SHAPE ANALYSIS DRIVEN SURFACE CORRECTION

ON Animation Studios
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Mune: Le Gardien de la Lune
Our production rig

- Fully procedural rig
  - Facial
  - Body
- Auto rig system
  - No blendshapes
  - No corrective blendshapes
Dynasculpt: *All in one* tool

- Pose space deformation
  - Facial
  - Body
- Artistic refinement
  - Post animation model polishing
  - Post corrections for physically simulated models
Dynasculpt main features

• Sculpt wrapping
  • Surface Local coordinate system

• Shape analysis to drive corrections
  • Direct drive
  • Across Radial Basis Function interpolators
Sculpt wrapping

• Use smoothed normals of laplacian filtered mesh
Computing sculpt deltas

• Artist sculpts the corrected shape from a reference shape
• Compute smoothed normals of reference shape

For each moved vertex:
  Compute the delta in world space
For each edge of vertex umbrella:
  Compute an edge matrix
  Compute a local delta using edge matrix
Local Delta for edge 1
Local Delta for edge 2
Local Delta for edge 3
Local Delta for edge 4
Restoring Sculpt deltas

- Compute smoothed normals of current model

For each vertex:
  For each edge in vertex umbrella:
    Compute edge matrix
    Transform each local delta to get world delta
  Compute average delta
  Scale average delta to the right length
Restore local delta 1 in world space
Restore local delta 2 in world space
Restore local delta 3 in world space
Restore local delta 4 in world space
World delta is average of previous deltas
Multiple deltas VS classical simple delta

• More stability when restoring a sculpt

• Single delta technique failed with :
  • Huge tangential displacements (skin sliding)
  • Hard polygon deformation of target model
Sculpt wrapping efficiency

• Geometry post process
• Can be applied on current shape independently of previous deformations
• Sculpts are additive, orderless
• Good visual results when applied on animated model
• Good stability even with extreme deformation and polygon stretching
Shape Analysis

- Kind of point cloud comparison
- Similarity factor between
  - Reference shape of correction
  - Current shape of animated model
Shape analysis

Data needed:

- A reference shape (the *wrong* shape to recognize)
- Current animated shape
- A set of vertices to analyse
  - Vertices moved by correction
  - User defined recognition zone
Angular variation of each possible vertex pair

- Reference shape
- Current shape
Angular variation of each possible vertex pair

- Reference shape
- Current shape
Angular variation of each possible vertex pair

- Reference shape
- Current shape
Angular variation of each possible vertex pair

- Reference shape
- Current shape
\[ D_{ij} = 0.5 \times \left( \overrightarrow{VC_i} - \overrightarrow{VC_j} \right) \cdot \overrightarrow{Nc_i} - \left( \overrightarrow{VR_i} - \overrightarrow{VR_j} \right) \cdot \overrightarrow{Nr_i} \]

\[ \text{Similarity} = 1.0 - s \times \left( \frac{\sum_{i=0}^{n-1} \sum_{j=i+1}^{n} D_{ij}^p}{n* (n-1) \over 2} \right)^{\frac{1}{p}} \]

N = vertices count
Vc = current vertex position
Nr = reference vertex position
s = scale factor (user tuning)
Nc = current vertex normal
Nr = reference vertex normal
P = power mean factor (for user tuning)
Combine Shape Analysis with PSD?

We need a POSE SPACE for ‘Pose Space Deformation’
Realtime performance

• Use OpenCL on workstation
• Use Intel OpenCL driver on farm
• Working Buffers are mostly stored on GPU
  • Corrections deltas
  • Vertex connectivity
  • Vertex normals
  • tangent matrices, etc...
Shape analysis with GPU

- Two stages parallel reduction algorithm
- Preprocess a reduced set of vertices to analyse
  - Precompute vertices decimation with a 3D grid
Conclusion

• Sculpt wrapping vs blendshapes or corrective blendshapes.
  • Less intermediate sculpting
  • Good visual results and stability

• Shape recognition
  • Fast shape fixes and refinement without any driver
  • Requires minimal user skills

• PSD for facial and body rig correction require more advanced user skills
Many thanks for coming

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