increases the imagery accessibility and value by providing fast, dynamic image distribution and processing.

Author

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Object-based Image Analysis (OBIA) Symposium
Geospatial Imaging & Informatics Facility (GIIF)
UC Berkeley, June 7-8, 2007
Co-sponsored by the ASPRS Northern California Region

High spatial resolution remotely sensed images have become commercially available and increasingly used in various aspects of environmental monitoring and management. Analysts face challenges dealing with the detail provided by the imagery. New classifiers that make inferences based not only on spectral properties, but also on information such as object shape, texture, spatial relationship as well as human knowledge are proving to be useful in this high spatial resolution world. These object-based classifiers are proving to be useful in many applications. The object-based image analysis research field is rapidly developing, the GIIF will be hosting a symposium and workshop for OBIA practitioners from academia, government and industry where we will discuss the latest developments in programming and application, and work through some of the more thorny problems facing scientists using these tools.

Objectives
- Build a community of practice of OBIA practitioners from academia, government and industry;
- Promote knowledge exchange among scientists;
- Develop new tools for object-based image analysis;
- Evaluate open source and freeware image segmentation and classification; and
- Develop plans and outlines for a Special Issue on OBIA

Keynote Speaker
Thomas Blaschke, University of Salzburg

Registration will be open in March, 2007. Space will be limited! For more information, please see the website:

http://giif.cnr.berkeley.edu/obia2007/index.html