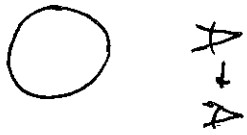
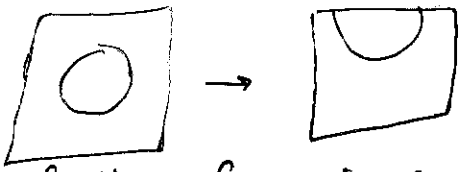
Arcball

* intuitive rotation with a mouse

→ translate
  ↳ move the camera position in the scene in camera up/down (y) and left/right (x) direction



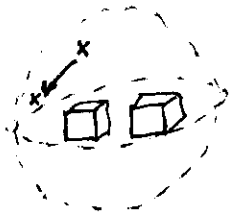
→ scale
  ↳ move camera closer or farther from scene



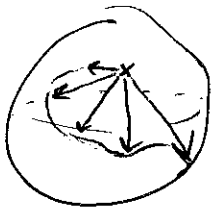
→ rotate
  ↳ harder

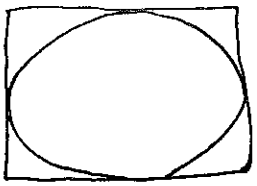
  use "arcball"

  imagine a ball surrounding the scene



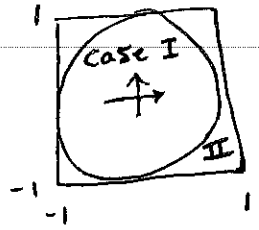
* click → mouse grabs onto sphere surface
* drag → mouse pulls sphere with it
* rotations are directly from click point to current point





pixel (i,j) → $(-1,1)$ Canonical (x,y)

unit sphere (looks like ellipse!)



Case I

(x,y) in unit circle

$x^2+y^2 \le 1$

$\Rightarrow (x',y',z') = (x,y,\sqrt{1-x^2-y^2})$ ← point on sphere

Case II

(x,y) outside unit circle

find closest point to $(x,y,0)$

$\left(\frac{x}{\sqrt{x^2+y^2}}, \frac{y}{\sqrt{x^2+y^2}}, 0\right)$ ← point on sphere

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have two points on unit sphere $\vec{u}, \vec{v}$ $\|\vec{u}\| = \|\vec{v}\| = 1$

find rotation R so $Ru = v$

$w = u \times v$ ← rotation axis

$Ru = v$

$Rw = w$

$R(u \times w) = v \times w$

$$\rightarrow R\underbrace{\begin{pmatrix} u & w & u\times w \end{pmatrix}}_{M} = \underbrace{\begin{pmatrix} v & w & v\times w \end{pmatrix}}_{N}$$

$$R = NM^{-1}$$