

Sze, K. Y.; Zhou, Y. X.

An efficient rotation-free triangle for drape/cloth simulations – part I: model improvement, dynamic simulation and adaptive remeshing. (English) [Zbl 1359.74255](#)

Int. J. Comput. Methods 13, No. 3, Article ID 1650021, 27 p. (2016).

MSC:

74K15 Membranes

74S05 Finite element methods applied to problems in solid mechanics

65M60 Finite element, Rayleigh-Ritz and Galerkin methods for initial value and initial-boundary value problems involving PDEs

Cited in 1 Document

Keywords:

rotation-free; triangle; drape/cloth simulations; adaptive remeshing

Full Text: [DOI](#)

References:

- [1] Benson, D. J., Bazilevs, Y., Hsu, M. C. and Hughes, T. J. R. [2011] "A large deformation, rotation-free, isogeometric shell," *Comput. Methods Appl. Mech. Eng.* 200, 1367-1378. [genRefLink\(16, 'S0219876216500213BIB001', '10.1016%252Fj.cma.2010.12.003'\)](#); [genRefLink\(128, 'S0219876216500213BIB001', '000288884900003'\)](#); · [Zbl 1228.74077](#)
- [2] Breen, D. E., House, D. H. and Wozny, M. J. [1994] "Predicting the drape of woven cloth using interacting particles," *Proc. SIGGRAPH '94*, pp. 365-372.
- [3] Chen, S. F., Hu, J. L. and Teng, J. G. [2001] "A finite-volume method for contact drape simulation of woven fabrics and garments," *Finite Elem. Anal. Des.* 37, 513-531. [genRefLink\(16, 'S0219876216500213BIB003', '10.1016%252FS0168-874X%252800%252900060-3'\)](#); [genRefLink\(128, 'S0219876216500213BIB003', '000168937100003'\)](#);
- [4] Choi, K. J. and Ko, H. S. [2005] "Research problems in clothing simulation," *Comput.-Aided Des.* 37, 585-592. [genRefLink\(16, 'S0219876216500213BIB004', '10.1016%252Fj.cad.2004.11.002'\)](#); [genRefLink\(128, 'S0219876216500213BIB004', '000227425500002'\)](#);
- [5] Cirak, F. and Ortiz, M. [2001] "Fully C1-conforming subdivision elements for finite deformation thin-shell analysis," *Int. J. Numer. Methods Eng.* 51, 813-833. [genRefLink\(16, 'S0219876216500213BIB005', '10.1002%252Fnme.182.abs'\)](#); [genRefLink\(128, 'S0219876216500213BIB005', '000169433300004'\)](#); · [Zbl 1039.74045](#)
- [6] Cui, X. Y., Liu, G. R., Li, G. Y. and Zhang, G. Y. [2011] "A thin plate formulation without rotation DOFs based on the radial point interpolation method and triangular cells," *Int. J. Numer. Methods Eng.* 85, 958-986. [genRefLink\(16, 'S0219876216500213BIB006', '10.1002%252Fnme.3000'\)](#); [genRefLink\(128, 'S0219876216500213BIB006', '000287059700002'\)](#); · [Zbl 1217.74143](#)
- [7] Eischen, J. W., Deng, S. G. and Clapp, T. G. [1996] "Finite-element modeling and control of flexible fabric parts," *IEEE Comput. Graph.* 16, 71-80. [genRefLink\(16, 'S0219876216500213BIB007', '10.1109%252F38.536277'\)](#); [genRefLink\(128, 'S0219876216500213BIB007', 'A1996VE32400013'\)](#);
- [8] Flores, F. G. and Oñate, E. [2005] "Improvements in the membrane behaviour of the three node rotation-free BST shell triangle using an assumed strain approach," *Comput. Methods Appl. Mech. Eng.* 194, 907-932. [genRefLink\(16, 'S0219876216500213BIB008', '10.1016%252Fj.cma.2003.08.012'\)](#); [genRefLink\(128, 'S0219876216500213BIB008', '000225912100011'\)](#); · [Zbl 1112.74510](#)
- [9] Flores, F. G. and Oñate, E. [2011] "Wrinkling and folding analysis of elastic membranes using an enhanced rotation-free thin shell triangular element," *Finite Elem. Anal. Des.* 47, 982-990. [genRefLink\(16, 'S0219876216500213BIB009', '10.1016%252Fj.finel.2011.03.014'\)](#); [genRefLink\(128, 'S0219876216500213BIB009', '000291051000003'\)](#);
- [10] Gan, L., Ly, N. G. and Steven, G. P. [1995] "A study of fabric deformation using nonlinear finite elements," *Text. Res. J.* 65, 660-668. [genRefLink\(16, 'S0219876216500213BIB010', '10.1177%252F004051759506501106'\)](#); [genRefLink\(128, 'S0219876216500213BIB010', 'A1995TC02200006'\)](#);
- [11] Gardsback, M. and Tibert, G. [2007] "A comparison of rotation-free triangular shell elements for unstructured meshes," *Comput. Methods Appl. Mech. Eng.* 196, 5001-5015. [genRefLink\(16, 'S0219876216500213BIB011', '10.1016%252Fj.cma.2007.06.017'\)](#); [genRefLink\(128, 'S0219876216500213BIB011', '000250494900014'\)](#); · [Zbl 1173.74420](#)
- [12] Gong, D. X., Hinds, B. K. and McCartney, J. [2001] "Progress towards effective garment CAD," *Int. J. Cloth. Sci. Technol.* 13, 12-22. [genRefLink\(16, 'S0219876216500213BIB012', '10.1108%252F09556220110384833'\)](#);
- [13] Guo, Y., Gati, W., Naceur, H. and Batoz, J. [2002] "An efficient DKT rotation free shell element for springback simulation in sheet metal forming," *Comput. Struct.* 80, 2299-2312. [genRefLink\(16, 'S0219876216500213BIB013', '10.1016%252FS0045-7949%252802%252900256-0'\)](#); [genRefLink\(128, 'S0219876216500213BIB013', '000179864300030'\)](#);
- [14] Smith Micro Software Inc. [2012] *Poser 9 Reference Manual*, Columbia, USA.
- [15] Ji, F., Li, R. Q. and Qiu, Y. P. [2006] "Three-dimensional garment simulation based on a spring-mass system," *Text. Res. J.* 76, 12-17. [genRefLink\(16, 'S0219876216500213BIB015', '10.1177%252F0040517506057169'\)](#); [genRefLink\(128, 'S0219876216500213BIB015', 'A1996VE32400013'\)](#);

- '000236651000003');
- [16] Kang, T. J. and Yu, W. R. [1995] "Drape simulation of woven fabric by using the finite-element method," *J. Text. Inst.* 86, 635-648. [genRefLink\(16, 'S0219876216500213BIB016', '10.1080%252F00405009508659040'\)](#); [genRefLink\(128, 'S0219876216500213BIB016', 'A1995TP63400010'\)](#);
- [17] Lee, C. K. and Lo, S. H. [1995] "An automatic adaptive refinement procedure using triangular and quadrilateral meshes," *Eng. Fract. Mech.* 50, 671-686. [genRefLink\(16, 'S0219876216500213BIB017', '10.1016%252F0013-7944%252894%2529E0053-J'\)](#); [genRefLink\(128, 'S0219876216500213BIB017', 'A1995QP91100008'\)](#);
- [18] Liu, X. H. and Sze, K. Y. [2009] "A corotational interpolatory model for fabric drape simulation," *Int. J. Numer. Methods Eng.* 77, 799-823. [genRefLink\(16, 'S0219876216500213BIB018', '10.1002%252Fnmme.2434'\)](#); [genRefLink\(128, 'S0219876216500213BIB018', '000262767900003'\)](#); · [Zbl 1156.74395](#)
- [19] Lo, S. H. and Lee, C. K. [1994] "Generation of gradation meshes by the background grid technique," *Comput. Struct.* 50, 21-32. [genRefLink\(16, 'S0219876216500213BIB019', '10.1016%252F0045-7949%252894%252990434-0'\)](#); [genRefLink\(128, 'S0219876216500213BIB019', 'A1994NC05500003'\)](#);
- [20] Narain, R., Samii, A. and O'Brien, J. F. [2012] "Adaptive anisotropic remeshing for cloth simulation," *ACM Trans. Graph.* 31, Article: 152. [genRefLink\(16, 'S0219876216500213BIB020', '10.1145%252F2366145.2366171'\)](#); [genRefLink\(128, 'S0219876216500213BIB020', '000311298900026'\)](#);
- [21] Oñate, E. and Zarate, F. [2000] "Rotation-free triangular plate and shell elements," *Int. J. Numer. Methods Eng.* 47, 557-603. [genRefLink\(16, 'S0219876216500213BIB021', '10.1002%252F%2528SICI%25291097-0207%252820000110%252F30%252947%253A1%252F3%253C%2528NME784%253E3.0.CO%253B2-9'\)](#); [genRefLink\(128, 'S0219876216500213BIB021', '000084864500027'\)](#); · [Zbl 0968.74070](#)
- [22] Phaal, R. and Calladine, C. R. [1992a] "A simple class of finite elements for plate and shell problems. I: Elements for beams and thin flat plates," *Int. J. Numer. Methods Eng.* 35, 955-977. [genRefLink\(16, 'S0219876216500213BIB022', '10.1002%252Fnmme.1620350502'\)](#); [genRefLink\(128, 'S0219876216500213BIB022', 'A1992JM51300001'\)](#); · [Zbl 0775.73285](#)
- [23] Phaal, R. and Calladine, C. R. [1992b] "A simple class of finite elements for plate and shell problems. II: An element for thin shells, with only translational degrees of freedom," *Int. J. Numer. Methods Eng.* 35, 979-996. [genRefLink\(16, 'S0219876216500213BIB023', '10.1002%252Fnmme.1620350503'\)](#); [genRefLink\(128, 'S0219876216500213BIB023', 'A1992JM51300002'\)](#); · [Zbl 0775.73286](#)
- [24] Provot, X. [1995] "Deformation constraints in a mass-spring model to describe rigid cloth behavior," *Proc. Graph. Interface*, pp. 147-154.
- [25] Sabourin, F. and Brunet, M. [2006] "Detailed formulation of the rotation-free triangular element "S3" for general purpose shell analysis," *Eng. Comput.* 23, 469-502. [genRefLink\(16, 'S0219876216500213BIB025', '10.1108%252F02644400610671090'\)](#); [genRefLink\(128, 'S0219876216500213BIB025', '000240150900001'\)](#); · [Zbl 1182.74207](#)
- [26] Sze, K. Y., Chen, J. S., Sheng, N. and Liu, X. H. [2004] "Stabilized conforming nodal integration: Exactness and variational justification," *Finite Elem. Anal. Des.* 41, 147-171. [genRefLink\(16, 'S0219876216500213BIB026', '10.1016%252Fj.finel.2004.05.003'\)](#); [genRefLink\(128, 'S0219876216500213BIB026', '000224513800003'\)](#);
- [27] Sze, K. Y. and Liu, X. H. [2005] "A new skeletal model for fabric drapes," *Int. J. Mech. Mater. Des.* 2, 225-243. [genRefLink\(16, 'S0219876216500213BIB027', '10.1007%252F0099-006-9004-0'\)](#);
- [28] Sze, K. Y. and Liu, X. H. [2007] "Fabric drape simulation by solid-shell finite element method," *Finite Elem. Anal. Des.* 43, 819-838. [genRefLink\(16, 'S0219876216500213BIB028', '10.1016%252Fj.finel.2007.05.007'\)](#); [genRefLink\(128, 'S0219876216500213BIB028', '000249911200001'\)](#);
- [29] Tan, S. T., Wong, T. N., Zhao, Y. F. and Chen, W. J. [1999] "A constrained finite element method for modeling cloth deformation," *Vis. Comput.* 15, 90-99. [genRefLink\(16, 'S0219876216500213BIB029', '10.1007%252F003710050164'\)](#); [genRefLink\(128, 'S0219876216500213BIB029', '000080053000003'\)](#);
- [30] Teng, J. G., Chen, S. F. and Hu, J. L. [1999] "A finite-volume method for deformation analysis of woven fabrics," *Int. J. Numer. Methods Eng.* 46, 2061-2098. [genRefLink\(16, 'S0219876216500213BIB030', '10.1002%252F%2528SICI%25291097-0207%252819991230%252946%253A12%253C2061%253A%253AAID-NME802%253E3.0.CO%253B2-Q'\)](#); [genRefLink\(128, 'S0219876216500213BIB030', '000084066500007'\)](#); · [Zbl 0977.74071](#)
- [31] Villard, J. and Boeouchaki, H. [2005] "Adaptive meshing for cloth animation," *Eng. Comput.* 20, 333-341. [genRefLink\(16, 'S0219876216500213BIB031', '10.1007%252F00366-005-0302-1'\)](#); [genRefLink\(128, 'S0219876216500213BIB031', '000230903100005'\)](#);
- [32] Volino, P. and Cordier, F. [2004] "Cloth simulation," in *Handbook of Virtual Humans*, eds. Magnenat-Thalmann, N. and Magnenat-Thalmann, D. (John Wiley & Sons, Ltd., Chichester). [genRefLink\(16, 'S0219876216500213BIB032', '10.1002%252F0470023198.ch9'\)](#);
- [33] Volkov, V. and Li, L. [2005] "Adaptive triangular meshes for cloth simulation," *Res. J. Text. Apparel* 9(1), 48-59. [genRefLink\(16, 'S0219876216500213BIB033', '10.1108%252FRJTA-09-01-2005-B006'\)](#);
- [34] Weimar, K. [2001] "LS-DYNA user's guider," CAD-FEM GmbH, Munchen.
- [35] Zhang, D. L. and Yuen, M. M. F. [2001] "Cloth simulation using multilevel meshes," *Comput. Graph.* 25, 383-389. [genRefLink\(16, 'S0219876216500213BIB035', '10.1016%252F0097-8493%252801%252900062-0'\)](#); [genRefLink\(128, 'S0219876216500213BIB035', '000169143500003'\)](#);
- [36] Zhou, Y. X. [2013] *An Efficient Rotation-Free Triangle and its Application in Cloth Simulations*, PhD thesis, The University of Hong Kong, Hong Kong.
- [37] Zhou, Y. X. and Sze, K. Y. [2012] "A geometric nonlinear rotation-free triangle & its application in drape simulation," *Int. J. Numer. Methods Eng.* 89(4), 509-536. [genRefLink\(16, 'S0219876216500213BIB037', '10.1002%252Fnmme.3250'\)](#); [genRefLink\(128, 'S0219876216500213BIB037', '000299078500004'\)](#);
- [38] Zulch, G., Koruca, H. I. and Borkircher, M. [2011] "Simulation-supported change process for product customization - A case study in a garment company," *Comput. Ind.* 62, 568-577. [genRefLink\(16, 'S0219876216500213BIB038', '10.1016%252Fj.compind.2011.04.006'\)](#); [genRefLink\(128, 'S0219876216500213BIB038', '000294747600003'\)](#);

This reference list is based on information provided by the publisher or from digital mathematics libraries. Its items are heuristically matched to zbMATH identifiers and may contain data conversion errors. It attempts to reflect the references listed in the original paper as accurately as possible without claiming the completeness or perfect precision of the matching.