# Interactive specification of 3D displacement vectors using arcball

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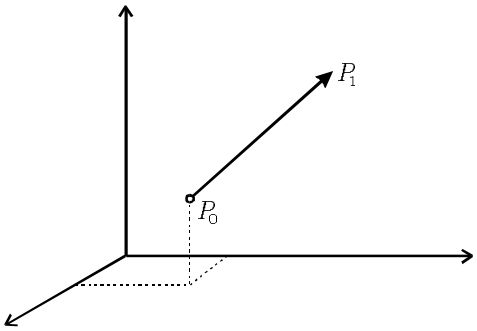
## Problem

- 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

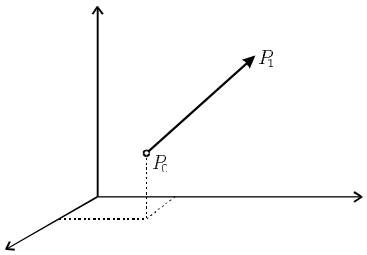


## Some applications

- 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
  - G. M. Nielson and D. R. Olsen, *Direct manipulation techniques for 3d objects using 2d locator devices.* Workshop on Interactive 3D Graphics'1986
    - Use a triad cursor as a locator
  - Elvis Ko-Yung Jeng and Zhigang Xiang, *Moving cursor plane for interactive sculpting*, SIGGRAPH'92.
    - Use cursor plane as a locator

## Previous work

- Use of special input device
  - Colin Ware and Danny R. Jessone,
    *Using the bat: A six-dimensional mouse for object placement,*
    IEEE Computer Graphics and Applications, 1988.

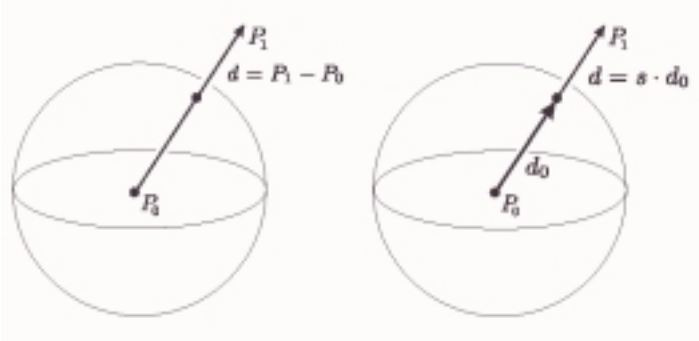


## Use of 2D input devices

- Choose good parameterizations
  - M. Chen, *A study in interactive 3d rotation using 2d control devices.* SIGGRAPH'88
    - Virtual trackball
  - Ken Shoemake, *Arcball: A user interface for specifying three-dimensional orientation using a mouse.*
    Proceedings of Graphics Interface'92

## Revisiting our problem

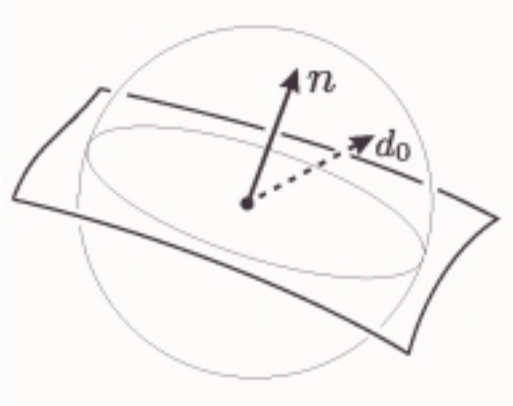
- Displacement vector
  - Point + direction + scale






## 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 $v$

$$R(a) = qaq^{-1}$$

## Arcball

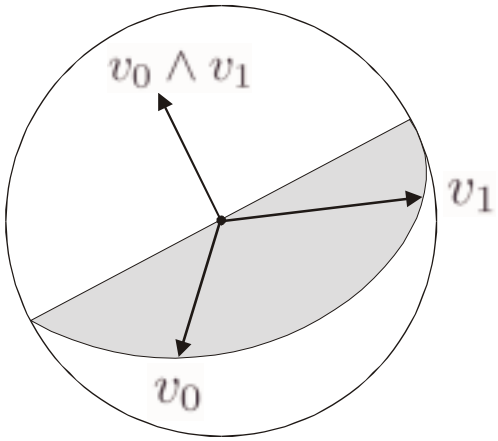
$$v_0, v_1 \in S^2 \subset \mathbb{R}^3$$

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

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

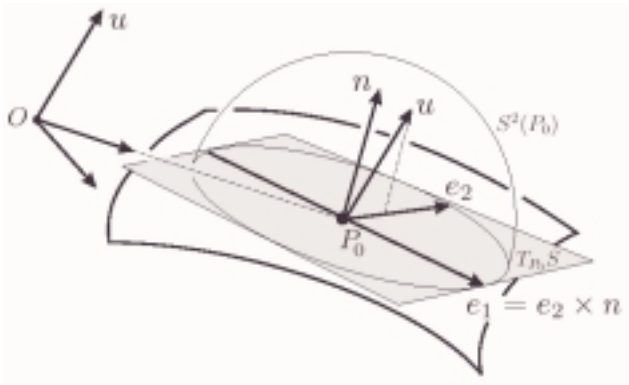


## The Arcball Sphere



## Arcball sphere for displacement vector

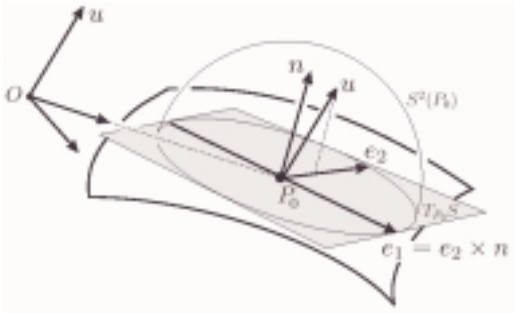
- Proper coordinate system for arcball sphere
  - Adapted to the camera position






## Basis computation

$$e_2 = \frac{u - \langle u, n \rangle n}{||u - \langle u, n \rangle n||}$$

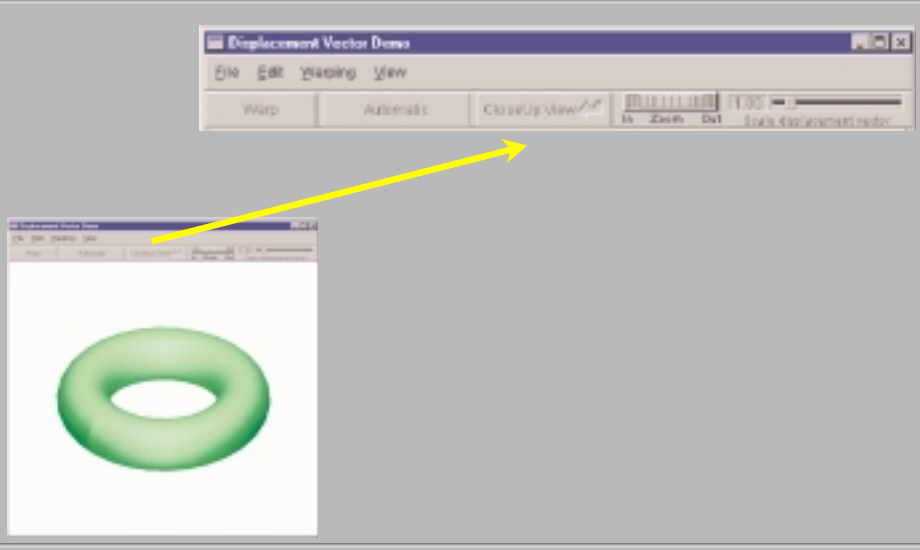


## The implementation

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

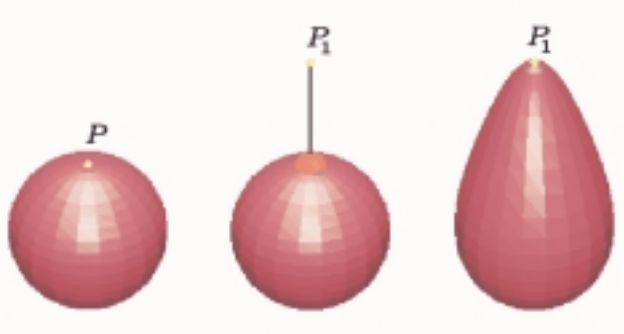


## The Interface Window



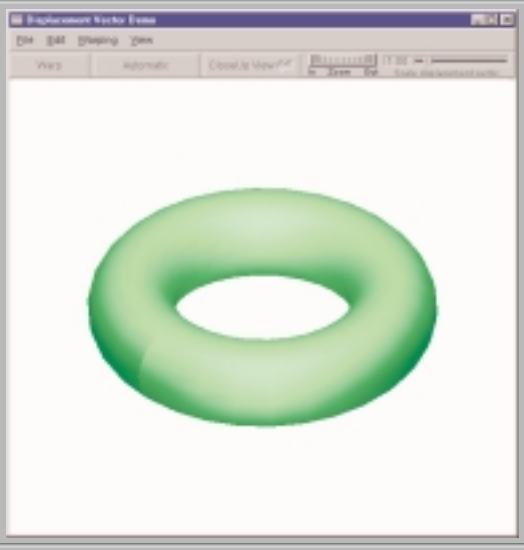
## Application 1:

- Surface warping with direct specification

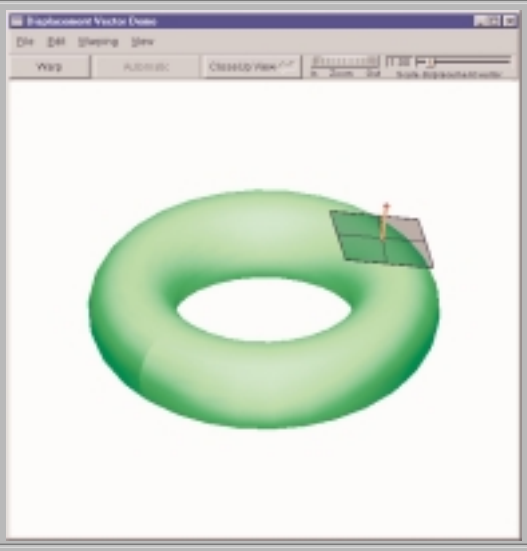





## Input surface



## Select the point



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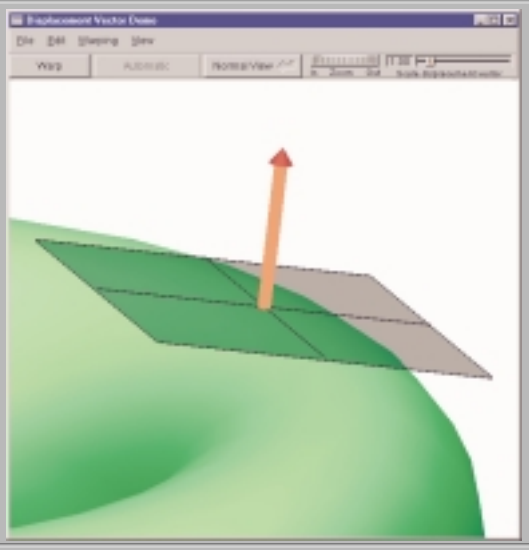
## Zoom in



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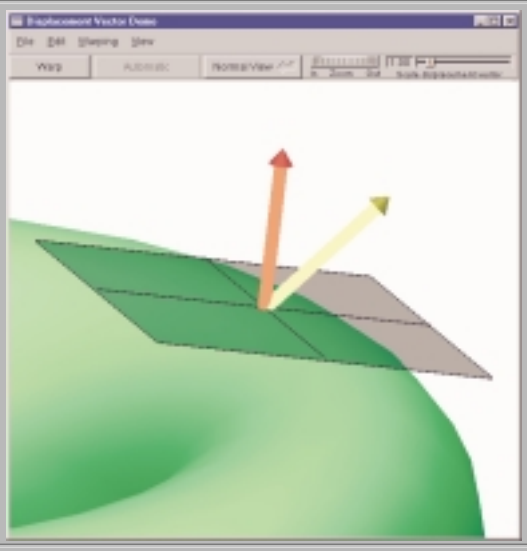
## Specify direction (Arcball)



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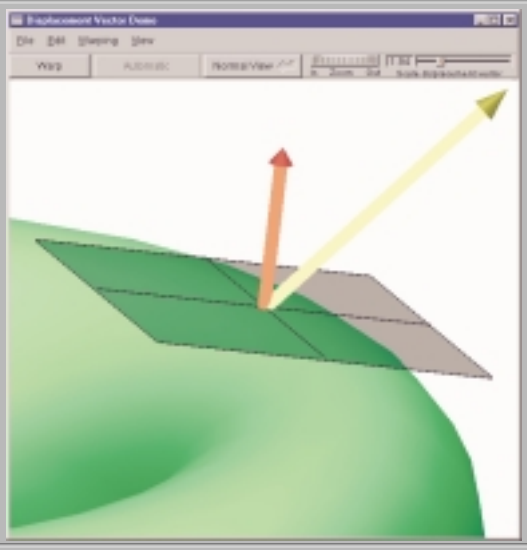
## Specify length



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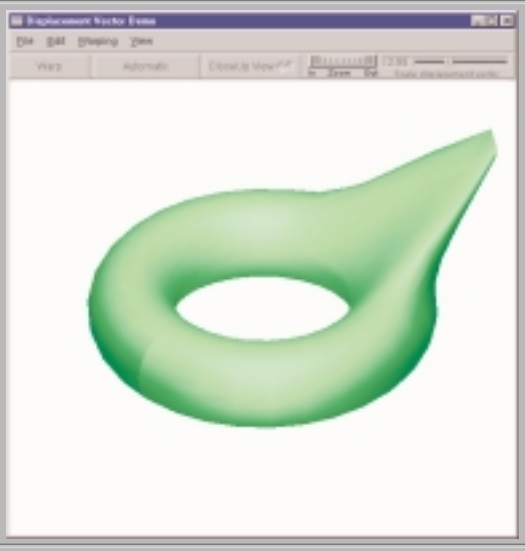
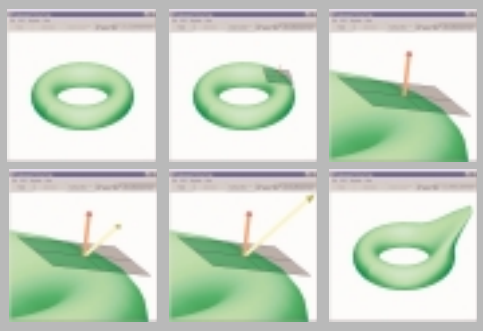
## Compute the warp





## 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/
- Subdivision surface
  - http://www.cs.nyu.edu/biermann/