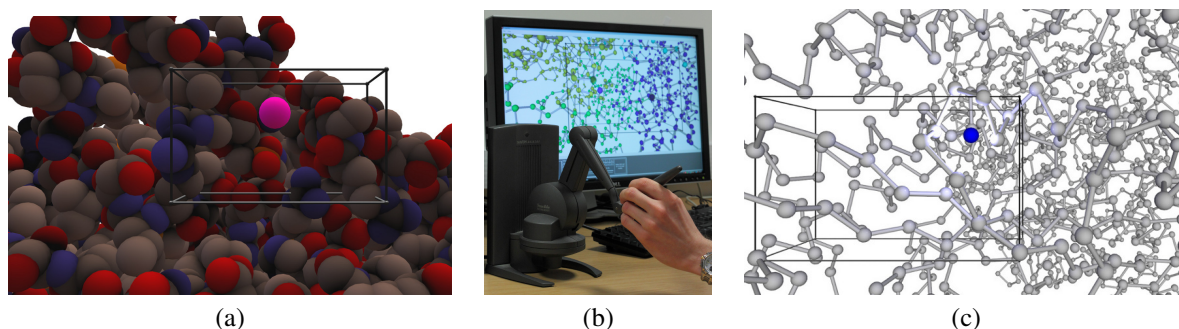


# Navigation and exploration of large data-sets using a haptic feedback device

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**Figure 1:** The 'Navigation Cube' automatically transforms a scene for exploration of a molecule (a). The user manipulates a probe sphere using a Phantom Desktop (b). The 'Haptic Light' aids the user in selecting atoms in an elastic network application (c).

## Abstract

A haptic feedback device enables a user to manipulate three dimensional structures and feel forces contained within complex data-sets such as those resulting from computational biology. However, as the data-set grows in size it becomes difficult to ensure that the user can easily interact with every part of it. One could scale the data-set down to fit into the haptic workspace, however, this could result in important features being missed. A secondary problem is enabling the user to select points efficiently within the three dimensional data set, where the perception of depth can be difficult. In this paper we present novel techniques to rapidly navigate large and complex data-sets with a haptic feedback device, whilst still permitting accurate and fast selection of points in three dimensional space. We have applied these techniques as part of software dedicated to studying the response of biomolecules to externally applied forces using elastic network models.

**CR Categories:** I.3.6 [Computing Methodologies]: Computer Graphics—Methodology and Techniques;

**Keywords:** Force-feedback, Haptic Rendering, Elastic Network Model, Biomolecule, Protein

## 1 Our Approach

Utilising a haptic feedback device to navigate a large three dimensional volume can be difficult due to the limited workspace of the device. We introduce the concept of the 'Navigation Cube' which automatically transforms the environment as the user reaches for an area of interest. The 'Navigation Cube' is similar to the bubble technique [Dominjon et al. 2005], however, the spherical navigation volume in that approach does not correspond well to the workspace of the haptic device, whereas here the navigation cube is automatically scaled to fit the workspace. Furthermore, unlike the bubble technique no forces of interaction between the navigation cube and the probe are included to avoid confusion with forces arising due to interaction with the objects in the scene. To explore areas outside this cube, the user simply moves the haptic probe in the direction of the new location, without worrying about whether the new area

is currently residing in the workspace of the device. The speed of translation is dependent on the distance the haptic probe is from the side of the cube it penetrated. This allows the user to move slightly outside the cube for fine navigation control and to move further for faster translation.

Accurately selecting three dimensional objects within complex data sets is another challenge, typically worsened by 2D viewing. Stereoscopic displays present one strategy for overcoming this. We introduce a further enhancement termed the haptic light to aid in accurate selection of objects within a complex scene. Initially the scene is rendered with one light source located at the viewers' position. This light illuminates the structures with only ambient and diffuse lighting; to provide three dimensional definition but without a specular highlight. A second light source, the 'haptic light', is attached to the location of the probe and illuminates in all directions. This light source contains ambient, diffuse, specular and light attenuation parameters. The light attenuation is utilised to ensure that the light only illuminates the parts of the scene which are in close proximity to it. The specular component aids in determining the location of the probe in relation to the objects surrounding it. The illumination effects are achieved through implementing the techniques using OpenGL and the OpenGL Shading Language (GLSL).

## 2 Results

To test the utility of the approach we have implemented our techniques within software for interacting with biomolecules (<http://www.haptimol.com/>). Figure 1(a) illustrates the 'Navigation Cube' aiding the user in exploring a protein rendered in space filling mode. Figure 1(c) illustrates the 'Haptic Light' assisting in object selection in an elastic network model of a protein.

## References

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