Zoomable interfaces

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Definition:
The appearance of personal computers has opened to theirs users general purpose tasks such as word processing, Internet browsing, multimedia playback, computer game play, etc. If all these tasks benefit of computer hardware evolution (power, memory, etc.), the display possibilities and interaction means remain the same since twenty years (Beaudouin-Lafon, 2004). The field of Information Visualization plays an important and crucial role for visual representation possibilities because it considers limits and possibilities of the human perception and the display support. One of the interfaces created in the field of Information Visualization are Zoomable user interfaces (ZUI) which give an efficient and promising mean of interaction to represent and manipulate great quantity of information. The principle of navigation inside zoomable user interfaces is based on the space-scale diagrams developed by Furnas and Bederson (1995). The objects containing the information are organized in the spatial dimension but also in the scale dimension. In order to access the information, the user interacts directly with the information space using mainly pans and zooms. By contrast with the classic zoom or bitmap zoom (see below), which is discrete, the zoom employed in ZUI, is a continuous geometrical zoom (see below) which gives the user “a feel of flying through a space”. In addition to the continuous zoom, the graphic content of the information changes at each level by the technique of semantic zoom (see below). The main improvement brought about by zoomable interfaces is a reduction in the amount of information which is displayed at any one point in time. This reduction alleviates the cognitive overload during navigation in a large data-base, because the principle underlying these interfaces is much more intuitive. These interfaces do however require an amplification of the data-base itself which must contain a number of different, hierarchically structured representations of the object.

Below we present the different types of zoom.

Bitmap zoom.

A bitmap zoom consists of performing an enlargement of a pixelated bitmap image. The zoom is carried out directly on the pixels, so that the zoom corresponds to a change in resolution. The bitmap zoom is discrete (the unit is the pixel) and its range of variation is limited (it is bounded in both directions). Thus: at the lowest level of zoom, the whole image is reduced to a single pixel. In the other direction, the more the size of the pixels is increased, the resolution is reduced. In some software applications, when the image is enlarged additional pixels are created; but even this inevitably leads to a blurring of the image. This type of zoom is used in Paint software for MS Windows, Adobe Photoshop.
Geometrical zoom.

When a zoom is performed on a vectorial image, the curves which compose the image are automatically recalculated for the rescaled image. Thus, contrary to the bitmap image [see: zoom, bitmap] where the objects are composed of pixels, a vectorial image is composed of points, lines and mathematical curves. For example, a straight line is defined solely by the co-ordinates of the two extreme points. A circle is defined solely by the co-ordinates of its centre and its radius. Thus, all the transformations involved in rescaling the image change only these mathematical values and do not alter the quality of the curves. The main advantage of a geometrical zoom is that it does not suffer from the phenomenon of pixelization when all or part of the image is zoomed. With a bitmap image composed of discrete points (pixels), when a forward zoom (magnification) is performed, the pixels become clearly visible (this phenomenon is familiar to users of software such as “Paint”). By contrast, in vectorial mode, all the components of the image are mathematical curves which are not intrinsically pixelated. When performing a forward zoom, the computer recalculates all the curves so as to adapt them to the required scale. This geometrical zoom is unlimited since whatever the scale, the contours are perfect and the images appear “clean”. This type of zoom is used in software for vectorial drawing as Corel draw, Adobe Illustrator.

Semantic zoom.

The semantic zoom is an articulation between the geometrical zoom, which makes it possible to provide greater detail, and the logical zoom which provides more information. Goldstein & Roth (1994) define access to a certain level of detail as follows: the user changes the granularity of the data which are the focus of attention. Since Goldstein & Roth use this definition to describe hierarchically structured data, this definition can also be used to give an account of the technique of “semantic zoom”. In other words, a semantic zoom is just a modification in the structure of data which are organized hierarchically and presented at different levels of granularity. By contrast with an ordinary zoom where the object has just a single representation with different degrees of resolution, the object in the environment of a semantic zoom has a number of different representations in the data-base of the interface. The idea of using a semantic zoom as the basis for interaction has been proposed by Perlin & Fox (1993) with the Pad interface, as an alternative to the WIMP paradigm. In Pad, a hierarchy is created where at the lowest level the object resembles a legend or a title, and at the highest level the object is a (part of) the complete document. This technique has been taken up by Frank & Timpf (1994): in order to render this “intelligent” zoom operational, use a hierarchical tree-structure to display representations of geographical maps at different scales. Thus, the semantic zoom changes the form and the context in which the information is presented. For example, the display of a digital clock can differ according to the scale. In an initial median view, the clock displays the time of day and the date. If the user performs a forward zoom, the form of the clock changes and displays the minutes and seconds. With a backward zoom, the time of day disappears and only the date and year are displayed (Stephens 2003). The advantage of the semantic zoom is that it avoids the use of deformed views such as the “fisheye” (Leung and Apperley, 1994). This advantage is linked to the use of a semantic transition between the general view and the detailed view (Modjeska, 1997). This type of zoom is used in Zoomable user interfaces.
The use of the type zoom depends on the task. For example, it is more judicious to use bitmap zoom to modify pictures because one works on pixels, but it is more recommended to use geometrical or semantic zoom when one works on the display of a great amount of data. New techniques of interaction, as ZUI have the advantage to be more intuitive and natural.

For demo of ZUI:
http://www.cs.umd.edu/hcil/piccolo/
http://maps.google.com/
http://www.infres.enst.fr/net/zomit/zomit-net/more.html

References:


