Curve Skeleton Extraction Using Directional Distance Transform

E-mail: 374891@ mail.dyu.edu.tw

ABSTRACT

Curve-skeletons are a simply representation of complex objects and are useful for many visualization tasks including virtual navigation, animation, medical image, etc. There are many algorithms in the literature describing extraction methodologies. Many of them still have different unsolved problems, and few algorithms allow users to determine different levels of skeletons.

In this thesis, we present a curve-skeleton extraction algorithm using directional distance transform, whose basic idea is to mimic the water flow to locate feature points. For each pixel, the shortest distance to boundaries is determined first. If two or more pixels on the boundaries are within the distance, a compact angel and a vector of water-flow direction are also determined. Such a pixel is called a feature point. A curve-skeleton can be obtained by connecting these feature points, and then pruning the result.

We also build a software platform for experimental purposes. The user can set different parameters to extract skeletons in different abstraction levels. The preliminary results indicate that our algorithm is orientation-independent and can produce better skeletons than existing methods.

Keywords : medial axis transform　curve-skeleton　directional distance transform　digital image processing

Table of Contents

REFERENCES

[1] H. Blum, " A Transformation for Extraction New Descriptors of Shape," in Proc. Models for the Perception of Speech and Visual Form, W. Wathen-Dunn, Ed. Cambridge,MA: MIT Press, November 1967, pp. 362-380.

[2] N.D. Cornea, D. Silver, and P. Min, " Curve-Skeleton Properties, Applications, and Algorithms," IEEE Trans. Visualization and Computer Graphics, vol. 13, no. 3,pp. 530-548, 2007.

[3] T.Y. Kong, A. Rosenfeld. " Digital topology:Introduction and survey," CVGIP:Image Understanding, vol. 48, pp. 357-393, 1989.

[4] D. Brunner, G. Brunnett. " Mesh Segmentation Using the Object Skeleton Graph," in Proc. Int'l Conf. Computer Graphics and Imaging, pp. 48-55, 2004.

[5] W. Gong and G. Bertrand. " A Simple Parallel 3D Thinning Algorithm," in Proc. IEEE Pattern Recognition, pp. 188-190, 1990.

[6] T. Lee and R.L. Kashyap. " Building Skeleton Models via 3D Medial Surface/Axis Thinning Algorithms," CVGIP:Graphical Models and Image Processing, vol. 56, no. 6,pp. 462-478, November 1994.

[7] S.J. Shyu, T. Chou, and T.L. Chia, " Distance Transformation in Parallel," Proc. Workshop Combinatorial Math. and Computation Theory, pp. 298-304, 2006.

[8] J.A. Sethian. " Fast Marching Methods," SIAM Review, vol. 41, no. 2, pp. 199-235, 1999.

[9] A. Telea and A. Vilanova. " A Robust Level-Set Algorithm for Centerline Extraction," in Proc. of the symposium on Data Visualisation, pp. 185-194, 2003.

[10] M. Wan, F. Dachille, A. Kaufman. " Distance-Field Based Skeletons for Virtual Navigation," in Proc. IEEE Visualization Conf., 2001.

[11] N. Gagvani and D. Silver. " Animating Volumetric Models," Academic Press Professional, vol. 63, no. 6, pp. 443-458, 2001.

[12] C. Pudney. " Distance-Ordered Homotopic Thinning: A Skeletonization Algorithm for 3D Digital Images," Computer Vision and Image Understanding, vol. 2, no. 3,pp. 404-413, 1998.

[13] M. N?f, O. Kubler, R. Kikinis, M.E. Shenton, G. Szekely. " Characterization and Recognition of 3D Organ Shape in Medical Image Analysis Using Skeletonization," in Proc. IEEE Workshop Math. Methods in Biomedical Image Analysis, pp. 139-150, 1996.

[14] R. Ogniewicz, O. K?bler. " Hierarchic Voronoi skeletons," Pattern Recognition, vol. 28, no. 3, pp. 343-359, 1995.

[15] T.Y. Zhang and C.Y. Suen. " A fast parallel algorithm for thinning digital patterns," Communications of the ACM, vol. 27, pp. 236-239, 1984.

[16] Holt, C. M., Stewart, A., Clint, M. and R. H. Perrott. " An Improved Parallel Thinning Algorithm," Communications of the ACM, vol. 30, no. 2, pp. 156-160, 1987.

[17] The MathWorks, Inc.. " Documentation Center." Internet:www.mathworks.com/help/images/ref/bwmorph.html, [Jan., 2013].

[18] M. Ramanathan, B. Gurumoorthy. " Constructing medial axis transform of planar domains with curved boundaries," Computer-Aided Design, vol. 35, no. 7,pp. 619– 632, 2003.

[19] Wei Shen, Xiang Bai, Rong Hu, Hongyuan Wang and Longin Jan Latecki. " Skeleton growing and pruning with bending potential ratio," Pattern Recognition, vol. 44,pp. 196-209, February 2011.

[20] R. C. Gonzalez, R. E. Woods. Digital Image Processing. Prentice Hall, 2008, pp. 814.

[21] A. Telea, J. J. van Wijk. " An Augmented Fast Marching Method for Computing Skeletons and Centerlines," in Proc. Eurographics -IEEE TCVG Symposiumon Visualization, pp. 27-29, May 2002.

[22] Pinto, F. d. M., Freitas, C. M. D. S.. " Fast Medial Axis Transform for Planar Domains With General Boundaries," in Proc.Computer Graphics and Image Processing (SIBGRAPI), 2009 XXII Brazilian Symposium, pp. 96-103, October 2009.