Motion Modeling
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Modeling Human Motion
Articulated Motion

• Rigging
  – Attaching a skeleton to a model
  – Skeleton is key-framed to move the model
Articulated Motion

• Rigging
  – Embed the skeleton
  – Attach the bones to the model
Articulated Motion

- Rigging
  - What is a skeleton

Bones

Joints

Hierarchy
Articulated Motion

• Rigging
  – What is stored in a skeleton
  Rigid transformations
  On bones or joints
  Bones can be transformed rigidly
Articulated Motion

- Rigging
  - Bones can be transformed rigidly
Articulated Motion

• Rigging
  – Attach the bones to the model
  – Weights indicate how much a vertex is effected by a bone
Articulated Motion

• Rigging
  – Attach the bones to the model
Articulated Motion

• Rigging
  – Attach the bones to the model

\[ T(x) = \text{avg}(T_1, T_2, w_1, w_2) \]
Articulated Motion

• Rigging
  – How to blend (average) transformations

Linear Blend Skinning

Represent $T_i$ with $T_i$ in homogenous coordinates

$T(x) = w_1(x)T_1 + w_2(x)T_2$

$x' = T(x)x$

$T(x) = \text{avg}(T_1, T_2, w_1, w_2)$
Articulated Motion

• Rigging
  – How to blend (average) transformations
    Linear Blend Skinning
Articulated Motion

- Forward vs. inverse kinematics

Forward

• goal

move

move

move
Articulated Motion

• Forward vs. inverse kinematics

Inverse

move

inferred

goal
Articulated Motion

• Controllers
  – Classical controllers e.g. in Autodesk Maya
Articulated Motion

• Controllers
  – Sketch-based controllers
Articulated Motion

• Key-framing controllers
Motion Capture

- Special suits with markers
- Controlled
  - Lighting
  - Cameras
- Track markers
- Real-time monitoring
Motion Capture

- Motion capture
Motion Estimation

Input depth map

- Pose Estimator
- Pose Parameters
- Pose Deformer
- Resampler Rasterizer
- Collision & Physical Constraints
- Shape
Motion Estimation

Input

Pose Estimator

$\theta$

Pose Parameters

Pose Deformer

Resampler Rasterizer

Resampler Rasterizer

Latent Space

Shape

depth map & colour image

[Diagram of motion estimation process with blocks labeled Pose Estimator, $\theta$, Pose Parameters, Pose Deformer, Resampler Rasterizer, Latent Space, Shape, and input images of a hand in different poses.]
Facial Motion

• Face is the most delicate part of a character
• Hard not to fall into the uncanny valley
Facial Motion

• The uncanny valley: don’t fall into it
Facial Motion

• How can we control facial animation
• Blendshapes
  – Provides a linear space of facial expressions
Facial Motion

- How can we control facial animation

Blendshapes

\[ \sum_{i} w_i F_i \]
Facial Motion

• How can we control facial animation
Facial Motion Capture

• Fine scale details
  – Solution: Capture
Facial Motion Capture

- Fine scale details
  - Solution: Capture
  - Use as examples to define shape spaces, e.g. with blendshapes