A super-resolution imaging method based on dense subpixel-accurate motion fields

Le H.V., Seetharaman G.

Department of Electrical and Computer Engineering, Vietnam National University, 144 Xuan Thuy, Hanoi, Viet Nam; Department of Electrical and Computer Engineering, Air Force Institute of Technology, Wright-Patterson AFB, OH 45433-7765; Robotics Laboratory, Department of Electrical and Computer Engineering, Vietnam National University, Hanoi; Air Force Institute of Technology; Tau Beta Pi; Eta Kappa Nu; ACM; IEEE

Abstract: A super-resolution imaging method suitable for imaging objects moving in a dynamic scene is described. The primary operations are performed over three threads: the computation of a dense inter-frame 2-D motion field induced by the moving objects at a sub-pixel resolution in the first thread. Concurrently, each video image frame is enlarged by the cascode of an ideal low-pass filter and a higher rate sampler, essentially stretching each image onto a larger grid. Then, the main task is to synthesize a higher resolution image from the stretched image of the first frame and that of the subsequent frames subject to a suitable motion compensation. A simple averaging process and/or a simplified Kalman filter may be used to minimize the spatio-temporal noise, in the aggregation process. The method is simple and can take advantage of common MPEG-4 encoding tools. A few experimental cases are presented with a basic description of the key operations performed in the over all process. ?? Springer Science + Business Media, Inc. 2006.

Author Keywords: Motion compensation; Optical flow; Super-resolution

Index Keywords: Kalman filtering; Low pass filters; Optical resolving power; Spurious signal noise; Optical flow; Super-resolution; Imaging techniques

Year: 2006

Source title: Journal of VLSI Signal Processing Systems for Signal, Image, and Video Technology

Volume: 42

Issue: 1

Page : 79-89

Cited by: 2

Link: Scorpus Link

Correspondence Address: Le, H.V.; Robotics Laboratory, Department of Electrical and Computer Engineering, Vietnam National University, Hanoi; email: hvle@hn.vnn.vn

ISSN: 13875485

CODEN: JVSPE

DOI: 10.1007/s11265-005-4167-8

Language of Original Document: English

Abbreviated Source Title: Journal of VLSI Signal Processing Systems for Signal, Image, and Video Technology

Document Type: Article

Source: Scopus

Authors with affiliations:

1. Le, H.V., Department of Electrical and Computer Engineering, Vietnam National University, 144 Xuan Thuy, Hanoi, Viet Nam, Robotics Laboratory, Department of Electrical and Computer Engineering, Vietnam National University, Hanoi
2. Seetharaman, G., Department of Electrical and Computer Engineering, Air Force Institute of Technology, Wright-Patterson AFB, OH 45433-7765, Air Force Institute of Technology, Tau Beta Pi, Eta Kappa Nu, ACM, IEEE

References:

1. Tsai, R.Y., Huang, T.S., Multiframe image restoration and registration (1984) Advances in Computer Vision and Image Processing, 1, pp. 317-339. , R.Y. Tsai and T.S. Huang (Eds.), JAI Press Inc
2. Kim, S.P., Su, W.-Y., Recursive high-resolution reconstruction of blurred multiframe images (1993) IEEE Trans. on Image Processing, 2 (10), pp. 534-539
3. Tekalp, A.M., Ozkan, M.K., Sezan, M.I., High resolution image reconstruction from low resolution image sequences, and space varying image restoration (1992) Proceedings of the IEEE Conference on Acoustics, Speech, and Signal Processing, 3, pp. 169-172. , San Francisco, CA
4. Elad, M., Hel-Or, Y., A fast super-resolution reconstruction algorithm for pure translational motion and common space-invariant blur (2001) IEEE Trans. on Image Processing, 10 (8), pp. 1187-1193
5. Irani, M., Peleg, S., Motion analysis for image enhancement: Resolution, occlusion and transparency (1993) Journal of Visual Communications and Image Representation, 4, pp. 324-335
6. Patti, A.J., Sezan, M.I., Tekalp, A.M., Superresolution video reconstruction with arbitrary sampling lattices and nonzero aperture time (1997) IEEE Trans. on Image Processing, 6 (8), pp. 1064-1076
7. Elad, M., Feuer, A., Restoration of a single superesolution image from several blurred, noisy and undersampled measured images (1997) IEEE Trans. on Image Processing, 6 (12), pp. 1646-1658
8. Schultz, R.R., Stevenson, R.L., Extraction of high-resolution frames from video sequences (1996) IEEE Trans. on Image Processing, 5 (6), pp. 996-1011
9. Meijering, E., A chronology of interpolation: From ancient astronomy to modern signal and image processing (2002) Proc. of the IEEE, 90 (3), pp. 319-344
10. Cho, B.C., Iyengar, S.S., Seetharaman, G., Holyer, R.J., Lybanon, M., Velocity vectors for features of sequential oceanographic images (1998) IEEE Transactions on Geoscience and Remote Sensing, 36 (3), pp. 985-998
11. Altunbasak, Y., Tekalp, M., Closed-form connectivity-preserving solutions for motion compensation using 2-D meshes (1997) IEEE Transactions on Image Processing, 6 (9), pp. 1255-1269
12. Canny, J.F., A computational approach to edge detection (1986) IEEE Transactions on Pattern Analysis and Machine Intelligence, 8 (6), pp. 679-698
13. Mokhtarian, F., Mackworth, A.K., A theory of multiscale, curvature-based shape representation for planar curves (1992) IEEE Transactions on Pattern Analysis and Machine Intelligence, 14 (8), pp. 789-805
14. Strickland, R.N., Mao, Z., Computing correspondences in a sequence of non-rigid images (1992) Pattern Recognition, 25 (9), pp. 901-912
15. Guha, S., An optimal mesh computer algorithm for constrained delaunay triangulation (1994) Proceedings of the International Parallel Processing Symposium, pp. 102-109. , Cancun, Mexico
16. Barron, J.L., Fleet, D.J., Beauchemin, S.S., Performance of optical flow techniques (1994) International Journal of Computer Vision, 12 (1), pp. 43-77

17. Black, M.J., Anandan, P., The robust estimation of multiple motions: Parametric and piecewise-smooth flow field (1996) Computer Vision and Image Understanding, 63 (1), pp. 75-104
18. Lucas, B.D., Kanade, T., An iterative image registration technique with an application to stereo vision (1981) Proceedings of the DARPA Image Understanding Workshop, pp. 121-130
19. Fleet, D.J., Jepson, A.D., Computation of component image velocity from local phase information (1990) International Journal of Computer Vision, 5 (1), pp. 77-104
20. Kuhn, P.M., (1999) Algorithms, Complexity Analysis and VLSI Architectures for Mpeg-4 Motion Estimation, , Kluwer Academic Publishers, Boston, MA