Interactive specification of 3D displacement vectors using arcball

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Problem

- Interactive specification of 3D displacement vectors
  - Translation specification
Our approach

- No special input devices
  - Mouse + keyboard
- One-window interface
  - No more info than necessary
- “WIMP” interface with good motor control

Some applications

- Warp specification in 3D-Space
- Editing geometric models
- Normal vector specification
- 3D grid editing
Possible solutions

- Two-point specification
  - Use a 3D point locator
  - Specify initial and final points
  - Good for accurate specifications
- Use of special input device
  - Not always available

Previous work

- Two-point specification
    - Use a triad cursor as a locator
    - Use cursor plane as a locator
### Previous work

- **Use of special input device**

### Use of 2D input devices

- **Choose good parameterizations**
    - Virtual trackball
Revisiting our problem

- Displacement vector
  - Point + direction + scale

Direction specification

- rotation of the unit normal
Our choice

- Arcball
- Better motor control
  - Kinesthetic correspondence between mouse movement and rotation
  - Path independence
- Novel use of the arcball interface

Arcball, Rotation and Quaternions

- Unit quaternion
  \[ q = [t, x, y, z] = [t, (x, y, z)] = [\cos \theta, v \sin \theta] \]

- Rotation of angle \(2\theta\) around \(\mathbf{u}\)
  \[ R(\alpha) = qaq^{-1} \]
Arcball

\[ v_0, v_1 \in S^2 \subset \mathbb{R}^3 \]

\[ p_1 = [0, v_0], \quad p_2 = [0, v_1] \]

\[ \frac{p_1}{p_2} = [\langle v_0, v_1 \rangle, v_0 \wedge v_1] \]

The Arcball Sphere

![Diagram of the Arcball Sphere](image)
Arcball sphere for displacement vector

- Proper coordinate system for arcball sphere
  - Adapted to the camera position

Basis computation

\[ e_2 = \frac{u - \langle u, n \rangle n}{\|u - \langle u, n \rangle n\|} \]
The implementation

- Windows 95/NT
- OpenGL
- Interface design: FLTK

The Interface Window

![Image of the Interface Window]
Application 1:

- Surface warping with direct specification

Input surface
Select the point

Zoom in
Specify direction (Arcball)

Specify length
Compute the warp

Surface Warping

- Video
### Application 2:

- **Smooth Subdivision surfaces with normal control**
  - H. Biermann, D. Levin and D. Zorin  
    *NYU Media Research Lab*

- **Video**

### Warping software

- **Surface warping**
  - [http://www.visgraf.impa.br/morph/software/](http://www.visgraf.impa.br/morph/software/)

- **Subdivision surface**