Kinodynamic skinning using volume-preserving deformations

Authors: Alexis Angelidis, Karan Singh Authors Info & Claims

SCA '07: Proceedings of the 2007 ACM SIGGRAPH/Eurographics symposium on Computer animation
• August 2007 • Pages 129–140

Published: 03 August 2007 Publication History Check for updates

ABSTRACT

We present a new approach to character skinning where divergence-free vector fields induced by skeletal motion, describe the velocity of skin deformation. The joint transformations for a pose relative to a rest pose create a bend deformation field, resulting in pose-dependent or kinematic skin deformations, varying smoothly across joints. The bend deformation parameters are interactively controlled to capture the varying deformability of bone and other anatomic tissue within an overall fold-over free and volume-preserving skin deformation. Subsequently, we represent the dynamics of skeletal motion, tissue elasticity, muscular tension and the environment as forces that are mapped to vortices at tissue interfaces. A simplified Biot-Savart law in the context of elastic deformation recovers a divergence-free velocity field from the vorticity. Finally, we apply a new stable technique to efficiently integrate points along their deformation trajectories. Adding these dynamic forces over a window of time prior to a given pose provides a continuum of user

References

Graph. 21, 3 (2002), 612--619.

2. {ACWK04} Angelidis A., Cani M.-P., Wyvill G., King S.: Swirling-Sweepers: Constant-Volume Modeling. In *Pacific Graphics 2004* (Oct 2004), pp. 10--15.

3. {AHS03} Albrecht I., Haber J., Seidel H.-P.: Construction and animation of anatomically based human hand models. In *SCA '03: Proceedings of the 2003 ACM SIGGRAPH/Eurographics Symposium on Computer animation* (Aire-la-Ville, Switzerland, Switzerland, 2003), Eurographics Association, pp. 98--109.

4. {Ale02} Alexa M.: Linear Combination of Transformations. *ACM Trans. Graph. 21*, 3 (Jul 2002), 380--387.

5. {CBC*05} Capell S., Burkhart M., Curless B., Duchamp T., Popović Z.: Physically Based Rigging for Deformable Characters. In *SCA'05: Proc. of the 2005 Symposium on Computer Animation* (Jul 2005), pp. 301--310.

6. {CGC*02} Capell S., Green S., Curless B., Duchamp T., Popović Z.: Interactive Skeleton-Driven Dynamic Deformations. *ACM Trans. Graph. 21*, 3 (Jul 2002), 586--593.

7. {CHP89} Chadwick J. E., Haumann D. R., Parent R. E.: Layered construction for deformable animated characters. In *SIGGRAPH '89: Proceedings of the 16th annual conference on Computer graphics and interactive techniques* (New York, NY, USA, 1989), ACM Press, pp. 243--252.

8. {HYC*05} Hyun D., Yoon S., Chang J., Seong J., Kim M., Juttler B.: Sweep-based Human Deformation. In *Pacific Graphics* (Oct 2005), pp. 542--550.

9. {JP02} James D. L., Pai D. K.: DyRT: Dynamic Response Textures for Real Time Deformation Simulation with Graphics Hardware. *ACM Trans. Graph. 21*, 3 (Jul 2002), 582--585.

10. {KJP02} Kry P. G., James D. L., Pai D. K.: Eigenskin: real time large deformation character skinning in hardware. In *SCA '02: Proceedings of the 2002 ACM SIGGRAPH/Eurographics symposium on Computer animation (New York, NY, USA, 2002)*, ACM Press, pp. 153--159.

11. {Kot91} Kotiuga P.: Clebsch potentials and the visualization of three-dimensional solenoidal vector fields. *IEEE Transactions on Magnetics 27(5)* (Sep 1991), 3986--3989.

13. {LCF00} Lewis J., Cordner M., Fong N.: Pose Space Deformation: A Unified Approach to Shape Interpolation and Skeleton-Driven Deformation. In *ACM Trans. Graph. (Proc of SIGGRAPH'99)* (Jul 2000), pp. 165--172.

14. {LTW95} Lee Y., Terzopoulos D., Walters K.: Realistic modeling for facial animation. In *SIGGRAPH '95: Proceedings of the 22nd annual conference on Computer graphics and interactive techniques* (New York, NY, USA, 1995), ACM Press, pp. 55--62.

15. {MG03} Mohr A., Gleicher M.: Building Efficient, Accurate Character Skins from Examples. *ACM Trans. Graph. 22*, 3 (Jul 2003), 562--568.

16. {MHTG05} Muller M., Heidelberger B., Teschner M., Gross M.: Meshless deformations based on shape matching. In *SIGGRAPH '05: ACM SIGGRAPH 2005 Papers* (New York, NY, USA, 2005), ACM Press, pp. 471--478.

17. {MT97} Moccozet L., Thalmann N. M.: Dirichlet free-form deformations and their application to hand simulation. In *CA '97: Proceedings of the Computer Animation* (Washington, DC, USA, 1997), IEEE Computer Society, p. 93.

18. {NMK*05} Nealen A., Maller M., Keiser R., Boxerman E., Carlson M.: Physically based deformable models in computer graphics. In *Eurographics 2005 State of the Art Report* (Sep 2005).

19. {PCLS05} Pratscher M., Coleman P., Laszlo J., Singh K.: Outside-In Anatomy Based Character Rigging. In *SCA '05: Proc. of the 2005 Symposium on Computer Animation* (Jul 2005), pp. 329--338.

20. {Rut89} Rutherford A.: *Vectors, Tensors, and the Basic Equations of Fluid Mechanics*. Dover Publications, Inc, 1989.

21. {SCFRC01} Sloan P.-P. J., Charles F. Rose I., Cohen M. F.: Shape by example. In *SI3D '01: Proceedings of the 2001 symposium on Interactive 3D graphics* (New York, NY, USA, 2001), ACM Press, pp. 135--143.

22. {Sin95} Singh K.: *Realistic Human Figure Synthesis and Animation for VR Applications*. PhD thesis, The Ohio State University, 1995.

23. {SK00} Singh K., Kokkevis E.: Skinning Characters using Surface-Oriented Free-Form Deformations. In *Graphics Interface* (2000), pp. 35--42.

24. {SP86} Sederberg T., Parry S.: Free-Form Deformation of Solid Geometric Models. In *ACM Trans. Graph. (Proc of SIGGRAPH'86)* (Aug 1986), pp. 151--160.

26. {TJ81} Thomas F., Johnston O.: *The illusion of life*. Hyperion, 1981.

27. {TSB*05} Teran J., Sifakis E., Blemker S. S., Ng-Thow-Hing V., Lau C., Fedkiw R.: Creating and simulating

SCA

28. {TSIF05} Teran J., Sifakis E., Irving G., Fedkiw R.: Robust Quasistatic Finite Elements and Flesh Simulation. In *SCA'05: Proc. of the 2005 Symposium on Computer Animation* (Jul 2005), pp. 181--190.

29. {vFTS06} Von Funck W., Theisel H., Seidel H.-P.: Vector field based shape deformations. *ACM Trans. Graph. 25*, 3 (2006), 1118--1125.

30. {WG97} Wilhelms J., Gelder A. V.: Anatomically Based Modeling. In *ACM Trans. Graph. (Proc of SIGGRAPH'97)* (Aug 1997), pp. 173--180.

31. {WP02} Wang X. C., Phillips C.: Multi-weight enveloping: least-squares approximation techniques for skin animation. In *SCA '02: Proceedings of the 2002 ACM SIGGRAPH/Eurographics symposium on Computer animation* (New York, NY, USA, 2002), ACM Press, pp. 129--138.

Cited By

Brunel C, Bénard P and Guennebaud G. (2021). A time-independent deformer for elastic contacts. *ACM Transactions on Graphics*. **40**:4. (1-14). Online publication date: 31-Aug-2021.

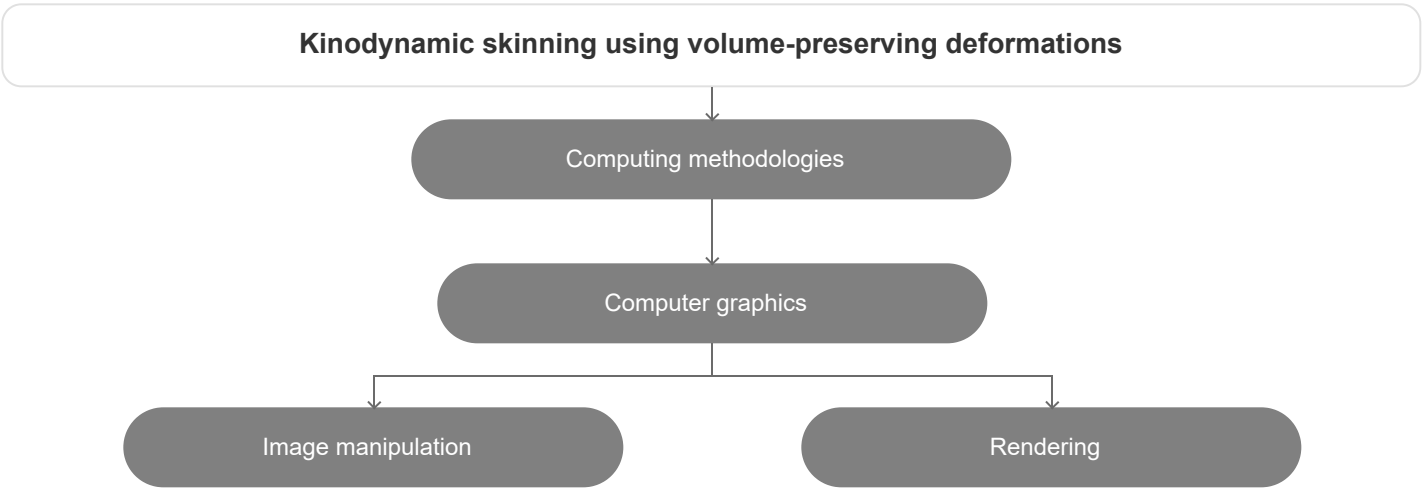
https://doi.org/10.1145/3450626.3459879

Brunel C, Bénard P, Guennebaud G and Barla P. (2020). A Time-independent Deformer for Elastic-rigid Contacts. *Proceedings of the ACM on Computer Graphics and Interactive Techniques*. **3**:1. (1-21). Online publication date: 18-Apr-2020.

https://doi.org/10.1145/3384539

Atsumi N, Kato D, Hirabayashi S, Nakahira Y and Iwamoto M. Human articular movement algorithm to simulate muscle contraction and embedded tissue deformation. Proceedings of the 18th annual ACM

Index Terms



Recommendations

Skinning arbitrary deformations

I3D '07: Proceedings of the 2007 symposium on Interactive 3D graphics and games

Read More

Reusable skinning templates using cage-based deformations

Read More

Reusable skinning templates using cage-based deformations

SIGGRAPH Asia '08: ACM SIGGRAPH Asia 2008 papers

Read More

Comments