CPSC 314
Computer Graphics

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Affine Spaces

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Today

- Assignment 1, part 1c, update
- Transformations wrap up
- Affine spaces

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Assignment 1, part 1c, update

- You need to take transformations of the armadillo into account.
- Alternative: can use the armadillo without any transformations, with following modifications to A1.js

```
Change
    loadOBJ('obj/armadillo.obj', armadilloMaterial, 3, 0,3,0, 0,Math.PI,0);
To
    loadOBJ('obj/armadillo.obj', armadilloMaterial, 1, 0,0,0, 0,0,0);
-------------------------------------------------
Change
    var gemPosition = {type: 'v3', value: new THREE.Vector3(0,5,3)};
To
    var gemPosition = {type: 'v3', value: new THREE.Vector3(0,1,1)};
```

- IF (and only if) you treat the gemRadius as a “scale” in the gem.vs.glsl, you can visualize deformation better by displaying sphere at half size

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Live Demo

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Affine Spaces

Note Title 1/16/2015

Recap: Want to represent points $\check{p}$

Picked an origin $\check{o}$

Saw how to represent and transform vectors $\vec{v}$

$$\vec{v} = \vec{b}\,\bar{v}$$

$$\mathcal{L}(\vec{v}) = \vec{b}\,\underline{L}\,\bar{v}$$

Examples of linear transforms: scaling, rotation
translation is NOT.

- Wish we could include this in the same framework :-(
- Want to unify points and vectors
- Not have a special origin

First extend the '+' op. to allow

$$\check{o} + \vec{v} = \check{p} \quad \text{and} \quad \check{p} - \check{o} = \vec{v}$$

$$1\,\check{p} = \check{p}$$

Not (yet) $\check{p} + \check{q}$ or $2\check{p}$

§ Extend basis to include a point

$$\check{p} = \check{b}_0 + \vec{v} \qquad \check{b}_0 \text{ is "origin"}$$

$$= \check{b}_0 \cdot 1 + \vec{b}_1 v_1 + \vec{b}_2 v_2 + \vec{b}_3 v_3$$

$$= \begin{bmatrix} \vec{b}_1 & \vec{b}_2 & \vec{b}_3 & \check{b}_0 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ 1 \end{bmatrix}$$

$$\check{p} = \underline{\check{b}}\, \bar{v}$$

Affine frame or just frame

homogeneous coordinates

- Homogeneous coord of a point $\begin{pmatrix} * \\ * \\ * \\ 1 \end{pmatrix}$
- Homogeneous " " vector $\begin{pmatrix} * \\ * \\ * \\ 0 \end{pmatrix}$ try multiply it out
- " " " " linear transform of 3D vector

$$\underline{\bar{L}} = \begin{bmatrix} \underline{\bar{l}}_{3\times 3} & \begin{matrix} 0 \\ 0 \\ 0 \end{matrix} \\ \hline 0\ 0\ 0 & 1 \end{bmatrix}$$

$$\begin{bmatrix} \underline{\bar{l}}_{3\times 3} & \begin{matrix} 0 \\ 0 \\ 0 \end{matrix} \\ \hline 0\ 0\ 0 & 1 \end{bmatrix} \begin{bmatrix} v_1 \\ v_2 \\ v_3 \\ \hline 0 \end{bmatrix} = \begin{pmatrix} \underline{\bar{l}}_{3\times 3} \begin{pmatrix} v_1 \\ v_2 \\ v_3 \end{pmatrix} \\ 0 \end{pmatrix}$$

- translation of points

$$\underset{\sim}{p} \rightarrow \underset{\sim}{p} + \vec{t}$$

$$\underline{\underline{T}} = \begin{array}{c} \\ 3 \\ \\ 1 \end{array} \overset{\begin{array}{ccc} 3 & & 1 \end{array}}{\left[\begin{array}{ccc|c} 1 & 0 & 0 & t_1 \\ 0 & 1 & 0 & t_2 \\ 0 & 0 & 1 & t_3 \\ \hline 0 & 0 & 0 & 1 \end{array}\right]}$$

In general assume blank = zero

So translation is a linear transform in homogeneous coordinates!

A 4x4 matrix.

$$\begin{pmatrix} p_1 \\ p_2 \\ p_3 \\ 1 \end{pmatrix} \rightarrow \begin{pmatrix} p_1 + t_1 \\ p_2 + t_2 \\ p_3 + t_3 \\ 1 \end{pmatrix}$$