CS 112 - Hierarchical Model Representation

Animations

- Need efficient representation of
  - Model geometry
  - Motion
  - Interactive rendering
Inherent relationship of parts

- Arm - Simple model
- Shoulder moves all the three parts
- Elbow moves everything below it
- Inherent hierarchical relationship

Directed Acyclic Tree
Dependency

- Any transformation applied to the parent will be undergone by the children
  - Children must be placed appropriately with respect to the parent
- Children may have their own independent movement
  - Not transmitted to the parent

Representing Transformations

- Transformation with respect to the parent
- Transformation to place it appropriately with respect to the parent
Representing Transformations

- Transformation with respect to the parent
- Transformation to place it appropriately with respect to the parent

Representing Transformations

- Assume each part is defined with origin at center
Representing Transformations

- Assume each part is defined with origin at center
  - $R_w$
  - $T_{we}$
Representing Transformations

- Assume each part is defined with origin at center
  - \( R_w \) - Wrist
  - \( T_{we} \) - Wrist
  - \( R_E \) - Elbow and Wrist
  - \( T_{es} \) - Elbow and Wrist
Representing Transformations

- Assume each part is defined with origin at center
  - $R_w$ - Wrist
  - $T_{we}$ - Wrist
  - $R_e$ - Elbow and Wrist
  - $T_{es}$ - Elbow and Wrist
  - $R_s$ - Shoulder, elbow and wrist

Wrist: $R_s T_{es} R_e T_{we} R_w$
Elbow: $R_s T_{es} R_e$
Shoulder: $R_s$
Data Structure

- Depth first traversal of the tree
- Push matrix when entering a node
- Pop matrix when leaving a node
- Render the node as you encounter it
- Example

Data Structure

Shoulder - Rs
       T_{es}  T_{ts}
         Torso - R_t
Elbow - Re
       T_{we}
       Wrist - Rw

R_s T_{es} R_e T_{we} R_w
R_s T_{es} R_e
R_s

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Data Structure

Shoulder - $R_s$

Elbow - $R_e$

Wrist - $R_w$

Torso - $R_t$

$R_sT_{es}R_e$

$R_s$
Data Structure

Shoulder - Rs

Elbow - Re

Wrist - Rw

Torso - Rt

Rs
Representing Motion

- **Keyframes**
  - Generate the transformations for key postures
    - Done manually
  - Interpolate everything in between
    - Done automatically