Motion estimation using learning automata

Machine Vision and Applications
October 2016, Volume 27, Issue 7, pp 1047–1061

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Original Paper
First Online: 20 June 2016
DOI (Digital Object Identifier): 10.1007/s00138-016-0788-0

Cite this article as:
Damerchilu, B., Norouzzadeh, M.S. & Meybodi, M.R. Machine Vision and Applications (2016) 27: 1047. doi:10.1007/s00138-016-0788-0

Abstract

Block-matching algorithms (BMAs) are widely employed for motion estimation. BMAs divide input frames into several blocks and minimize an error function for each block to calculate motion vectors. Afterward, each motion vector is applicable for all of the pixels within the block. Since computing the error functions is resource intensive, many fast-search motion estimation algorithms have been suggested to reduce the computational cost. These fast algorithms provide a significant reduction in computation but often converge to a local minimum. A learning automaton is an adaptive decision-making unit that learns the optimal action through repeated interactions with its environment. Learning automata (LA) have been applied successfully to a wide range of applications including pattern recognition, dynamic channel assignment, and social network analysis. In this paper, we apply LA to motion estimation problem, which is one of the basic problems in computer vision. We

compare the accuracy and performance of the suggested algorithms with other well-known BMAs. Interestingly, the obtained results indicate high efficiency and accuracy of the proposed methods. The results suggest that simplicity, efficiency, parallel nature, and accuracy of LA-based methods make them a good candidate to solve computer vision problems.

Keywords

Motion estimation Block-matching Learning automata Pursuit learning algorithm

References

1. Stuhlmüller, K., Färber, N., Link, M., Girod, B.: Analysis of video transmission over lossy channels. Sel. Areas Commun. IEEE J. **18**(6), 1012–1032 (2000) CrossRef (http://dx.doi.org/10.1109/49.848253)

2. Courtney, J.D.: Automatic video indexing via object motion analysis. Pattern Recognit. **30**(4), 607–625 (1997) CrossRef (http://dx.doi.org/10.1016/S0031-3203(96)00107-0)

3. Zhang, H.J., Kankanhalli, A., Smoliar, S.W.: Automatic partitioning of full-motion video. Multimed. Syst. **1**(1), 10–28 (1993) CrossRef (http://dx.doi.org/10.1007/BF01210504)

4. Koga, T.: Motion-compensated interframe coding for video conferencing. Proc. NTC **81**, C9–6 (1981)

5. Kratz, S., Ballagas, R.: Gesture recognition using motion estimation on mobile phones. In: Proceedings of 3rd International Workshop on Pervasive Mobile Interaction Devices (PERMID'07) (2007)

6. Chua, C.-S., Guan, H., Ho, Y.-K.: Model-based 3d hand posture estimation from a single 2d image. Image Vis. Comput. **20**(3), 191–202 (2002) CrossRef (http://dx.doi.org/10.1016/S0262-8856(01)00094-4)

7. Sarrut, D., Delhay, B., Villard, P.-F., Boldea, V., Beuve, M., Clarysse, P.: A comparison framework for breathing motion estimation methods from 4-d imaging. Med. Imag. IEEE Trans. **26**(12), 1636–1648 (2007) CrossRef (http://dx.doi.org/10.1109/TMI.2007.901006)

8. Wang, Yao: Motion Estimation for Video Coding. Polytechnic University, Brooklyn (2003)

9. Yaakob, R., Aryanfar, A., Halin, A.A., Sulaiman, N.: A comparison of different block matching algorithms for motion estimation. Proc. Technol. **11**, 199–205 (2013) CrossRef (http://dx.doi.org/10.1016/j.protcy.2013.12.181)

10. Barjatya, A.: Block matching algorithms for motion estimation. IEEE Trans. Evol. Comput. **8**(3), 225–239 (2004)
CrossRef (http://dx.doi.org/10.1109/TEVC.2004.826069)

11. Jong, H.-M., Chen, L.-G., Chiueh, T.-D.: Accuracy improvement and cost reduction of 3-step search block matching algorithm for video coding. Circuits Syst. Video Technol. IEEE Trans. **4**(1), 88–90 (1994)
CrossRef (http://dx.doi.org/10.1109/76.276175)

12. Li, R., Zeng, B., Liou, Ming L.: A new three-step search algorithm for block motion estimation. Circuits Syst. Video Technol. IEEE Trans. **4**(4), 438–442 (1994)
CrossRef (http://dx.doi.org/10.1109/76.313138)

13. Lu, J., Liou, M.L.: A simple and efficient search algorithm for block-matching motion estimation. Circuits Syst. Video Technol. IEEE Trans. **7**(2), 429–433 (1997)
CrossRef (http://dx.doi.org/10.1109/76.564122)

14. Po, L.-M., Ma, W.-C.: A novel four-step search algorithm for fast block motion estimation. Circuits Syst. Video Technol. IEEE Trans. **6**(3), 313–317 (1996)
CrossRef (http://dx.doi.org/10.1109/76.499840)

15. Zhu, S., Ma, Kai-Kuang: A new diamond search algorithm for fast block-matching motion estimation. Image Process. IEEE Trans. **9**(2), 287–290 (2000)
MathSciNet (http://www.ams.org/mathscinet-getitem?mr=1766821)
CrossRef (http://dx.doi.org/10.1109/83.821744)

16. Nie, Y., Ma, Kai-Kuang: Adaptive rood pattern search for fast block-matching motion estimation. Image Process. IEEE Trans. **11**(12), 1442–1449 (2002)

17. Liu, L.-K., Feig, Ephraim: A block-based gradient descent search algorithm for block motion estimation in video coding. Circuits Syst. Video Technol. IEEE Trans. **6**(4), 419–422 (1996)
CrossRef (http://dx.doi.org/10.1109/76.510936)

18. Saha, A., Mukherjee, J., Sural, S.: A neighborhood elimination approach for block matching in motion estimation. Signal Process: Image Commun. **26**(8), 438–454 (2011)

19. Cuevas, E., Zaldívar, D., Pérez-Cisneros, M., Oliva, D.: Block-matching algorithm based on differential evolution for motion estimation. Eng. Appl. Artif. Intell. **26**(1), 488–498 (2013)
CrossRef (http://dx.doi.org/10.1016/j.engappai.2012.08.003)

20. Saha, A., Mukherjee, J., Sural, Shamik: New pixel-decimation patterns for block matching in motion estimation. Signal Process. Image Commun. **23**(10), 725–738 (2008)
CrossRef (http://dx.doi.org/10.1016/j.image.2008.08.004)

21. Li, W., Salari, Ezzatollah: Successive elimination algorithm for motion estimation. Image Process. IEEE Trans. **4**(1), 105–107 (1995)
CrossRef (http://dx.doi.org/10.1109/83.350809)

22. Chen, Y.-S., Hung, Y.-P., Fuh, C.-S.: Fast block matching algorithm based on the winner-update strategy. Image Process. IEEE Trans. **10**(8), 1212–1222 (2001)
MATH (http://www.emis.de/MATH-item?1062.68589)
CrossRef (http://dx.doi.org/10.1109/83.935037)

23. Zahiri, S.-H.: Learning automata based classifier. Pattern Recognit. Lett. **29**(1), 40–48 (2008)
CrossRef (http://dx.doi.org/10.1016/j.patrec.2007.08.011)

24. Sang, Q., Lin, Z., Acton, ST.: Learning automata for image segmentation. Pattern Recognit. Lett. **74**, 46–52 (2016)

25. Vahidipour, S.M., Meybodi, M.R., Esnaashari, M.: Learning automata-based adaptive petri net and its application to priority assignment in queuing systems with unknown parameters. IEEE Trans. Syst. Man Cybern. Syst. **45**(10), 1373–1384 (2015)

26. Rezvanian, A., Meybodi, MR.: A new learning automata-based sampling algorithm for social networks. Int. J. Commun. Syst. Wiley (2015). doi:10.1002/dac.3091 (http://dx.doi.org/10.1002/dac.3091)

27. Narendra, KS., Thathachar, MAL.: Learning Automata: An Introduction. Dover Publications, Inc. Mineola, New York (2012)

28. Narendra, KS., Thathachar, MLAA.: Learning automata-a survey. Syst. Man Cybern. IEEE Trans. (4):323–334 (1974)

29. Thathachar, M., Sastry, P.S.: Varieties of learning automata: an overview. Syst. Man Cybern. Part B: Cybern. IEEE Trans. **32**(6), 711–722 (2002)
CrossRef (http://dx.doi.org/10.1109/TSMCB.2002.1049606)

30. Phansalkar, V.V., Thathachar, M.A.L.: Local and global optimization algorithms for generalized learning automata. Neural Comput. **7**(5), 950–973 (1995)
CrossRef (http://dx.doi.org/10.1162/neco.1995.7.5.950)

31. Thathachar, M.A.L., Sastry, P.S.: Networks of Learning Automata: Techniques for Online Stochastic Optimization. Springer, Berlin (2011)

32. Thathachar, MAL., Sastry, PS.: Estimator algorithms for learning automata. In: Proceedings of the Platinum Jubilee Conference on system Signal Processing, Department of Electrical Engineering, Indian Institute of Science, Bangalore, India, December 1986

33. Oommen, B.J., Lanctôt, J.K.: Discretized pursuit learning automata. Syst. Man Cybern. IEEE Trans. **20**(4), 931–938 (1990)
MathSciNet (http://www.ams.org/mathscinet-getitem?mr=1067804)
MATH (http://www.emis.de/MATH-item?0709.68064)
CrossRef (http://dx.doi.org/10.1109/21.105092)

34. Thathachar, M.L., Harita, B.R.: Learning automata with changing number of actions. Syst. Man Cybern. IEEE Trans. **17**(6), 1095–1100 (1987)

CrossRef (http://dx.doi.org/10.1109/TSMC.1987.6499323)

35. Lee, C.-H., Chen, L.-H.: A fast motion estimation algorithm based on the block sum pyramid. Image Process. IEEE Trans. **6**(11), 1587–1591 (1997)
CrossRef (http://dx.doi.org/10.1109/83.641419)

36. Zhang, J.Q., Wang, C., Zhou, M.C.: Fast and epsilon-optimal discretized pursuit learning automata. Cybern. IEEE Trans. **45**(10), 2089–2099 (2015)
CrossRef (http://dx.doi.org/10.1109/TCYB.2014.2365463)

37. Yuan, X., Shen, X.: Block matching algorithm based on particle swarm optimization for motion estimation. In: Embedded Software and Systems, 2008. ICESS'08. International Conference on, pp. 191–195. IEEE (2008)

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Print ISSN 0932-8092

Online ISSN 1432-1769

Publisher Name Springer Berlin Heidelberg

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