

an opacity channel to specify transparent and opaque parts of the image by means of opacity values.

[0071] In addition to image data, Flashpix files contain meta-data, which is auxiliary data to the image. Meta-data includes information about the image, such as creator, contents, copyright, date and time created, date and time last modified, camera information, scanner information, etc. The meta-data also includes parameters for transformations to be applied to the image, such as rotations and scaling, general affine spatial transformations, contrast adjustment, color space transformations, etc.

[0072] Internet Imaging Protocol

[0073] A recently developed protocol, the Internet Imaging Protocol (IIP), specifies a method for a user to request portions of an image at a specific resolution. A reference for IIP is the document "Internet Imaging Protocol," @ 1997 Eastman Kodak Company, Hewlett-Packard Company and Live Picture, Inc., the contents of which are hereby incorporated by reference.

[0074] A server with server-side software that supports IIP is referred to as an "image server." There are two generic ways to request image data from an image server using IIP; server-side processing of the request, and client-side processing of the request.

[0075] To illustrate server-side processing, suppose a user with a viewing window of 480×640 pixels desires to view the full image from the abovementioned example whose original size is 3,600×4,800 pixels. In accordance with IIP, the full image at a 480×640 pixel resolution for an initial view can be requested using the following IIP request, containing a set of IIP commands:

[0076] OBJ=iip,1.0&FIF=<image-name>&WID=640&HEI=480&CVT=jpeg.

[0077] This request specifies the version of IIP being used by means of the OBJ=iip,1.0 command. It specifies the desired image by means of the FIF command, and specifies the width and height of the viewing window by means of the WID and HEI commands, respectively. The last command, CVT, specifies the format of the image to be sent. As indicated above, the CVT command instructs the image server to convert the image data to the JPEG image format. Typically, the JPEG image transmitted from the image server to the client is embedded within an HTML page.

[0078] For the image server to process the above IIP request, the server must analyze the original image and generate a JPEG image with the requested specifications, specifically the desired portion and dimensions.

[0079] Similarly, the IIP request

[0080] OBJ=iip,1.0,&FIF=<image-name>&RGN=0.25,0.35,0.4,0.6&WID=640&HEI=320&CVT=jpeg

[0081] specifies the rectangular portion with upper left coordinate at (0.25,0.35), height of 0.4 and width of 0.6, in resolution independent coordinates, and a viewing window of 320 pixels height by 640 pixels width. It also specifies that the designated image portion is to be returned as a single JPEG image. It can be verified that the requested image portion corresponds to a sampling frequency of 6 in each dimension.

[0082] In the above examples the image server does the image processing necessary to create a "ready for display" image for the client web browser. Alternatively, in a client-side processing application, the server can simply send the requested tiles to the client, and leave it up to client software to stitch the tiles together and resize.

[0083] To illustrate client-side processing, the IIP request

[0084] OBJ=iip,1.0&FIF=<image-name>&TIL=4,0-5

[0085] requests the image server to send tiles 0-5 from resolution Layer #4 within the designated image. Referring back to the Flashpix image from the abovementioned example, Layer #4 is the 450×600 version of the image. This version has 8 rows of 10 tiles. Tiles 0-5 within this layer are the first six tiles of the first row.

[0086] Tile ranges are interpreted as rectangular ranges of tiles, rather than serial ranges, with the first tile in the range representing the upper left tile in the rectangle, and the second tile in the range representing the lower right tile in the rectangle. Thus, referring back to FIG. 2, the 80 tiles that overlap with the desired image portion (namely, the top left quadrant) can be accessed by the single IIP request:

[0087] OBJ=iip,1.0&FIF=<image-name>&TIL=5,0-142.

[0088] IIP is independent of any particular image format. A CVT request for a desired image portion at desired pixel dimensions and a TIL request for tiles can be applied to any image format. For example, a JPEG image could be the object of a CVT or TIL command. If the image is not already in multi-resolution format, then the server is required to create the appropriate resolution from the original image data on-the-fly in order to process the IIP request. It may be appreciated that the redundancy in storage for a multi-resolution image format such as Flashpix is compensated by a corresponding reduction in the processing necessary to produce these resolutions on-the-fly for a single-resolution image format such as JEG.

[0089] Scalable Documents

[0090] The present invention also concerns scalable documents—i.e., documents including raster images that are scalable. The raster images are referenced within pages of the document by links. The pages of the scalable documents of the present invention can be enlarged or reduced to a wide range of resolutions, making the entire documents scalable—text characters, graphical objects and raster images. Regardless of the view, print or save parameters, a raster image in a scalable document of the present invention automatically scales according to the desired resolution.

[0091] The raster images referenced within the pages of a scalable document can be located on image servers connected to the Internet or any other suitable computer network, viewed interactively, saved on remote computers and printed on network printers. Moreover each client computer accessing the scalable document preferably downloads only the portion of the image data that is necessary for satisfying the user display, print or save request.

[0092] The scalable document may also have raster images embedded therewithin in their entirety, and not merely referenced by links. However, the present invention