3D BODY & FACE MODELING & ANIMATION

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Outline

• 3D Human Modeling
• Facial Expressions
• Lip Synchronization
• Advanced Rendering
• Applications
3D Human Modeling

- Body modeling
  - Skeleton and skin
- Face modeling
  - Texture mapping of multiple photographs
  - Blend-shapes for facial expressions
- Hair modeling
Body Modeling

- Skeleton fitted to the body mesh
- Hierarchical structure of 76 bones
Body Modeling

- Shaded version of the skin
- ~14500 polygons
Body Modeling

- Matrix palette skinning
- "Paint" weights for each joint
- Four influences per vertex
Skeletal Animation
Face Modeling

- Momentum’s patented semi-automatic face modeling method
  - A few photographs taken from specific angles
  - Accurately represent the geometry and the texture of the face in every direction.

- Method is insensitive to:
  - Position, scale and illumination differences among photographs
  - Rotation inaccuracies
  - Perspective deformations due to camera lens.
2D Feature Points
3D Reconstruction

\[ p^f_{n,x} = \frac{c^f_x + S_n \cdot \hat{I}^f}{\lambda^f + ES_n \cdot \hat{K}^f} \]

\[ p^f_{n,y} = \frac{c^f_y + S_n \cdot \hat{J}^f}{\lambda^f + ES_n \cdot \hat{K}^f} \]

Find \( S_n \) for each point (14x3)

and \( \hat{I}^f, \hat{J}^f, c^f_x, c^f_y, \lambda^f \) for each view (5x6)

given \( p^f_{n,x}, p^f_{n,y} \) for each pt. & view (58x2)
3D Face Adaptation
Texture Blending
Facial Animation

- Animation via weighted average of blend shapes
  - Expression blendshapes
    - Used to synthesize the six basic emotions
      - Happiness, Anger, Fear, Boredom, Surprise, Sadness
  - Viseme blendshapes
    - Used to synthesize sixteen visemes
      - A, F, O, P, W, ...
Expression Blendshapes
Viseme Blendshapes
Expressions
Visemes

A Selection of Viseme Definitions
Audio-Driven Face Animation

• Speech/music for animation control
• Auto-generate speaker & language independent facial animation from speech:
  - Lip synchronization (lip-sync)
  - Expression
  - Head Motion
Audio-driven Animation Analysis & Synthesis

Analysis
- Audio Database
- Audio Feature Extraction
- Statistical Training
  - lip-sync
  - expression
  - head motion
  - dance figure
  - timing info

Synthesis
- Animation Audio
- Audio Feature Extraction
- Synthesis
- Animation

Correlation model
Lip Synchronization

- Determine mouth shapes during speech
- Viseme (mouth shape)
  - Basic unit for lip-sync,
  - Animation parameters for all possible mouth shapes
- 16 standard visemes in facial animations
Advanced Rendering

- Shaded face model
- ~3000 polygons, 2k x 2k textures
Real-time Rendering

• GPU based rendering with vertex and pixel shaders
• Skeletal and blend-shape animation
• Dynamic shadow-casting lights
• Bump mapping
• Skin shading with subsurface scattering
• Global illumination by cube maps and ambient maps
• Crease maps
Skin Texture Maps

Diffuse Map

Normal Map

Occlusion Map

Oil Map
Skin Shading

- Real-time skin shading with subsurface scattering
- Dynamic shadows including self-shadowing
Skin Shading (Diffuse)

diffuse +70%
Skin Shading (Specular)

oil +100%
Skin Shading (Normal)

bump +100%
Facial Expressions
Eye Controls
Hair Modeling

• Hairstyling
  - Geometry of the hair, density, distribution, and orientation of hair strands.

• Hair simulation
  - Dynamic motion of hair, collision detection between the hair and objects

• Hair rendering
  - Color, shadows, light scattering effects, transparency
Hair Animation

• By fitting a skeleton
• Simple but not suitable for all hairstyles
Hair Styling
Applications

• Can be incorporated into any 3D rendering environment
  - PC and console games
  - TV and movies
  - Mobile messaging
  - Lip reading
PC & Console Games

• Many game genres need human animation:
  - Role-playing games (RPG)
  - Puzzle-adventure
  - First-person shooter (FPS)

• In-game cinematic cutscenes with dialogues

• Momentum’s Culpa Innata released worldwide in Fall 2007
  - 40+ main characters
  - 1400+ cutscenes
  - Animation localization for 5 languages
Work Started on CI2