

Motion Capture and Data-Driven Animation

CSE 888 Au'08

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Perceptually Guided Expressive Facial Animation

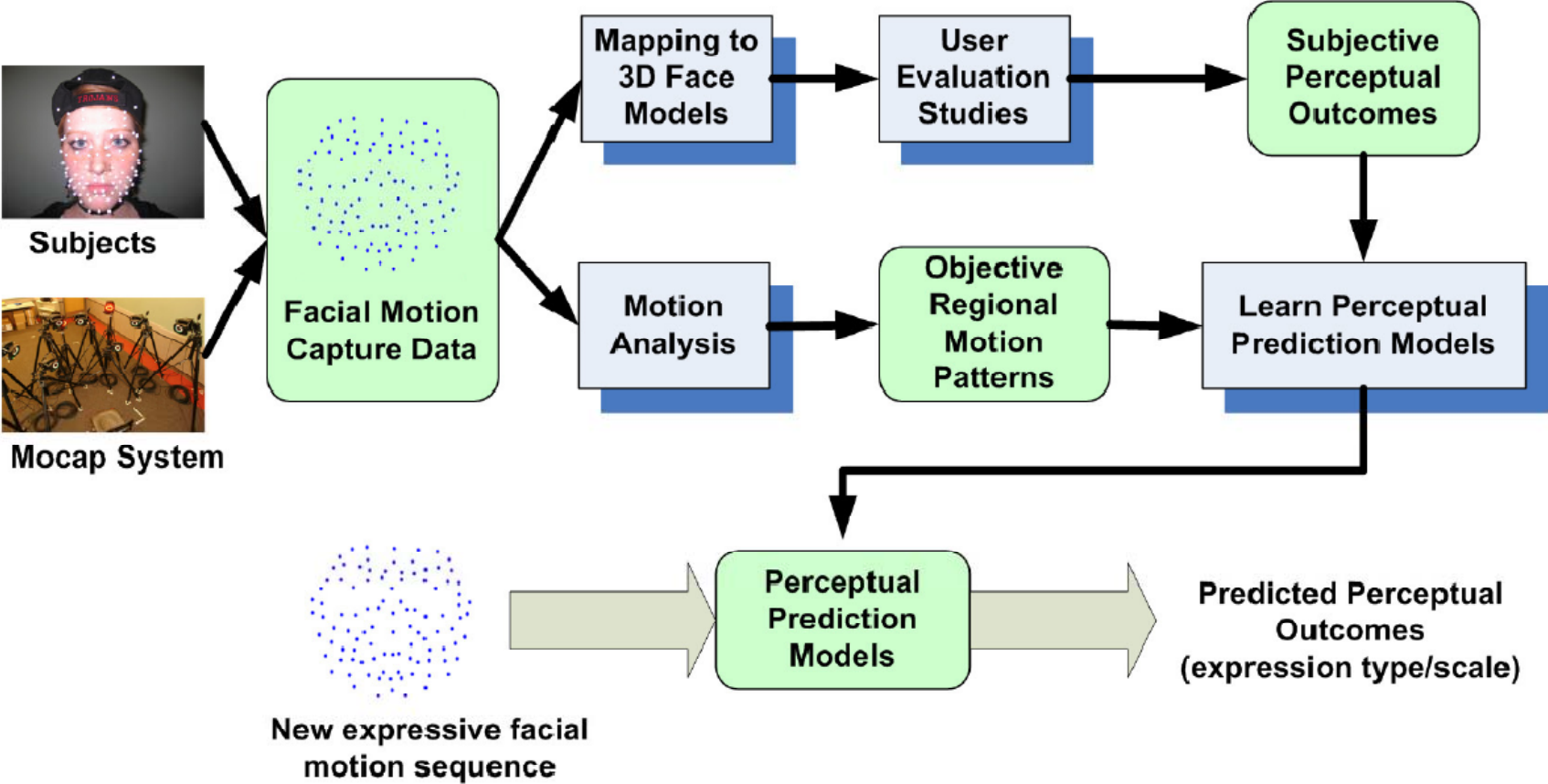
SCA 2008

- Computational perceptual metric (FacePEM) to measure and predict the emotional fidelity of expressive facial animation by bridging human perceptual insights with objective facial motion patterns
- FacePEM can be effectively incorporated into various expressive facial animation algorithms and applications
- Principal Component Analysis - Motion analysis
- M-order Linear Dynamical Systems - Facial motion pattern modeling
- Support Vector Machines - For learning the mapping between objective facial patterns and subjective perceptual outcomes

Limitations

1. Statistical learning approaches – how much data would be enough to train well-behaved statistical models
2. Did not consider the effects of eye-gaze motion. Set it to a fixed position

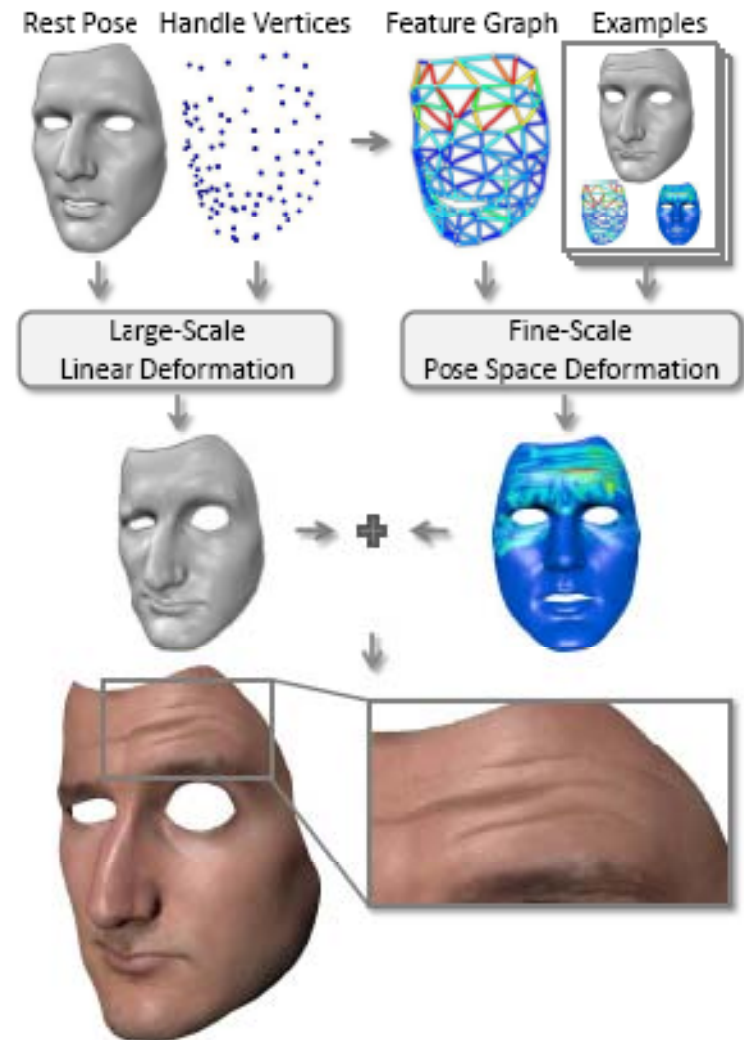
Construction of the computational perceptual metric (FacePEM) for measuring expressive facial animation



Pose-Space Animation and Transfer of Facial Details

SCA 2008

- Real-time animation of highly-detailed facial expressions
- Multi-scale decomposition of facial geometry into large-scale motion and fine-scale details, such as expression wrinkles
- Large-scale deformations - fast linear shell model
- Fine-scale details - novel pose-space deformation technique
- Their hybrid method allows both large-scale deformations and fine-scale wrinkles to be edited intuitively
- Pose-space representation enables the transfer of facial details to novel expressions or other facial models



Pose-Space Animation and Transfer of Facial Details

SCA 2008

- High resolution face mesh of the rest pose . Its deformation can be controlled through a set of handle vertices
- Set of example poses - high resolution meshes in full vertex correspondence with the rest pose
- Fine-scale details extracted and stored per-vertex
- To interpolate the fine-scale corrections of the examples onto other poses, they define a novel pose space for facial expressions based on skin strain, and learn the formation of skin bulges and wrinkles in this space.
- They construct a feature graph from the handle vertices. The skin strain is measured at the feature graph's edges.

Limitations

1. The face model cannot react to forces, only positional constraints.
2. The model could suffer from self intersections if the user edits the handles to arbitrary locations

DrivenShape - A Data-driven approach for Shape Deformation

SCA 2008

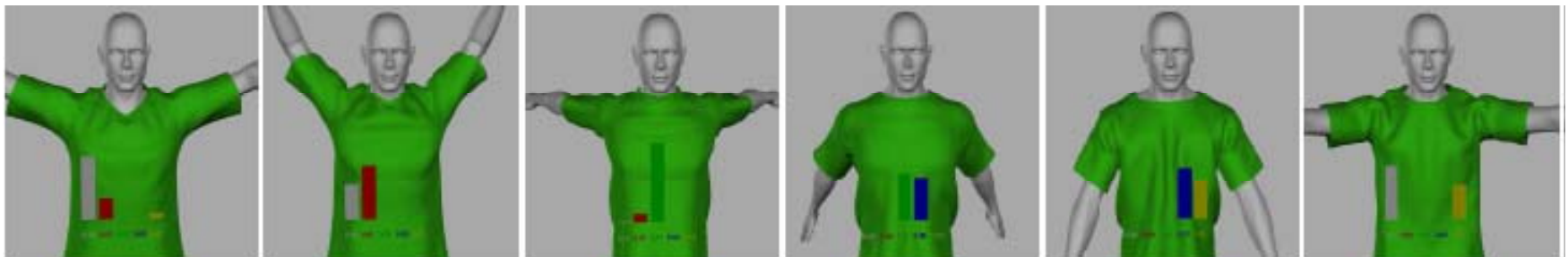
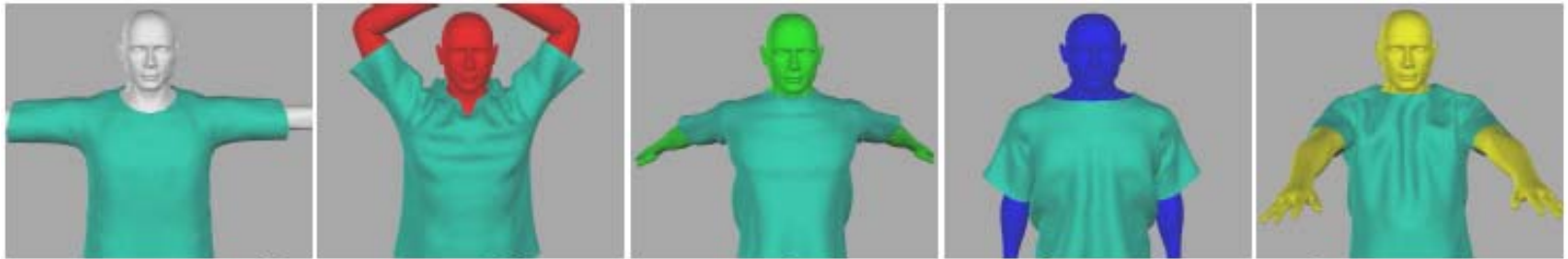
- DrivenShape exploits known correspondences between two sets of shape deformations
- Reuse of pre-computed deformations
- The tool is useful when there is high correlation between poses and secondary objects
- If the new pose can be interpolated from a set of key poses, then the same interpolation weights can be used to interpolate the target (driven) shapes.
- Analyze reference animations that contain both pose shape (driver) and its corresponding deformed (driven) shape. From these correspondences, N most distinct pairs of key shapes are extracted and stored as database.
- Key shapes can be extracted automatically or hand-picked

DrivenShape - A Data-driven approach for Shape Deformation

SCA 2008

Limitations

1. Linear blending of shapes not best suited for rotational deformation such as in articulated characters - generates artifacts such as shrinking shapes when blending shapes of different orientations
2. Does not try to recover any secondary dynamics



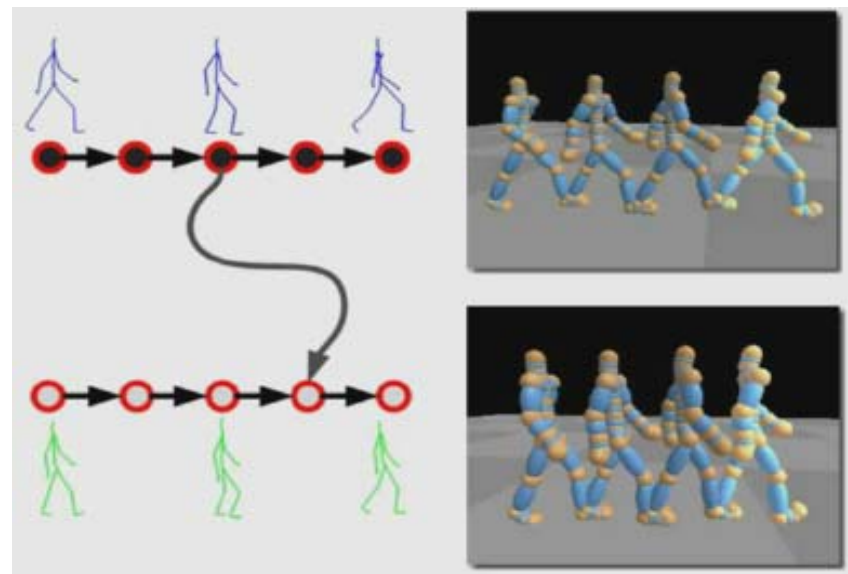
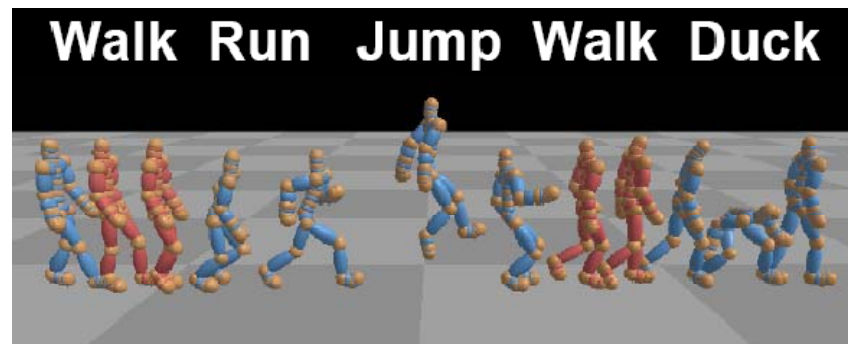
Achieving Good Connectivity in Motion Graphs

SCA 2008

- New method for building motion graphs
- First builds a set of interpolated motion clips
- Using this set, the method then constructs a motion graph and reduces its size by minimizing the number of interpolated poses present in the graph
- Outcome of the algorithm is a motion graph called a well-connected motion graph
- Good motion quality, high responsiveness for interactive control and require no post-processing of synthesized motions

Limitations

1. Greedy algorithm - trade off graph size for quality



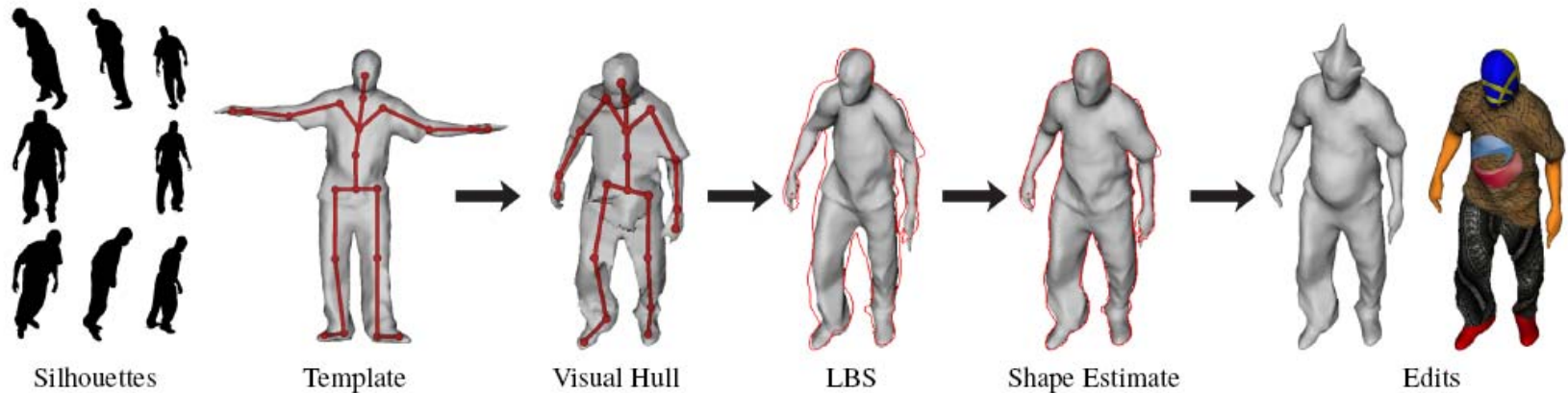
Articulated Mesh Animation from Multi-view Silhouettes

SIGGRAPH 2008

- Given a stream of synchronized video images that record a human performance from multiple viewpoints and an articulated template of the performer, their system captures the motion of both the skeleton and the shape.
- The output mesh animation is enhanced with the details observed in the image silhouettes.
- Fast pose tracking method followed by non-rigid deformation of the template to fit the silhouettes.
- Their method uses visual hulls to track the skeletal pose of the performer.
- The system then deforms a template mesh of the performer to fit the recovered pose and the silhouettes at each frame.
- Their pipeline uses two techniques
 1. Geometric pose tracking method fast enough to incorporate interactively provided user constraints.
 2. Iterative method for deforming a template mesh to match the observed silhouettes while preserving the detail in the template.

Articulated Mesh Animation from Multi-view Silhouettes

SIGGRAPH 2008



- The system starts with a stream of silhouette videos and a rigged template mesh. At every frame, it fits the skeleton to the visual hull, deforms the template using linear blend skinning (LBS), and adjusts the deformed template to fit the silhouettes.

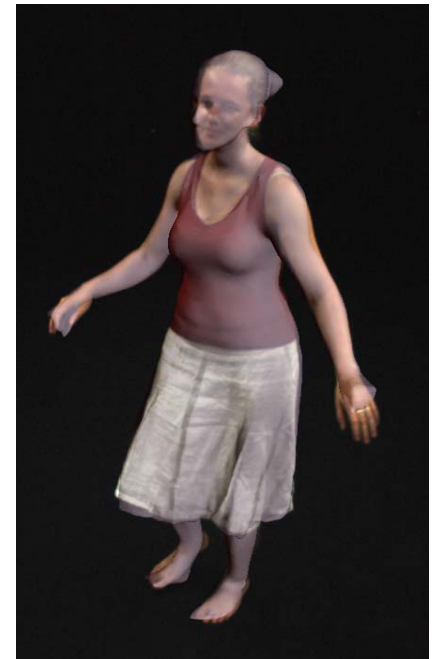
Limitations

1. It cannot reproduce the surface accurately away from the contours: it has to rely on the template to interpolate geometric information.
2. It is sensitive to errors in the silhouettes, and will produce incorrect geometry when visual hulls are noisy

Performance Capture from Sparse Multi-view Video

SIGGRAPH 2008

- Marker-less approach to capturing human performances from multi-view video.
- Reconstruct spatiotemporally coherent geometry, motion and textural surface appearance of actors that perform complex and rapid moves
- Algorithm is purely mesh based



Performance Capture from Sparse Multi-view Video

SIGGRAPH 2008

- Detailed static laser scan of the subject recorded – converted to a high-quality surface mesh and a corresponding lower-detail tet-version is generated
- Performances captured in multi-resolution way
- First global model pose is inferred using a lower-detail model
- Smaller-scale shape and motion detail is estimated based on a high-quality model
- Global pose capture - extracts a set of position constraints from input footage - based on image and silhouette cues
- A model-guided multi-view stereo contour alignment method reconstructs finer details at each time step

Performance Capture from Sparse Multi-view Video

SIGGRAPH 2008

- Apply skeleton-less shape deformation approach to make the scan mimic the real-world equivalent

Limitations

1. Resolution limit to deformation capture
2. Unable to track surfaces which arbitrarily change apparent topology over time because the system preserves the topology of the input scanned model over the whole sequence.
3. Their volume-based deformation technique mimics elastic deformation - rubbery look

Data-driven Modeling of Skin and Muscle Deformation

SIGGRAPH 2008

- Data-driven technique for synthesizing skin deformation from skeletal motion
- Build statistical model of deformations by dividing them into two parts: static and dynamic
- Static deformations modeled as a function of pose while dynamic deformations parameterized by acceleration are modeled by fitting a set of dynamic equations to pre-recorded data
- Generate high-resolution surface model using Park and Hodgins' method
- Subdivide body into 17 near-rigid parts. Define a local coordinate system for each body part. Allows separation of the marker motion into rigid transformation and a local deformation
- Net skin deformation represented as a linear combination of static and dynamic deformations

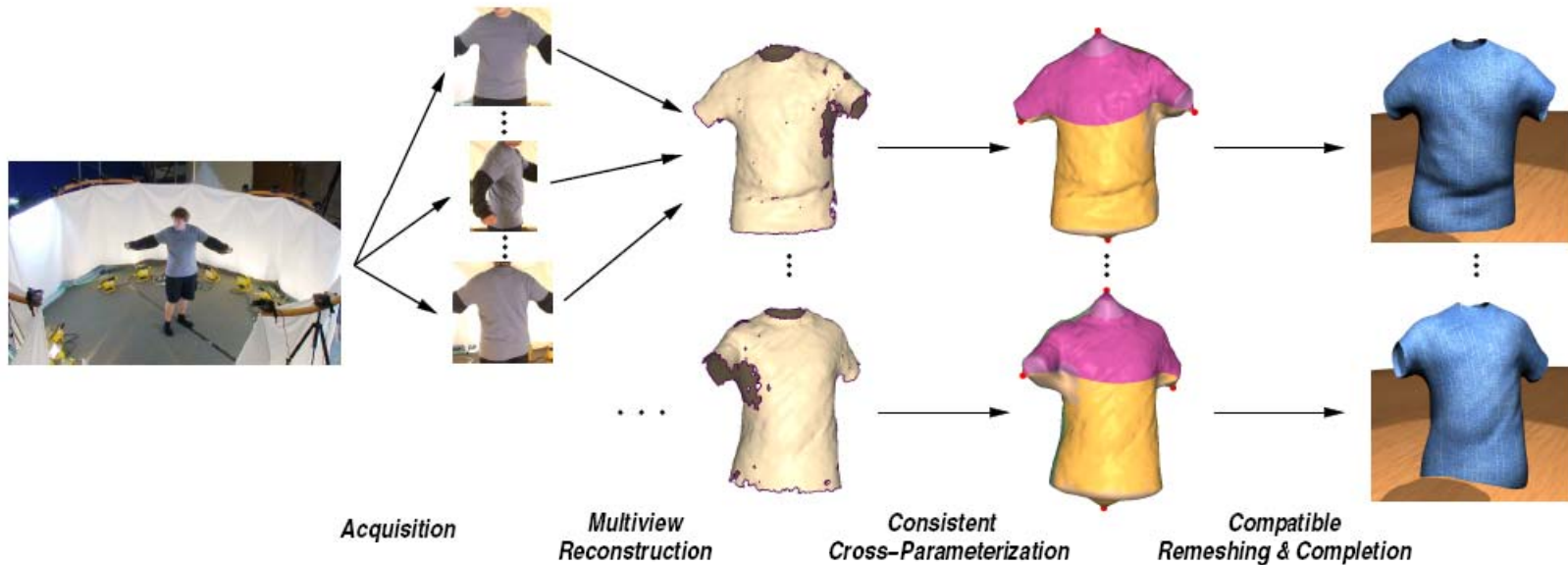
Limitations

1. Assumption - the skeletal structure obtained in the two captures is identical. So, off-the-shelf motion capture data might need to be retargeted
2. Dynamic model parameterized solely by joint acceleration

Markerless Garment Capture

SIGGRAPH 2008

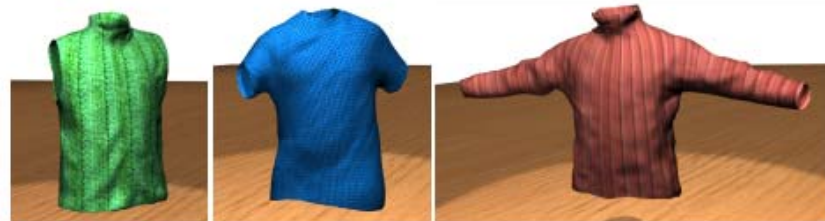
- A marker-free approach to capturing garment motion.
- Use multi-view stereo approach for obtaining initial garment geometry for each time step
- Obtain initial 3D mesh for each frame. Meshes contain holes. Each mesh has a different connectivity.



Markerless Garment Capture

SIGGRAPH 2008

- Consistent cross-parameterization among all input meshes by using strategically positioned off-surface anchors.
- Compatible re-meshing and surface completion using a template mesh.



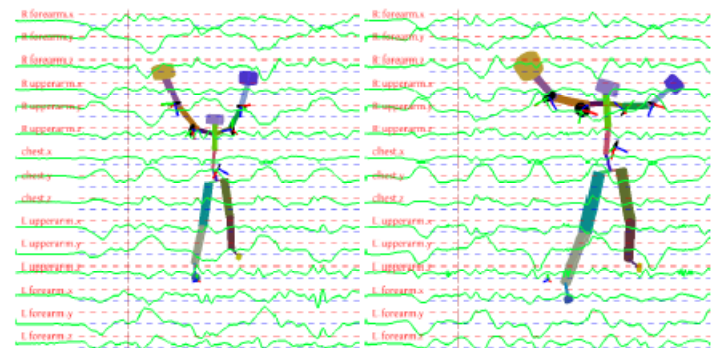
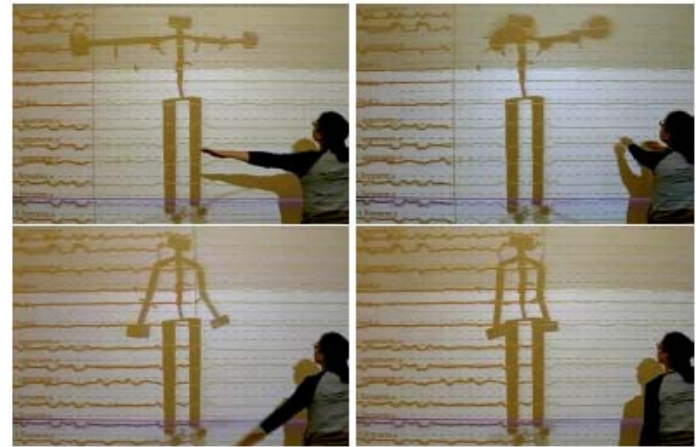
Limitations

1. The system does not handle situations where the garment surface comes in contact with itself.
2. The spatial and temporal smoothing steps tend to remove the fine detail in the geometry.

Action Capture with Accelerometers

SCA 2008

- The system built with only off-the-shelf parts, consists of five accelerometers sewn into a comfortable shirt that streams data to a computer.
- The shirt streams data to the software system in real time.
- The accelerometer readings are continuously matched against accelerations computed from existing motion capture data, and an avatar is animated with the closest match.



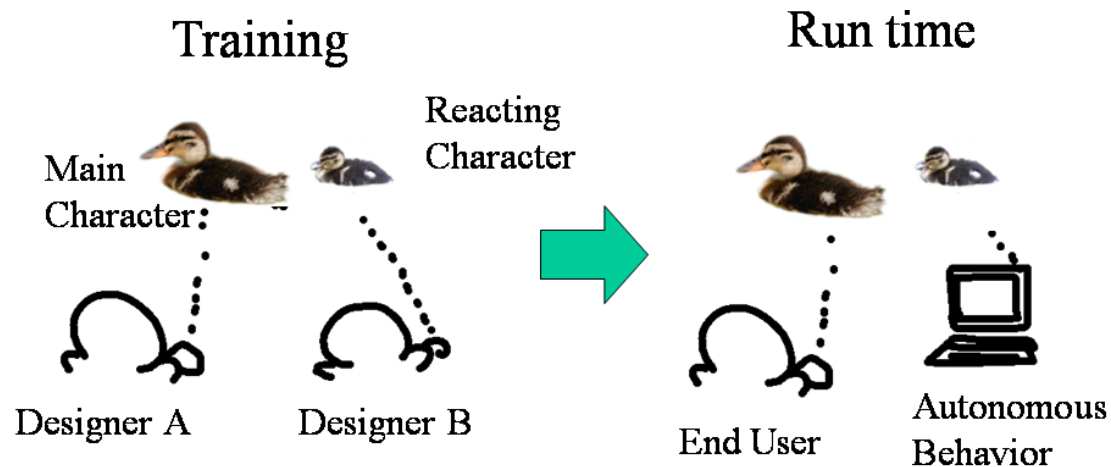
Limitations

1. It does well when the user is performing repeatable, easily recognizable motions. It does less well on motions where the accelerations do not have a consistent pattern.

Puppet Master: Designing Reactive Character Behavior by Demonstration

SCA 2008

- The system enables designers to rapidly create interactive and autonomous animated character behaviors that react to a main character controlled by end-user.
- The behavior is designed by demonstration.
- During training, designers demonstrate paired behavior between the main and reacting characters.



Puppet Master: Designing Reactive Character Behavior by Demonstration

SCA 2008

- During run time, the end user controls the main character and the system synthesizes the motion of the reacting character using the given training data.
- The algorithm is an extension of Image Analogies, modified to synthesize dynamic character behavior instead of an image.

Limitations

1. Does not handle dynamics over large time scale and will fail to accurately represent an angry character gradually calming down



Future Focus

1. Puppet Master: Designing Reactive Character Behavior by Demonstration, SCA 2008
2. Achieving Good Connectivity in Motion Graphs, SCA 2008

