[0046] As will be described hereinbelow, in a preferred embodiment of the present invention, the documents **150** that are transmitted from server computer **110** to client computers **120** are "image-less documents," constructed and operable in accordance with a preferred embodiment of the present invention. Image-less documents are documents generated from original documents, in which some or all of the images from the original document have been removed, and replaced by references thereto. A reference to an image is typically a universal resource locator (URL), that specifies the IP address or domain name of the server on which the image data is stored, along with the directory path and file name of a file that contains the image data.

[0047] In a preferred embodiment of the present invention, links **180** of documents **160** point to objects **190**, such as raster images, stored on computers **200** connected to the Internet. In a preferred embodiment of the present invention, objects **190** are images that were removed from original documents in generating image-less documents therefrom.

[0048] Web browsers **140** typically can display only a limited number of different page formats, such as HTML. In order for a web browser to display a document that is not in one of the supported formats, auxiliary client software **210** can be used to supplement the web browser so that it can interpret the document format,

[0049] Resolution Independence

[0050] The present invention uses resolution independent image data requests to achieve scalability of raster images referenced within documents. Resolution independence is a paradigm for processing large digital images based on the tenet that an image can be considered as a continuum of color values distributed over a rectangular spatial region. That is, an image can be considered as a two-dimensional continuous spatial signal, analogous to a one-dimensional continuous time signal. Carrying this analogy further, a continuous "resolution-independent" image can be converted to a discrete spatial array by sampling at appropriate frequencies in each dimension, just as a continuous time signal can be converted to a discrete time signal by sampling at an appropriate rate.

[0051] Resolution independent images are modeled by a continuous two dimensional coordinate system with coordinates x and y ranging over a rectangular region that can be normalized as the unit square, $0 \leqq x \leqq 1$, $0 \leqq y \leqq 1$. Specifically, a resolution independent image is determined by a vector-valued function f(x, y), with f(x, y) indicating the color value at location (x, y) as x and y range over the unit square. Color is typically prescribed by multiple values within a standard color space, such as RGB or CMYK.

[0052] In distributed imaging systems, one of the most common user requests is for access to a rectangular portion of an image. A rectangular portion can be described by a set of four values (t, l, h, w), where (t, l) are the coordinates of the top-left corner of the portion, h is the height of the portion and w is the width of the portion—all four numbers being relative to the normalized unit square. Thus, for example, the portion (0.25, 0.35, 0.15, 0.3) denotes the rectangle extending from top-left corner (0.25, 0.35) to bottom right cornea (0.4, 0.65). The height of this rectangle is 15% of the total height of the image, and its width is 30% of the total width of the image.

[0053] Any digital image, no matter how large, does not contain more information than the sum total of its color values. Thus, considering a digital image to be a continuum of color values is an idealization. The extent to which this idealization applies is up to the point where the pixel dimension of the original image is exceeded. For large digital images, this leaves enough room to make the idealization a practical one. This idealization is analogous to the applicability of continuum mechanics to physical bodies up to the point where the atomic level is reached.

[0054] Discretization

[0055] The present invention involves three types of client requests for documents: (i) interactively displaying and navigating through the document on a video monitor, (ii) printing the document on a local or network printer, and (ii) delivering the document to a client computer; i.e. downloading the document, such as by means of a "Save As" operation. In order to display, print or save a resolution-independent image included within a document, the image must first be converted to a pixel array, which is a raster array of discrete pixel values. The required dimensions of the pixel array determine the sampling frequencies, and as long as these frequencies arc each greater than or equal to one, the conversion can be accomplished without introducing artificial data. Every request for displaying, printing or saving a portion or all of an image can be described by a rectangle in resolution-independent coordinates, as described hereinabove, together with a pair of discrete pixel dimensions representing the width and height of the pixel array. The pixel array can represent a view window for display, a dot array for printing or a raster array for saving a raster image.

[0056] Consider, for example, a 6"×8" photograph that is converted to a high quality digital color image by scanning at 600 dots per inch (dpi). This produces a 3,600×4,800 pixel digital image. In order to view this entire image on a video monitor having 72 dpi resolution, the image has to be scaled to 432×576 pixels, which amounts to a reduction in size of the original image by a factor of 25/3=8.33 in each dimension; that is, the sampling frequency is 8.33 in each dimension. Using the resolution independent paradigm, the digital image is idealized as a resolution independent image, the rectangular portion designating the entire image is (0, 0, 1, 1) and the required view window size is 432×576 pixels.

[0057] If this same digital image is to be printed on a 300 dpi resolution color printer, then the relevant rectangular portion is (0, 0, 1, 1) and the required dot array size is 1,800×2,400 pixels. This corresponds to a sampling frequency of 2 in each dimension.

[0058] If a user wishes to display the top left quadrant of the image in a 450×600 view window, then the relevant resolution independent portion of the image is (0, 0, 0.5, 0.5) and the required view window size is 450×600 pixels. This corresponds to a sampling frequency of 4 in each dimension. On the other hand, if the user had wanted to save the top left quadrant of the image as a 2,400×3,200 pixel array, this would correspond to a sampling frequency of ⅔ in each dimension. In this latter case, the limits of the resolution independent idealization are exceeded, and the uses request cannot be accommodated, unless the image is stretched beyond its original dimensions by adding additional color data, such as interpolated color values, to the original image data.