Announcements

- Work in groups - groups of 2 for MPs, groups of 3-5 for the final project.
- MP1 is due on Sep 15, 11:59pm
- MP2 is released.
- Where to find projects announced in class?
  https://courses.engr.illinois.edu/cs498sl3/fa2017/gallery.php
Flight Simulator

https://www.youtube.com/watch?v=mrpqh8ZRLp4

Project goals:
• Add lighting and textures
• Professional looking, comfortable demo
• Maybe: add drone panoramas

Contact: blaksmatic@gmail.com, Blaks Zeng
prof. Anna Yershova, prof. Steve LaValle
"A Story of"
"Death of"
Sandra Bland

• "Sandra Bland was a 28-year-old black woman who was found hanged in a jail cell in Waller County, Texas, on July 13, 2015, three days after being arrested during a traffic stop."

• Exploration in:
  • Combining 3D and 2D media
  • Invoking emotion through sensory manipulation
  • Creating empathy in virtual reality

Sophia svlin2@illinois.edu
Archeology: Excavation Sites in VR

Contact professor: llshacke@illinois.edu
prof. Laura Shackelford, Associate Professor, College of Medicine,
Dept. of Surgery, Dept. of Anthropology

In the news: http://www.sci-news.com/othersciences/anthropology/article00538.html
More on the project:

Contact our TA:
Blaks Zeng
yzeng19illinois.edu
Experience in UE4 only!
VR Music Performance

Bryce
bdconra2@illinois.edu
Geometric Modelling
Geometric Modelling

Unity

the change of coordinate system

Righthanded Cartesian Coordinates

Lefthanded Cartesian Coordinates

X Y Z

X Y Z
Static vs Dynamic Models

Stationary objects: Defined in world coordinate frame
Static vs Dynamic Models

Movable objects: Defined in local coordinate frame

Not Rigid: sponge, leather, skin, water, clouds, feathers.
Movable objects: Composed of multiple rigid bodies, each of which is defined in its own frame.
3D Primitives vs 2D Boundary Representations

"3D primitives" Solid primitives

"2D primitives" boundary representation

model coherency
Transforming Rigid Bodies

1. Movable objects
   http://www.senocular.com/flash/tutorials/transformmatrix/examples/3dpicturebox.html

2. Perception of stationarity
   https://www.youtube.com/watch?v=A7q3mY0iNOQ
# Rigid Body Transformations

<table>
<thead>
<tr>
<th>DOFs</th>
<th>2D</th>
<th>3D</th>
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</thead>
<tbody>
<tr>
<td>1) Easy:</td>
<td>2</td>
<td>3</td>
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<tr>
<td>translations</td>
<td></td>
<td></td>
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<tr>
<td>2) More difficult:</td>
<td>1</td>
<td>3</td>
</tr>
<tr>
<td>rotation</td>
<td></td>
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<tr>
<td>3) Most difficult:</td>
<td>3</td>
<td>6</td>
</tr>
<tr>
<td>rotation + translations</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
3D Translations

Triangle: \((x_i, y_i, z_i)\) \(i=1,2,3\)

Shift: \(\begin{pmatrix} x \\ y \\ z \end{pmatrix} + \begin{pmatrix} 1 \\ 1 \\ 10 \end{pmatrix}\)

New Triangle: \((x_i + x, y_i + y, z_i + z)\)
2D Linear Transformations

\[
\begin{bmatrix}
    m_{11} & m_{12} \\
    m_{21} & m_{22}
\end{bmatrix}
\begin{bmatrix}
    x \\
    y
\end{bmatrix} =
\begin{bmatrix}
    x' \\
    y'
\end{bmatrix}
\]

\[
x' = m_{11}x + m_{12}y
\]
\[
y' = m_{21}x + m_{22}y
\]

\[
\begin{bmatrix}
    2 \\
    -1
\end{bmatrix}
\begin{bmatrix}
    1 \\
    0
\end{bmatrix} =
\begin{bmatrix}
    2 \\
    -1
\end{bmatrix}
\]
\[
\begin{bmatrix}
    2 & 0 \\
    -1 & 1
\end{bmatrix}
\begin{bmatrix}
    0 \\
    1
\end{bmatrix} =
\begin{bmatrix}
    1 \\
    1
\end{bmatrix}
\]
2D Linear Transformations: Examples

- Identity matrix: no effect
- "Scale" respect ratio
- Reflect over y
- Rotation by π around (0,0)
- X-shear
- Y-shear

http://math.mercyhurst.edu/~lwilliams/Applets/LinearTransformations.html
3. Draw a polygon that IS NOT a result of linear transformation.
2D Rotations

1) No scaling: \[ \| \mathbf{i} \| = \| \mathbf{j'} \| = 1 \]
   \[ m_{11} + m_{22} = 1 \]
   \[ m_{12} + m_{21} = 0 \]

2) No shearing: \[ \mathbf{i} \cdot \mathbf{j'} = 0 \]
   \[ m_{11} \cdot m_{12} + m_{21} \cdot m_{22} = 0 \]

3) \[ \det(M) = \pm 1 \]
2D Rotations

\[
\begin{align*}
m_{11} &= \cos \theta \\
m_{21} &= \sin \theta \\
\text{then} & \\
m_{12} &= -\sin \theta \\
m_{22} &= \cos \theta
\end{align*}
\]

\(\theta\) is one parameter that represents 2D rotations:

\[
\begin{pmatrix}
\cos \theta & -\sin \theta \\
\sin \theta & \cos \theta
\end{pmatrix}
\]
3D Rotations

\[ M = \begin{bmatrix} m_{11} & m_{12} & m_{13} \\ m_{21} & m_{22} & m_{23} \\ m_{31} & m_{32} & m_{33} \end{bmatrix} \]

9 DOFs

1) No scaling

\[
\begin{align*}
\| \mathbf{i}' \| &= 1 \\
\| \mathbf{j}' \| &= 1 \\
\| \mathbf{k}' \| &= 1
\end{align*}
\]

2) No shearing

\[
\begin{align*}
\frac{\mathbf{i}' \cdot \mathbf{j}'}{\mathbf{k}'} &= 0 \\
\frac{\mathbf{j}' \cdot \mathbf{k}'}{\mathbf{i}'} &= 0 \\
\frac{\mathbf{k}' \cdot \mathbf{i}'}{\mathbf{j}'} &= 0
\end{align*}
\]

3) \( \det(M) = \pm 1 \)