Digital Aerial Photo Image Server
Montgomery County, Maryland
Program Category #14: Information Technology

1.0 Abstract

The Montgomery County, Maryland Department of Technology Services - Geographic Information Systems (DTS-GIS) team, in cooperation with the Montgomery County Archives (MCA), developed the Digital Aerial Photo Image Server (DAPIS) to enable the public (customers) to locate, display, download, and print archived high-resolution digital aerial photo or ortho-photo images over the Internet using a web browser, such as Netscape Navigator or Microsoft's Internet Explorer. Multi-resolution Seamless Image Database (MrSID) software, developed by Lizardtech, Inc., and GIS software, developed by Environmental Systems Research Institute (ESRI), were used to prepare and serve available archived digital photos from 1951, 1970, 1979, 1993-1996, 1998, 2000, and 2002. Microsoft's Active Server Page (ASP) technology was used to create a web-based aerial photo map index application to enable customers to find and select a photo by map grid on the digital image archive server. An image viewer is used to display selected digital images and allows customers to adjust zoom scale and image size. Customers can also print or download the photo image using their web browser. Additional image viewers are also provided to enable the customer to better display, pan, and zoom about the photo image. DAPIS can be accessed by visiting the Montgomery County Government GIS web site http://gis.montgomerycountymd.gov/.

2.0 Need for the Program

DAPIS was developed to create a digital archive of existing delicate original aerial photo prints and to provide a web-based application to provide access to digital photos and ortho-photo images to improve customer services. Prior to the development of DAPIS, customers would visit the County Archives and meet with the County Archivist to find a particular photo print. The Archivist would then take several minutes to go through boxes of black and white aerial photos to find the desired photo. If the photo was available, it could only be viewed within the confines of the Archives reviewing area using soft cotton gloves. The archived original photos were not permitted to be taken from MCA. Thus, the process of finding archived aerial photos was time-consuming and limited at best. As a result, the County GIS manager offered to create a digital archive of the original photos and to create a web application to enable MCA customers to quickly find, display, print, and download available archived digital aerial photos or ortho-photos, thereby improving customer service and eliminating the need for customers and staff to access the delicate originals. The County Archivist accepted the offer.

3.0 Description of the Program

The DAPIS was designed, developed, and tested on a DTS-GIS intranet web server connected to the Montgomery County Government Intranet. The County Intranet, or internal web network, provided an effective proving-ground for testing DAPIS. Once approved by the DTS management and County Archivist, DAPIS was deployed on the Montgomery County GIS Internet Web Server for public access. The following sub-section describes the methods used to create and maintain DAPIS.

Step 1: Establish application requirements
The MCA provided DTS-GIS with application requirements in January of 2001 to provide a digital copy of existing archived aerial photo prints and to provide a web map application to

enable its customers to find an aerial photo or ortho-photo in the MCA. The original black and white aerial photos for 1951, 1970, and 1979 were to be checked out of the Archives a flight path at a time according to year, scanned into a digital image, and returned back to Archives within the same day. The scanned digital images were then to be downloaded from a GIS workstation to a CD-ROM, delivered back to Archives for storage, and prepared for web access. In preparation for web delivery, the scanned digital aerial photos were to be cropped, geo-referenced to a standard County map projection, merged into a seamless image, and subdivided into the County base map grid system, and converted into the MrSID compressed image format. The ortho-photos for 1993-1996, 1998, 2000, and 2002, all procured and managed by DTS-GIS, which were already prepared for web delivery, were then to be combined with the digital aerial photos to form the County's digital aerial photo image archive.

A web-based application was to be developed to enable customers to locate, display, print, and download a digital aerial photo copy in the County's digital archive using a web browser. The web application was to be deployed on the County GIS Internet web server, so that several customers could simultaneously access the digital aerial photo archive. In addition, the application and image server were to respond to web browser requests within an average of 5 seconds using a web browser and a standard 56 kilobyte (kb) modem connection 361 days (99%) a year. The DAPIS was to be updated as new ortho-photos or archived hard-copy aerial photos became available.

Step 2: Prepare the aerial photos and ortho-photos for web delivery
A total of 806 archived original black and white aerial photos of Montgomery County, Maryland for 1951, 1970, and 1979 were checked out of the archive and scanned into Tagged Image File Format (TIFF) using a large format IDEAL color scanner, at a resolution of 400 dots per inch, yielding a spatial resolution of roughly 4 square feet per pixel. The digital photos were then copied to a GIS enterprise server, downloaded or burned onto 24 CD-ROM disks using a CD-ROM writer, and delivered to the County Archivist on March 16, 2001. Next, the digital photo images were cropped using Adobe Photoshop 6.0 to eliminate black borders as well as flight-path and date text printed in white at the top or northern part of each photo. The digital photos were then geo-referenced to the County's base map projection (Maryland State Plane NAD 83) and merged together into large county-wide mosaics using Blue Marble's Geographic Transformer software (Version 4.1). The process of geo-referencing, using the affine transformation algorithm, took a considerable amount of time to complete because each photo required at least three control points for geo-registration. After a photo was referenced, it was visually checked in relation to other nearby photos to ensure the quality of the geo-registration.

After the digital aerial photos were geo-referenced and merged, they were subdivided into 662 map grids, in accordance with the County base map grid, using ESRI's Workstation ArcInfo 7.2 (Unix). The digital photo map grids were then converted from TIFF to MrSID format (SID) and compressed at a ratio of approximately 20:1 using MrSID Geo Version 1.4 for Solaris (Unix). The compressed MrSID files were then downloaded from the GIS enterprise server into the MrSID Image Server software hosted on the County GIS Intranet test web server.

Geo-referenced black and white digital ortho-photos for 1993-1996 were obtained as 'by products' via DTS-GIS's aerial photogrammetric mapping contracts with Analytic Survey Inc. (Colorado Springs, Colorado). The color ortho-photos for 1998, 2000, and 2002 were obtained

from VARGIS, LLC (Herndon, VA) in TIFF image format with a spatial resolution of one square foot per pixel. Ortho-photos have the characteristics of having image distortions corrected; they overlay with vector map files nicely. To facilitate efficient display, the ortho-photos were delivered on CD-ROM in quarter map grids (each 20MB in size), instead of map grid (80MB). There were a total of 2,640 TIFF files for a county-wide delivery. To convert these TIFF's into SID's using the MrSID Geo software, the mosaic option was used to sew the quarter grids back to whole grids. Using a compression ratio of 20:1, the 660 resultant SID files are about 4MB in size each. The compressed files enable customers to download and display the digital photos much faster than uncompressed files.

Step 3: Design, program, and test the web application and image server (DAPIS)
DAPIS was developed using MrSID Image Server, PERL, and ASP within a Microsoft Frontpage 2002 development environment. The MrSID formatted digital photos and ortho-photos were downloaded into to the MrSID Image Server hosted on the County GIS Intranet server for testing. The web application was initially developed on an Intranet test web server (Dell Poweredge 2300) running Microsoft Windows NT 4.0 Server with Internet Information Server 4.0. The test web server was later upgraded to Microsoft Windows 2000 Server running Internet Information Server 5.0.

DAPIS was designed to enable a customer to select an aerial photo or ortho-photo image archive by year. Once a year had been selected, a Montgomery County Aerial Photo Index Map (Figure 1) would enable the customer to select an index grid in order to geographically define an area of interest.
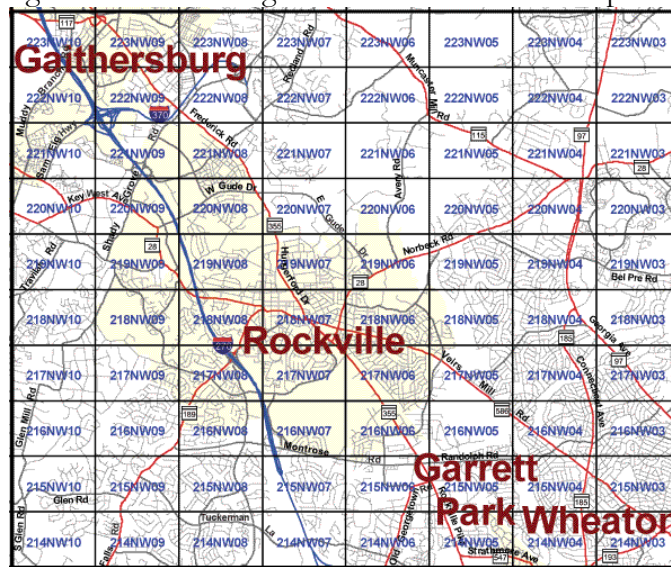
Figure 1: Digital Aerial Photo Index Map
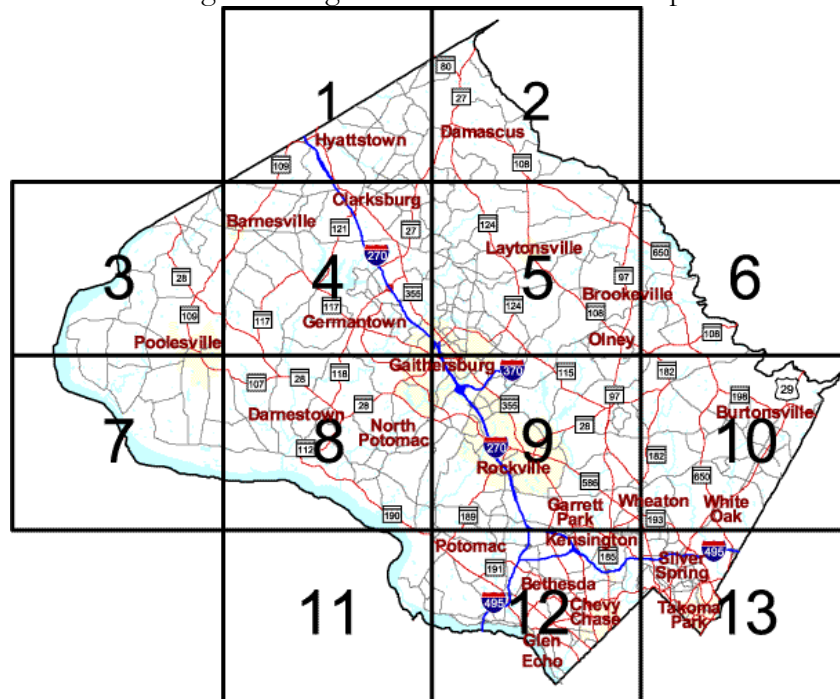
After selecting a map index, the customer is provided a more detailed map grid index to further refine their search (Figure 2).

Figure 2: Detailed Digital Aerial Photo Index Map Grid

ESRI's ArcView GIS (version 3.2a) software was used to create aerial photo index map postscript files to enable customers to find an aerial photo or ortho-photo using the County map grid system. The postscript map files were then imported into Adobe Illustrator 9.0 and Adobe Photoshop 6.0, enhanced, and saved for web presentation.

Once a map grid is selected, the corresponding digital aerial or ortho-photo for that map grid is served from the MrSID Image Server to the web browser using a PERL-based No Plug-in viewer (Figure 3). A PERL viewer template is provided with the MrSID Image Server software and can be easily modified by the programmer.

Figure 3: No Plug-in Image Viewer
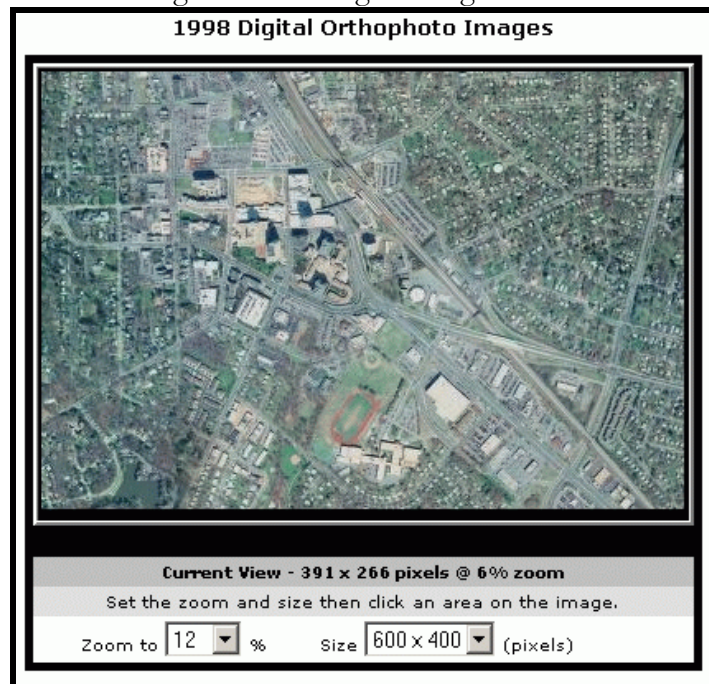
The customer can use the No Plug-in image viewer to set zoom scales and image sizes with drop-down menu boxes. The customer can also print or download this photo image as a JPG file to their home or work computer using their browser. A note indicating the month and year the photos were taken are also provided beneath the photo image. A help link is provided with the viewer to assist the customer with the application if they should have any questions, and links to Lizardtech and VARGIS are also provided. The Java image viewer provides the customer with additional tools to better display, pan, and zoom about the photo image (Figure 4).

Figure 4: Java Image Viewer

Step 4: Publish DAPIS on the County GIS Internet Web Server
DAPIS was approved by the GIS Manager in January of 2002. Consequently, the digital photos, ortho-photos, and web application were published to the County GIS Internet Web Server, a Dell Poweredge 2400 running Windows NT 4 and Internet Information Server 4.0 and MrSID Image Server.

Step 5: Maintain DAPIS on the County GIS Internet Web Server
The digital aerial photos or ortho-photos require very little maintenance and reside on the County GIS web server. Additional digital aerial photos or ortho-photos are added to DAPIS as they are acquired from a vendor or from the County Archives. The system administration of the County GIS web server is provided by DTS-GIS.

4.0 Use of Technology

DAPIS was developed using scanning, GIS, image processing, web design, and graphics software on both Windows and UNIX operating systems installed on Dell personal computers or Sun SPARC workstations (Table 1). The CAD Image Feature software, the Roxio Easy CD Creator 5, the Blue Marble Geographic Transformer (version 4.1), Workstation ArcInfo 7.2, and the MrSID Geo (version 1.4) software were used prepare the photos for web access.

Table 1: Software/Hardware used to develop DAPIS

Software	Function	Operating System	Hardware
ArcView GIS 3.2a	Create map indexes	Windows 2000 Professional	Dell Precision 330
Adobe Illustrator 9	Prepare map indexes for web access	Windows 2000 Professional	Dell Precision 330
Adobe Photoshop 6	Prepare map indexes for web access	Windows 2000 Professional	Dell Precision 330
Blue Marble Geographic Transformer	Geo-reference and mosaic the scanned digital aerial photos		
CAD Image Feature	Scan photo prints	Windows NT	Dell Optiplex GX1
Microsoft Frontpage 2002	Create ASP application to access the image server archive	Windows 2000 Professional	Dell Precision 330
MrSID Geo 1.4	Merge, convert, and compress aerial photos and ortho-photos	Unix / Solaris	Sun Ultra 1
MrSID Image Server (including PERL templates)	Serve SID images over the web	Windows NT 4 / Windows 2000 Server	Dell Poweredge 2300 / Dell Poweredge 2400
Roxio CD Creator 5	Write photos to CD-ROM	Windows NT	Dell Optiplex GX1
Workstation ArcInfo 7.2	Used to clip photos into County base map grid	Unix / Solaris	Sun Ultra 1

Microsoft FrontPage 2000 was used as the web development environment to design, program, and test the ASP scripts used to create the DAPIS map navigation front-end component. In addition, the MrSID Image Server software, with PERL viewer templates, was installed and configured on the County GIS Intranet web server, a Dell Poweredge 2300 running Microsoft Windows 2000 Server and Internet Information Server 5, and the County GIS Internet web server, a Dell Poweredge 2400 with Windows NT 4.0 Server and Internet Information Server 4. ESRI's ArcView GIS (Version 3.2), Adobe Illustrator 9, and Adobe Photoshop 6.0 were used to develop the maps indexes and related graphics used in the web application.

In order for a customer to use DAPIS, a 500 MHz or better personal computer running Windows 98, Windows 2000, Windows XP, or Windows NT 4 with a Netscape Navigator 6+ or Internet Explorer 5+ web browser is recommended. A standard 56KB modem with a connection to the Internet through an Internet Service Provider (ISP) should satisfy most customer needs.

5.0 The Cost of the Program

The total cost to develop DAPIS including staff time (data preparation, web programming and server maintenance) and software/hardware equipment was approximately $81,000.

Approximately 900 hours of staff time were invested into the preparation of the data, the development of the application, and the system administration at a cost of $16,600. The web servers, computers, and scanner used to create DAPIS cost a total of $49,384, while the graphic, the web publishing, and the GIS software cost approximately $15,000. The total calculated cost for the ortho-photos, approximately $595,370, was not applied to the total cost of the project because they were purchased to support all County-wide base mapping projects. Additional staff time and equipment costs for web upgrades, application revisions, and maintenance will vary in response to advances in technology. Since the software and hardware had already been acquired for earlier projects, the staff time was the main cost in developing DAPIS.

6.0 The Results/Success of the Program

DAPIS is currently evaluated by using web server reporting software technology and by reviewing customer feedback forms and e-mails. Since DAPIS was published to the Internet by DTS-GIS in January of 2002, it has received an estimated 15,631 visits, an average of 539 visits per month. The web server reporting software (Web Trends) enables DTS-GIS staff to calculate the number of visits, to determine the customer's domain, and to resolve the date and time of day that the client/server transaction occurred. As a result, the frequency and duration of web server transactions can be monitored over time, so that the web server can be tuned to balance or accommodate the in-coming request load to the application.

DAPIS has been used by the Montgomery County Public Schools Department of Planning and Capital Programming, the Montgomery County Police (Police), the Montgomery County Department of Public Works and Transportation (DPWT) for facilities management or building inventory purposes. The Montgomery County Department of Environmental Protection (DEP) uses DAPIS to study stream channel changes over time. Moreover, local real estate developers, historical researchers, and engineering (civil and transportation) companies also use DAPIS to review areas for proposed development or revitalization. Consequently, DAPIS has minimized the demand on County Archives and DTS-GIS staff in responding to customer service-related questions and has improved the customer's experience. So far, there have been no customer complaints.

7.0 Worthiness of an Award

DAPIS provides customers and County staff with tools to conveniently find, display, print, or download available digital aerial photos and ortho-photos in a matter of seconds or minutes using a web browser. Thereby eliminating the need for a customer to spend time, probably hours, visiting the County Archive just to find and look at a photo (if available). The application provides access to the digital archive 361 days per year, 24 hours per day. Therefore, DAPIS greatly improves the customer's experience of finding available archived aerial photography in Montgomery County and greatly reduces costs spent in providing customer service.

DAPIS serves as a model for other counties and municipalities who provide access to ortho-photos and aerial photography to their communities and constituents.