Object and Shape Perception

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The visual object is a useful metaphor in display design. Two radically different theories were proposed to explain object recognition — image-based and structure-based recognition [1]. In the first section of this essay, the image-based recognition theory is used in designing text browsers for small screens. In the second section, we outline a direct application of the structure-based theory in protein visualization. In the third section, we formulate guidelines for icon design based on object perception in humans.

Image-based Object Perception and RSVP Browsers

The image-based theory is supported by *Rapid Serial Visual Presentation* (RSVP), which is a method of rapidly displaying information (text or images) in quick succession at a fixed focal position [2]. It has been found that people can recognize objects in images presented through RSVP up to 10 images per second [3, 4]. Ware [1] outlines an application of this technique to an image database search task [5].

RSVP can also be used to present text information to users by displaying text word-by-word in a fixed focal position, instead of spatially arranging the words into lines and paragraphs[1]. Studies have shown that people can read text at rates as high as 720 wpm [9]. For short pieces of text, RSVP formats were shown to increase reading speeds by 33%, with no significant differences in comprehension or task load [7][2].

RSVP-based browsers [6] are a space-saving alternative for small screen devices like cell-phones and PDAs. RSVP-browsers can also help dyslexic readers. It has been found that dyslexic users have a shallower *attentional blink*[3] than normal users [8] (despite the visual and attentional disability associated with Dyslexia [10]). This allows them to use RSVP-based browsers at least as efficiently as normal users, while decreasing confusion [10] by aiding the correct sequencing of words. To make RSVP-based browsers practically useful though, requirements of navigation, context-awareness and adaptable reading speed need to be addressed [7].

[1] An RSVP-based text presentation would be a *temporal* arrangement of the words, with pauses acting as sentence and paragraph delimiters.

[2] This observation has led to the development of many "speed reader" applications like WordFlashReader (*http://sourceforge.net/projects/wordflashreader/*) and Reasy (*https://addons.mozilla.org/en-US/firefox/addon/reasy/*).

[3] Failure to detect a second object occurring in succession, if presented within 350ms of the first[1].

Structure-based Object Perception and Protein Visualization

The study of protein structures and functions employs a vast amount of protein data stored in the Protein Data Bank (PDB)[4]. This includes detailed protein structure information as 3-dimensional electron density data. Protein Visualization aims to present this in a format that is easy to understand, study and analyze.

Proteins, as biological macromolecules, are extremely complex. Electron density plots (Figure 1a) are hard to read. Therefore, an important part of the visualization is presenting the protein structure in terms of identifiable *objects* and the relationships between them. The *objects* chosen for visualization depend on the requirements of the specific application. Figure 1b shows individual atoms as spheres and atomic bonds as tubes. Figure 1c goes further by encapsulating the sub-structures within the protein [11] into well-understood units like *alpha* "helixes"[5] and *beta* "ribbons"[6]. This provides a clear idea of the structure of large proteins. It helps the user analyze interactions between these sub-structures without getting overwhelmed by the atomic (or electronic) detail. Figure 1d goes even further by representing individual proteins as closed single-colored shapes. Modern visualization software like Chimera [12] and PyMol [13] implement many of these object-based techniques.

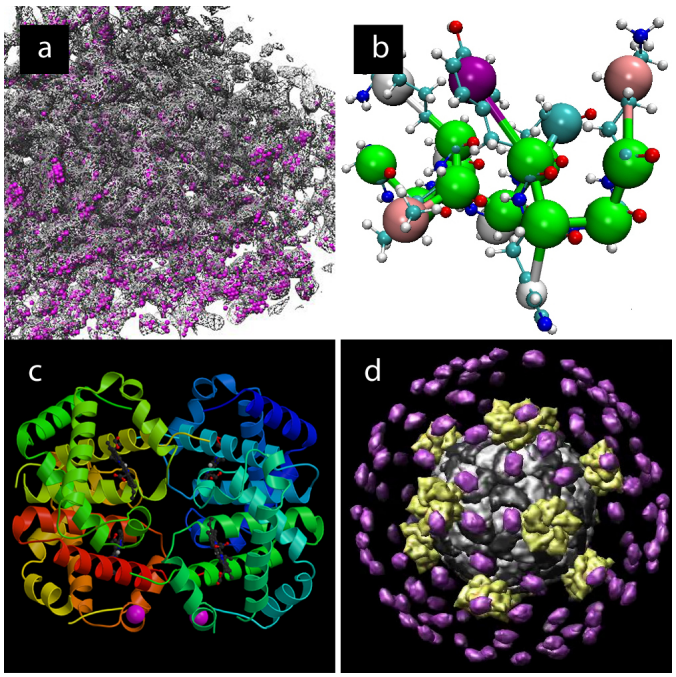

Figure 1: (a) Small part of a protein molecule - electron density map. (b) Atoms and bonds in the protein molecule. (c) Overall structure of the hemoglobin protein. (d) Protein arrangement in a virus.

[4]As of 1 March 2011, there were more than 70,000 proteins in this database.
[5]*http://en.wikipedia.org/wiki/Alpha_helix*
[6]*http://en.wikipedia.org/wiki/Beta_strand*

Object Perception and Guidelines for Icon Design

Experimental work by Biederman *et al* [14] has shown that the optimal size for recognizing a visual object is about 4 to 6 degrees of visual angle. This is an important observation for icon design. To enable a user to perceive an icon as a single unified *object*, the guidelines given below are useful. An illustration is shown in Figure 2.

0. Identify the usage scenario(s) for the icon.
1. The icon should have size between 4 to 6 degrees of visual angle, if possible.
2. Graphical sub-units of the icon should be much smaller than 4 degrees of visual angle.

Figure 2: The Brussels Airline logo on an airplane tail.

Conclusion

Awareness of the mechanisms involved in object perception helps designers to simplify interfaces and to portray modularity and encapsulation visually. In this essay, I have outlined three direct applications of object perception in HCI, Information Visualization and Graphic Design.

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