

Expression Cloning



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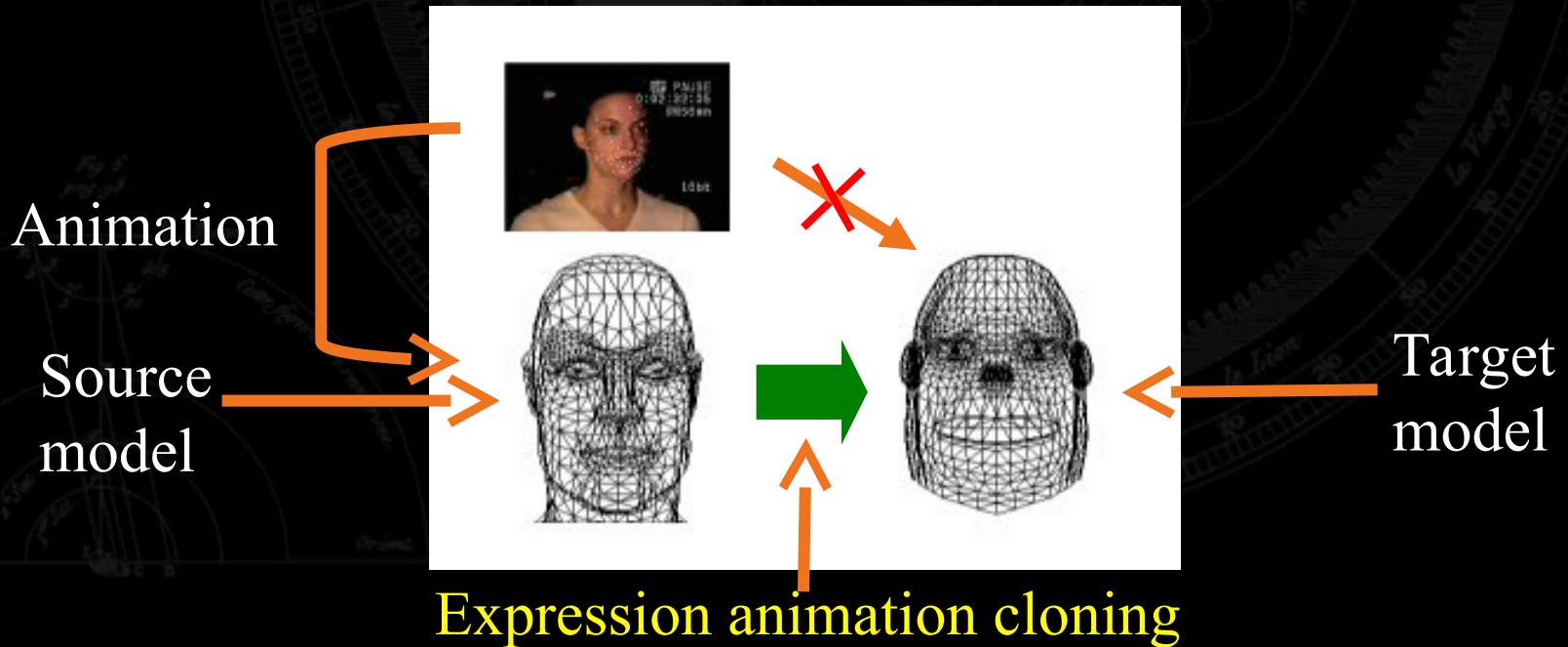
Overview



- Goal and related work
- Dense surface correspondences
- Motion vector transfer
- Cloned expression animations
- Discussion and future work
- Conclusion

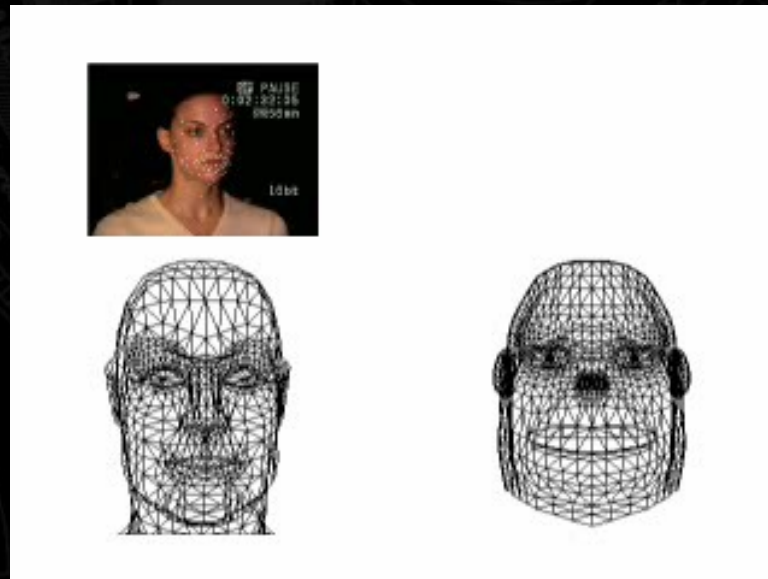
Research Goal

To **efficiently** duplicate available facial animation sequences onto **different** models by transferring **vertex motion vectors**



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To **efficiently** duplicate available facial animation sequences onto **different** models by transferring **vertex motion vectors**



Related Work

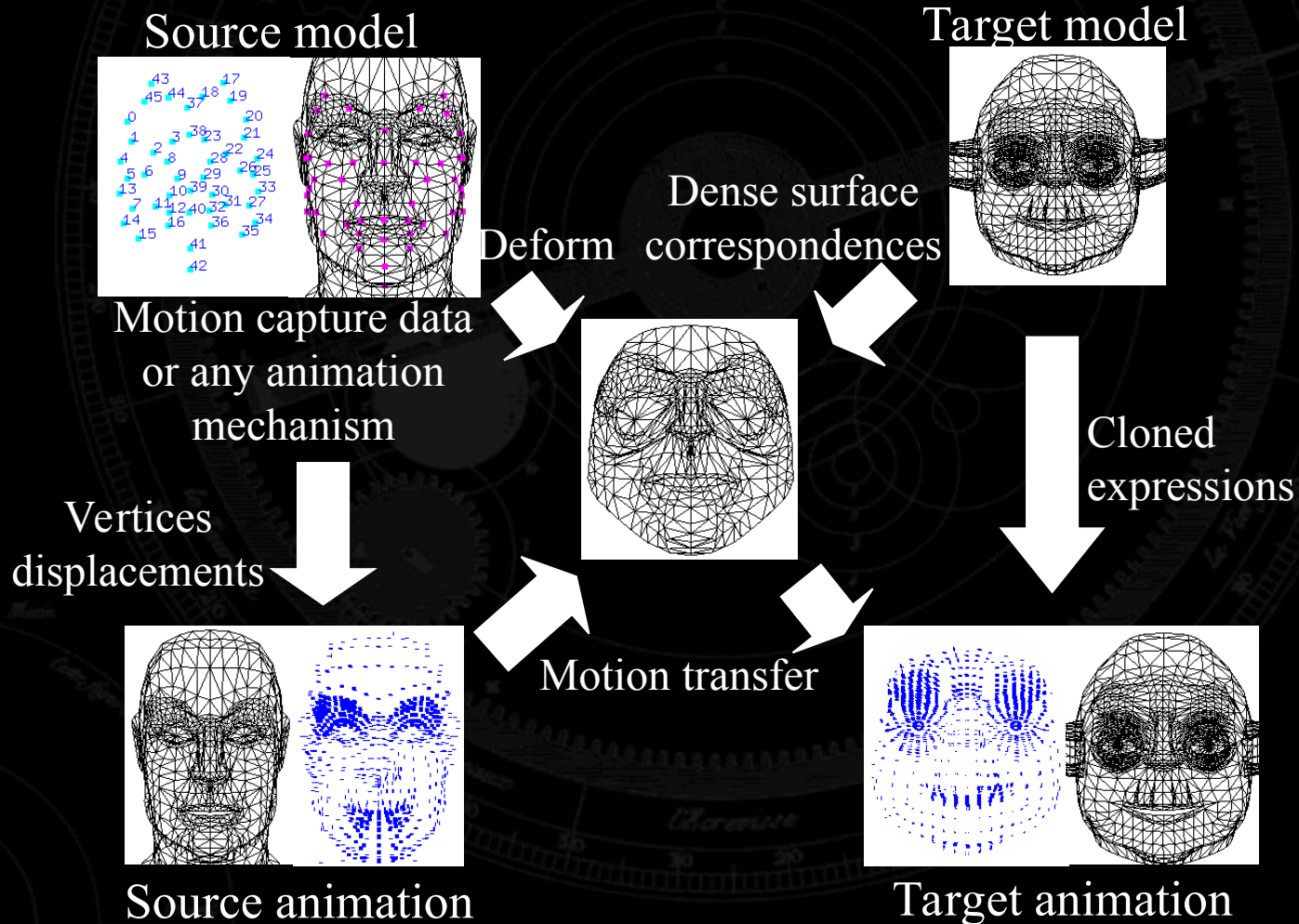
- Parametric approach [Parke 1982]
- Physics based approach [Waters 1995][Lee 1995]
- Key framing [Pighin 1998][Lewis 2000]
- Performance driven animation [Williams 1990]
- Mpeg-4 [Ostermann 1998]

Limitations of Previous Work

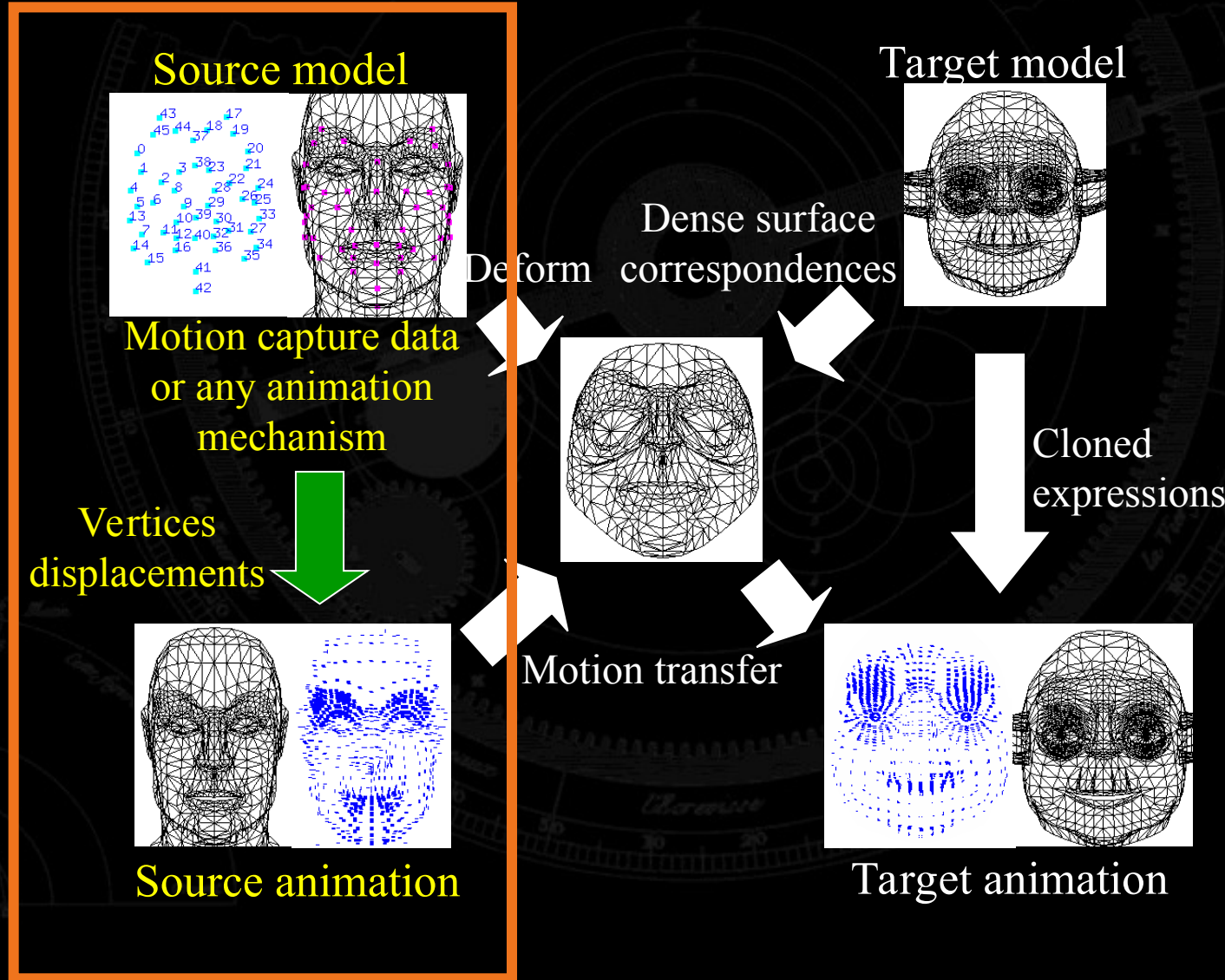
- Parameters tuned for a specific model
- Repeated effort required for new models

Manual processes, computation, or artistic talent are repeatedly required even for similar animations on different models.

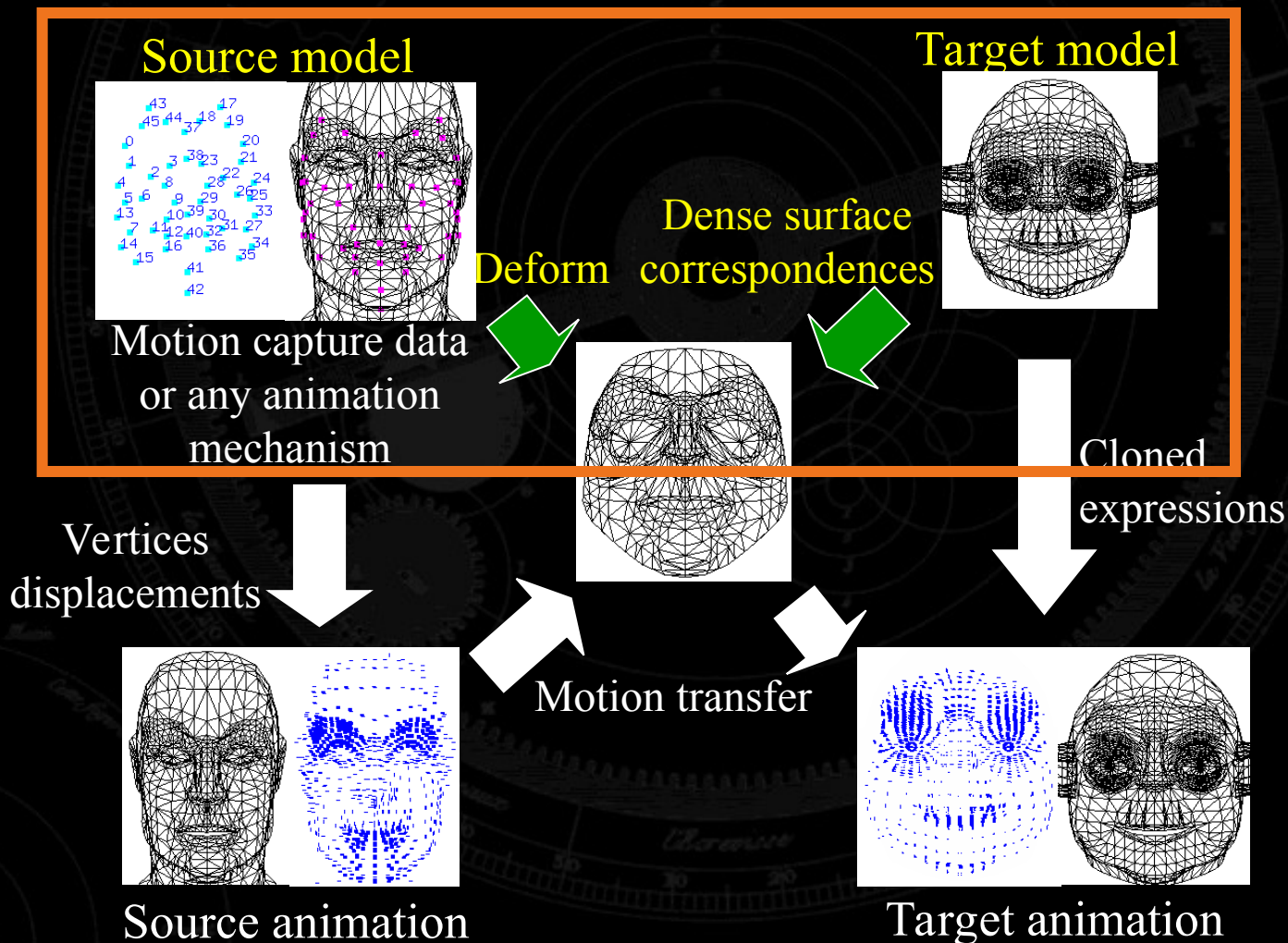
Expression Cloning System



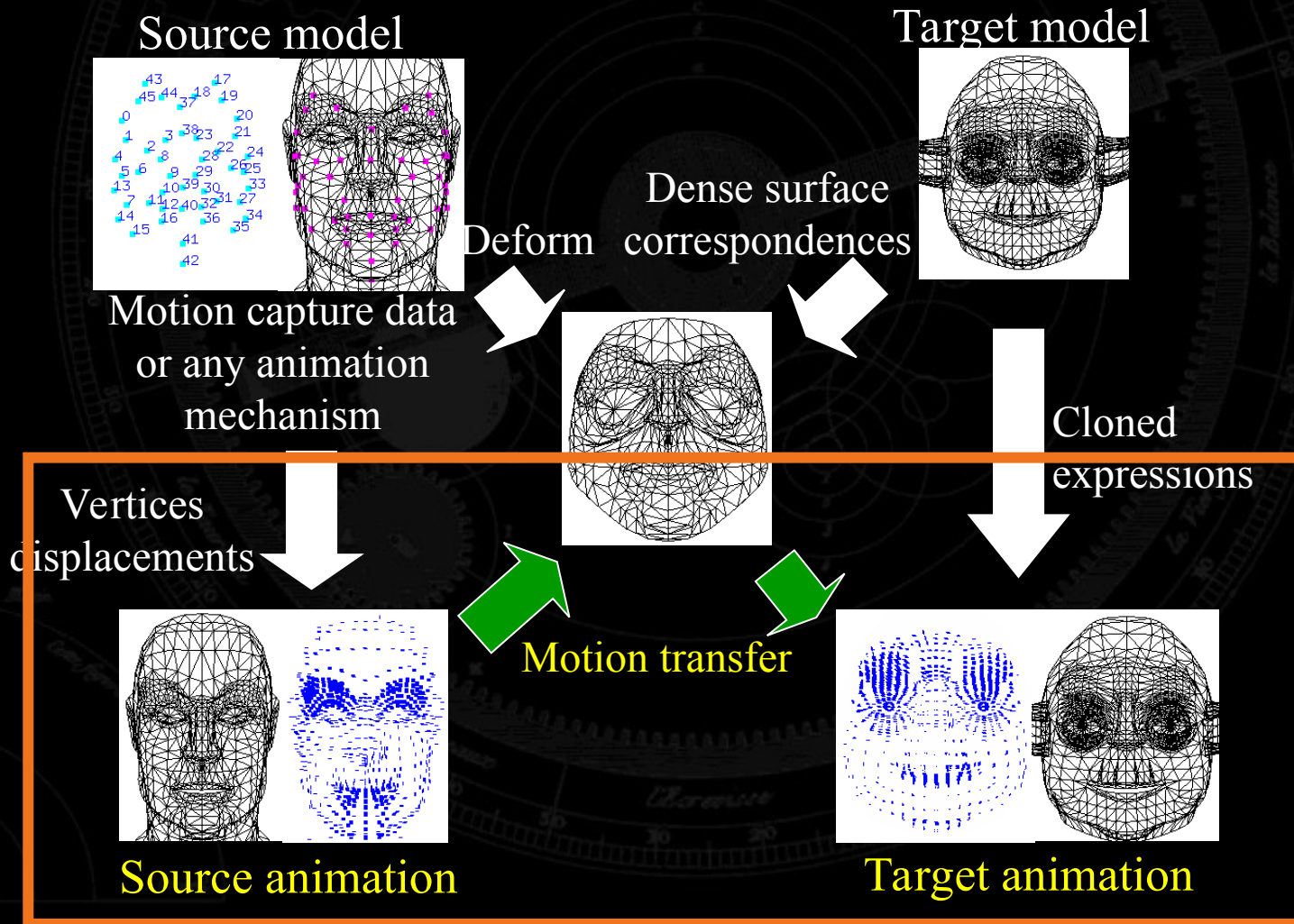
Source Animation Creation



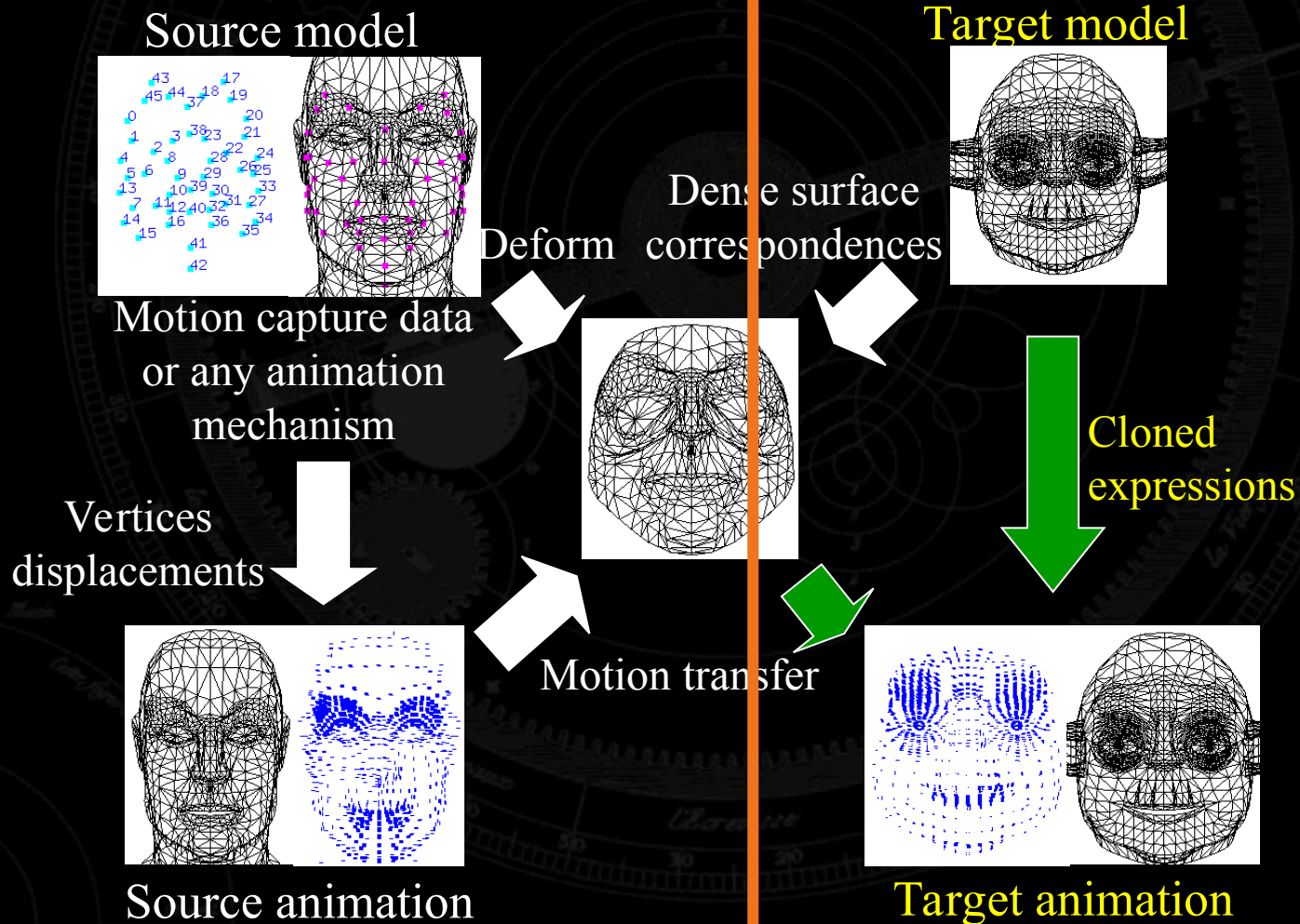
Dense Surface Correspondences



Motion Vector Transfer

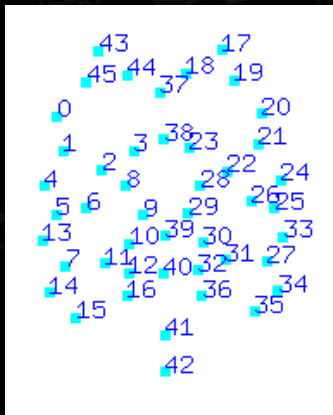


Cloned Expressions

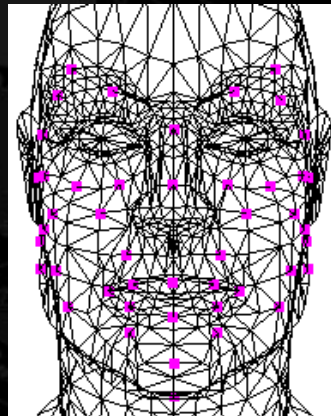


Source Animation Creation

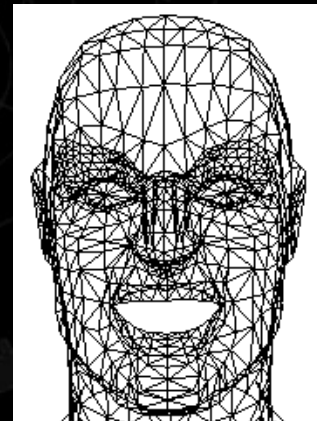
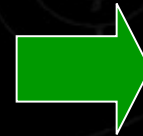
- Any available facial animation methods
- Motion capture data [Guenter 1998]



Motion capture
data



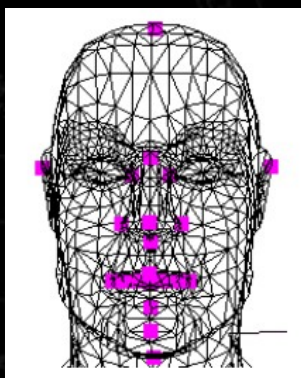
Source model



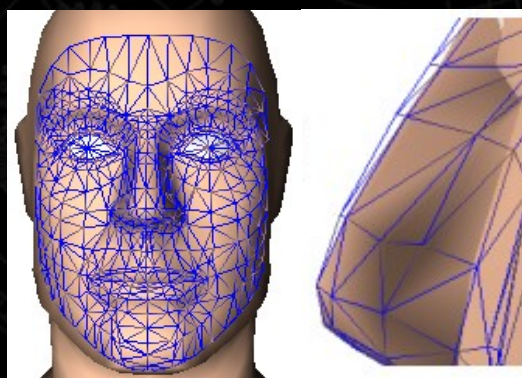
Source animation

Dense Surface Correspondences

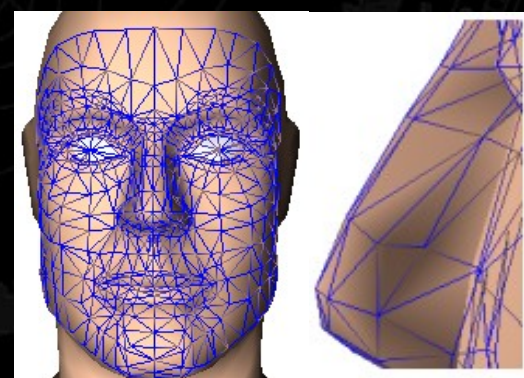
- Initial feature correspondence (15~35 points)
- Morphing with radial basis function
- Cylindrical projection



Initial Features



After RBF



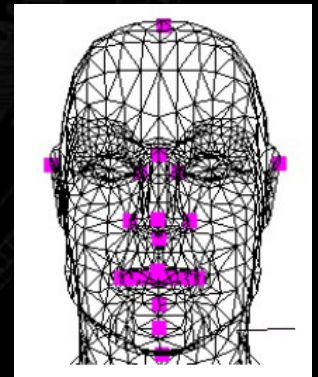
After projection

Initial Feature Search Rules

- Bootstrapping whole expression cloning process
- Exploiting typical human face geometry

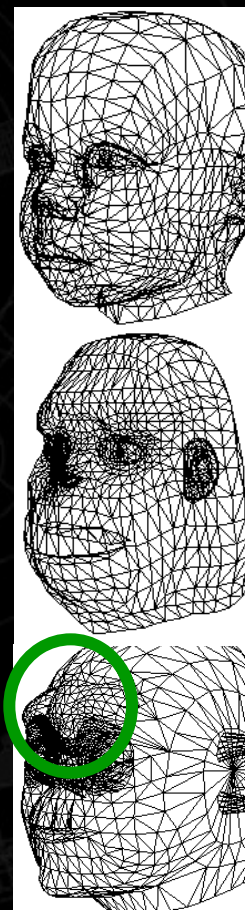
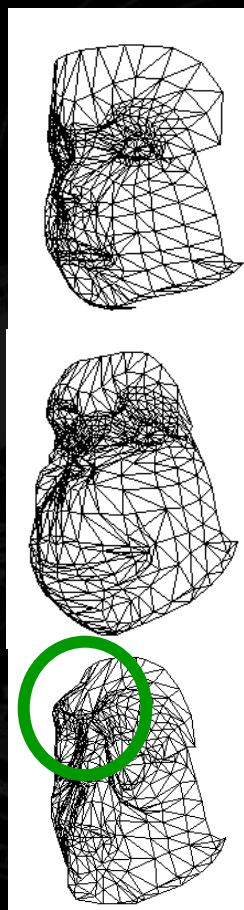
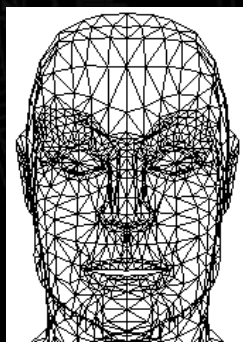
Examples

- Tip of nose: Vertex with highest z value
- Top of head: Vertex with highest y value
- Lip contact line: Set of duplicate vertices



Example Deformed Source Models

Closely approximates
the target models



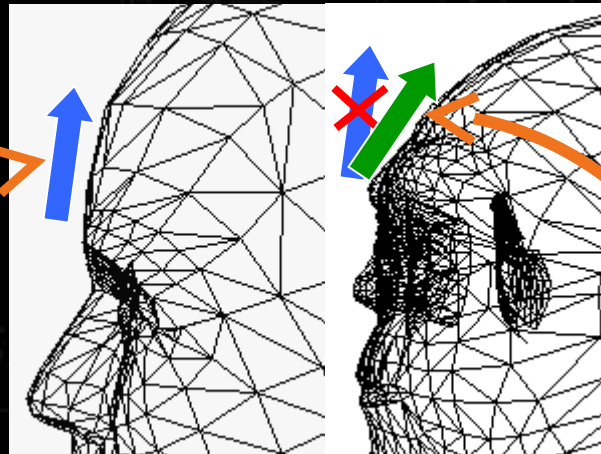
Source

Deformed source

Target

Correct Motion Vector Transfer

- Direction adjustment

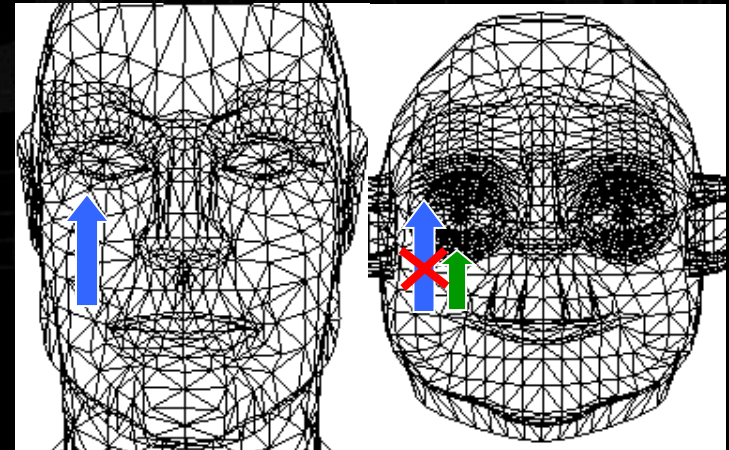


Source

Target

Source motion vector

- Magnitude adjustment



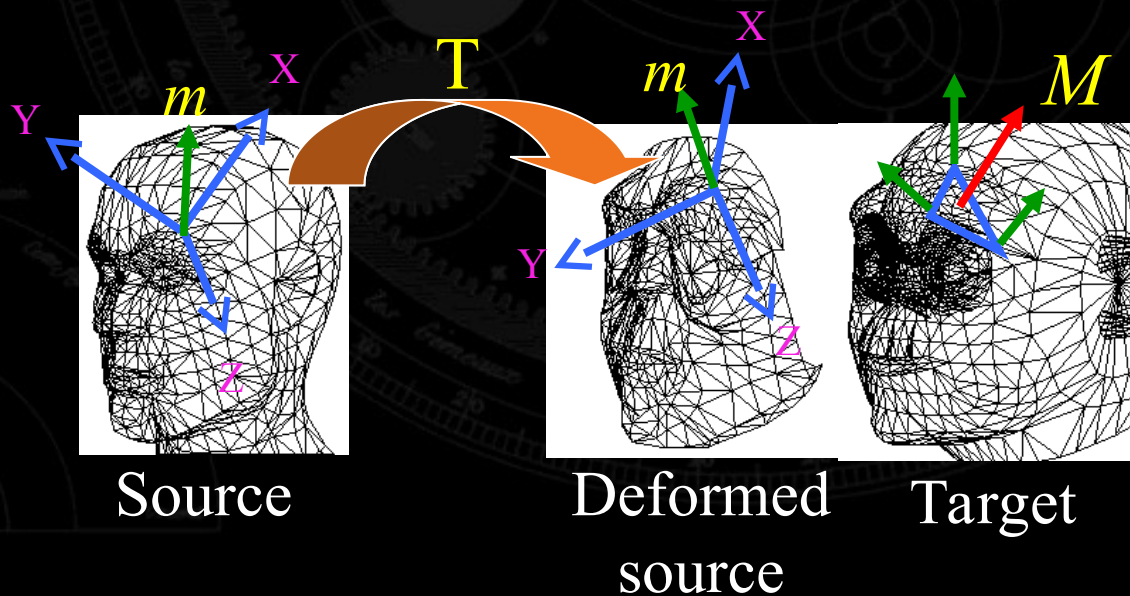
Source

Target

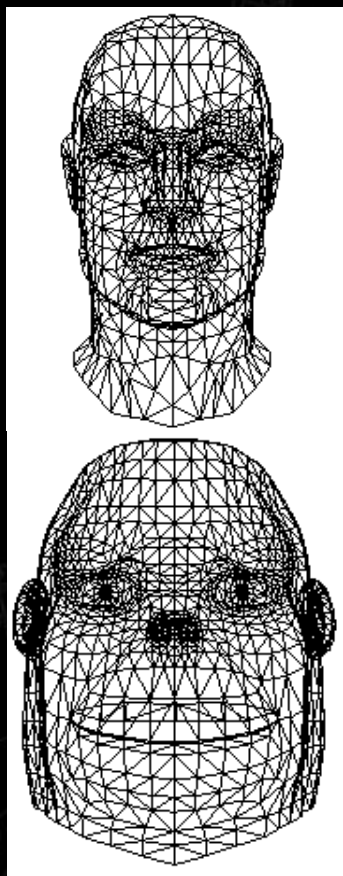
Correct target motion vector

Motion Vector Transfer Steps

- Local coordinate system at each vertex in **source** and **deformed** source model
- Transformation between corresponding vertices
- Barycentric coordinates of enclosing triangle

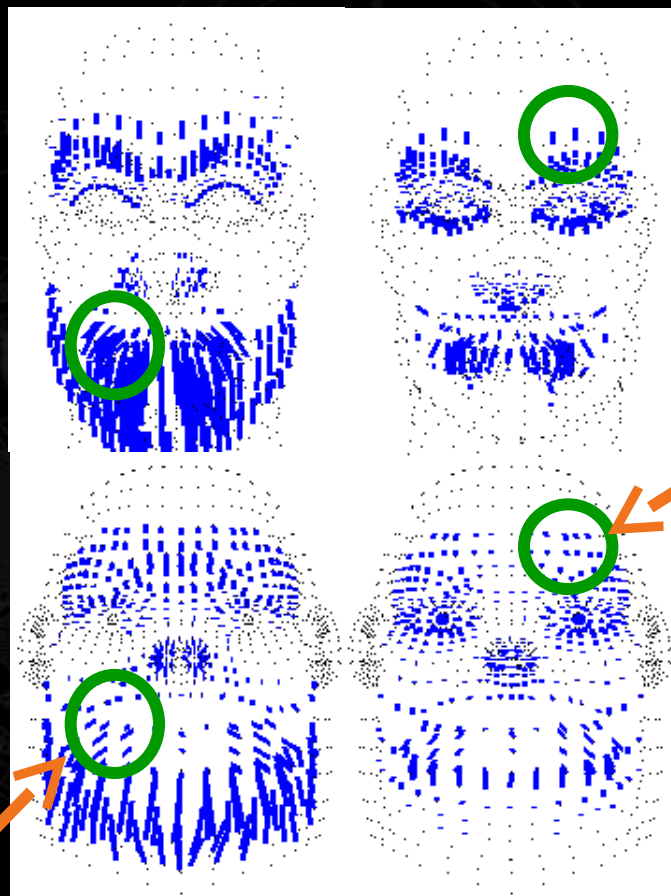


Example Adjusted Motion



Models

More horizontal



Motion vectors

Source

Denser smaller

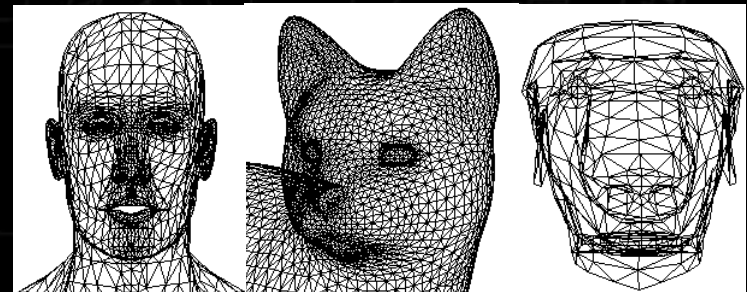
Adjusted motions

Target

Test Model Specifications

Model	Polygons	Vertices
Source	1954	988
Woman	5416	2859
Man	4314	2227
Yoda	3740	1945
Cat	5405	2801
Monkey	2334	1227
Dog	927	476
Baby	1253	2300

- Different geometric proportions
- Different mesh structures

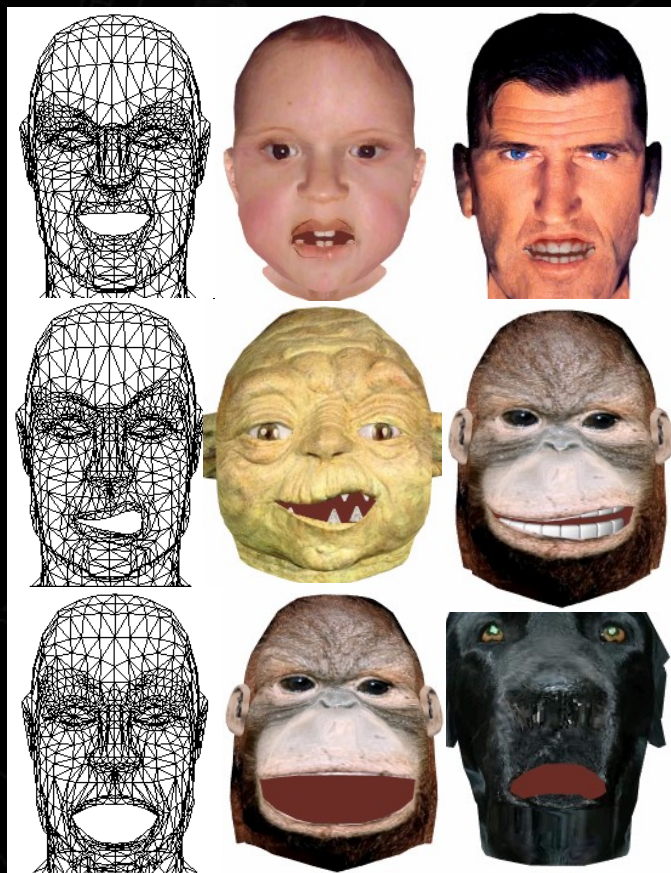


Man

Cat

Dog

Example Cloned Expressions



Source

Targets

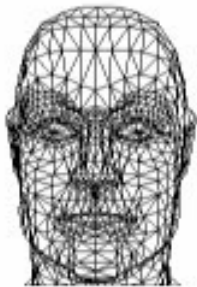
← Angry expression

← Distorted mouth

← Big open mouth

Expressions are faithfully cloned on a wide variety of models.

Example Cloned Animations



Wire-frame man model

Yoda model

Discussion and Future Work

- Lip contact line
- Multiple valid projection points
- Texture incorporation [Shinagawa 1998] [Liu 2001]
- Control knob [Bruderlin 1995]
- Eye blinking teeth tongue animation [Stone 1991]
- Animation library compilation

Conclusion

- Novel alternative to produce facial animation
- Almost automated process
- Dense 3D motion vector utilization
- Preservation of original animation dynamics
- High level control
- Real time performance on 550MHz PC

Acknowledgement

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- J.P. Lewis
- Albin Cheenath and Doug Fidaleo (USC)

Comparison with MPEG-4

Similarities

- Measured motion data
- Animation driven by existing data

Differences

- Easy duplication Vs. Compression
- Dense surface motion Vs. 84 Feature points
- Almost automated Vs. Manual preprocessing

Comparison with PDFA

Similarities

- Measured motion data
- Animation driven by existing data

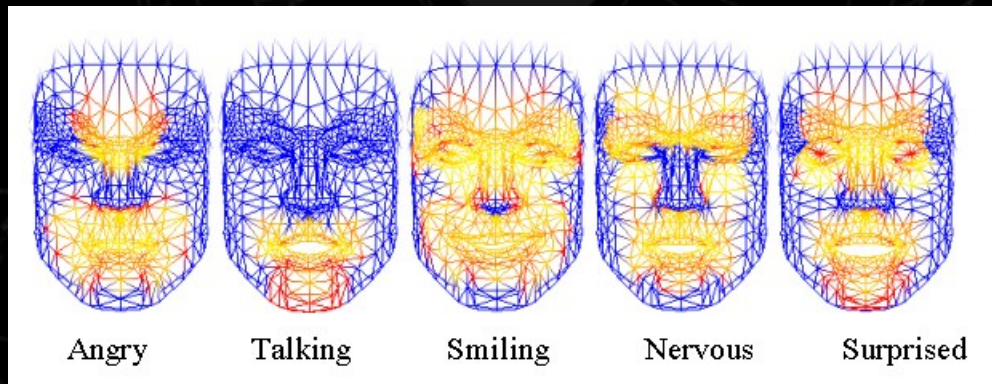
Differences

- Dense surface motion Vs. Sparse feature motions
- Precise 3D data Vs. Guessed animation parameters
- Ground truth data Vs. Error prone tracking data

Quantitative Error Measure

- Average position error WRT motion vector size

Angry	Talking	Smiling	Nervous	Surprised
5.28%	8.56%	4.77%	4.07%	4.56%



— No motion
— No error
— 10% error

Quantitative Error Measure

- Average position error WRT model size

	Angry	Talking	Smiling	Nervous	Surprised
x	0.22%	0.14%	0.13%	0.14%	0.16%
Y	0.18%	0.26%	0.16%	0.11%	0.12%
Z	0.09%	0.23%	0.06%	0.05%	0.05%