CPSC 314
Computer Graphics

Dinesh K. Pai

Transforms and Cameras

1

Today

- Exam preparation tips
- Wrap up transformations: lookAt, object rotations
- Cameras and projections
  (start reading Chapter 10 of text)

2

Exam Preparation

- Review lecture notes, and assignments
- Textbook. Read ALL of these, except as noted
  - Ch 1
  - Ch 2: skip Eq. 2.5
  - Ch 3: 3.6 is optional
  - Ch 4
  - Ch 5: 5.4 is optional
  - Ch 10
  - ~~Ch 11: skip 11.2.1, 11.4. Review this chapter last, since it's unclear how much we'll cover.~~ Skip for midterm 1

3

More resources for understanding transformation matrices

- There are several on the web (just google). E.g.
  - http://user.xmission.com/~nate/tutors.html
    An old but still useful one. Uses legacy OpenGL
  - A more recent one

  http://www.opengl-tutorial.org/beginners-tutorials/tutorial-3-matrices/

4

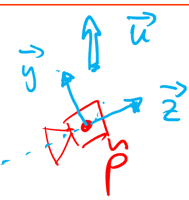
A closer look at "lookAt"

- Book description in 5.2.3 has a bug, fixed in online Errata (make this and other corrections in your textbook copy)
  - z = normalize(p - q)
    x = normalize(u × z)
    y = (z × x)

5

A closer look at "lookAt"

input: $\hat{p}, \hat{q}, \vec{u}$



$$\vec{z} = \text{normalize}(\hat{p} - \hat{q})$$
$$\vec{x} = \text{normalize}(\vec{u} \times \vec{z})$$
$$\vec{y} = \vec{z} \times \vec{x}$$

$$\begin{bmatrix} \vec{x} & \vec{y} & \vec{z} & \hat{p} \end{bmatrix}$$ in world coords

6

C^3 Homework: Viewing

- Find the view transform from world coordinates to eye coordinates, corresponding to an eye located at (2,5,0), looking straight at (10,5,0), both in world coordinates. Assuming y is the up direction.
- What are the world coordinates of a point whose eye coordinates are (5,3,-4)?
- What are the eye coordinates of a point whose world coordinates are (5,3,-4)?

Note Title 2014-01-31

§ How to transform points w.r.t. an auxiliary frame?

$\hat{p}$

$\underline{\hat{a}} = \underline{\hat{w}}\, A$

$\underline{\hat{o}} = \underline{\hat{w}}\, O$

$\underline{\hat{w}}$

Object frame

Suppose we now want a transform M to happen relative to $\underline{\hat{a}}$.

$$\hat{p} = \underline{\hat{o}}\, \bar{p}$$
$$= \underline{\hat{w}}\, \underline{\bar{O}}\, \bar{p}$$
$$= \underline{\hat{a}}\, \underline{\bar{A}}^{-1}\, \underline{\bar{O}}\, \bar{p}$$

Transformed pt

$$\hat{p}_{new} = \underline{\hat{a}}\, \underline{\bar{M}}\, \underline{\bar{A}}^{-1}\, \underline{\bar{O}}\, \bar{p}$$
$$= \underline{\hat{w}}\, \boxed{\underline{\bar{A}}\, \underline{\bar{M}}\, \underline{\bar{A}}^{-1}\, \underline{\bar{O}}}\, \bar{p}$$

Notation simplification

assume

lower case p, q etc. are $\bar{p}, \bar{q}$

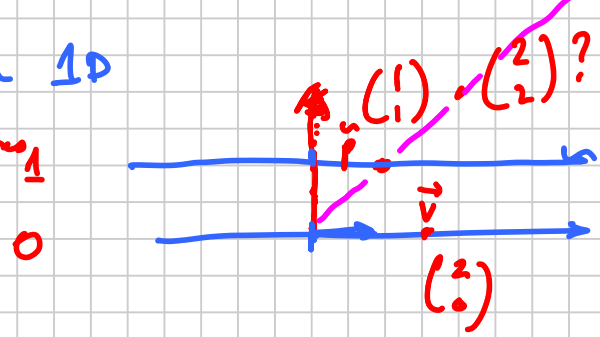
upper case O, T etc. are $\underline{\bar{O}}$, $\underline{\bar{T}}$

---

§ A crucial idea about homogeneous coordinates

In 1D

Homogeneous coords



Points / euclidean space

vector space

We assume $\begin{pmatrix} x \\ w \end{pmatrix} \equiv \begin{pmatrix} x/w \\ 1 \end{pmatrix}$ for all $w \neq 0$

normalized form

★ So all coords. along a ray from origin in homogeneous coordinates ("4D") represent same physical point (in "3D")

We will use this to simplify projection.