Commentary paper on "Visual Players Detection and Tracking in Soccer Matches"

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Abstract

This paper provides comments to the paper "Visual Players Detection and Tracking in Soccer Matches". It was prepared as part of an experimental open review process for the 5th IEEE International Conference On Advanced Video and Signal Based Surveillance for which the author of this commentary paper acted as a reviewer. Due to the conference submission process, this comment was prepared for the review version *of the paper and does not consider changes that the authors may have made for the print version of their work.*

The reviewed paper addresses the problems of automatically detecting, classifying and tracking players in soccer matches. It focuses on three separate sub-problems: estimation of a background model that represents the empty soccer field, classification of team players, and player tracking.

1. Comment on motivation and Novelty

The reviewed paper addresses the problem of soccer player tracking which is of general interest to the computer vision community as well as broadcasters and sports teams. References to previous work can be found in the paper. Additional contributions worth noting are the relatively recent papers by Nillius et. al [6], Sullivan et. al [10], Okuma [7] and Cai [3].

The reviewed paper describes components of a larger commercial system [1]. It outlines a selection of algorithmic components toward solving the player detection and tracking problem. The algorithmic challenges addressed in this work are: (i) modeling of a background image to initialize the background subtraction component, (ii) classification of players using partially unsupervised clustering, and (iii) player tracking. Some of the processing steps are being performed in unusual ways and several algorithm choices have been made to achieve computational efficiency and algorithmic simplicity.

2. Comment on Methodology

2.1. Background Modeling

The approach to foreground object detection is based on background modeling and subtraction with a continuously initializing background model. The approach is computationally very efficient but it also appears brittle for the task at hand and is likely to be challenged by rapid light changes, adverse weather conditions and camera vibrations, especially at the chosen HD image resolution of 1920x1080. Approaches based on mixture models [9], non-parametric (pixel-wise) representations [4] or even color histogram-based modeling of the background (and foreground) might be superior in performance. See [8] for a review of background modeling-based methods.

2.2. Team Player Detection

Unsupervised sequential clustering is used to obtain initial player class labeling. It is of concern that the algorithm has to be repeated if "an inadequate number of clusters" is found. The authors confirmed in discussions during the review process [1] that the expected number of clusters is actually known and only dependent on the camera view (which for example may or may not include the goalkeeper). Hence clustering algorithms, where the number of clusters is fixed or given by an operator, could be much more suitable to this particular application. It would also eliminate the possibility of repeated unsuccessful clustering

2.3. Player Tracking

The presented player tracking algorithm is related to Bayesian approaches, however a strict Bayesian formalism was not followed. The authors made a wide range of explicit and implicit simplifying assumptions in the presented formalism (equations (9)-(14) in the review version). Several

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concerns about the equations and assumptions were pointed out to the authors during the review phase and these issues will hopefully have been resolved in the published version. For interested readers, we recommend to consult additional literature such as [2] for good introductions to a wide range of tracking topics as well as tracking papers in the computer vision community (e.g., [5, 11]).

Segmentation of groups into isolated players and reliable ID maintenance during tracking is one of the most difficult problems for (soccer player) tracking. The authors address this problem briefly through a set of heuristic rules based on color information. Interested readers might also find the work [6] worth reading.

3. Comment on Experiments

The discussed paper presents a small selection of experimental result that are related to player tracking inside of merged blobs and the lifetime of tracked false alarm blobs, albeit only for a selection of four players and six blobs respectively. Since the paper addresses the problem of player detection and tracking, general player detection rates, false alarm rates, and measures that evaluate the identity maintenance capability of the system would have been of interest to the reader and should be considered for future work.

4. Conclusion

The commented paper presents some aspects of a larger soccer tracking system. A more detailed description of the system in addition to a formally more correct set of algorithmic steps would have been desirable, however it should be pointed out that the authors of the work have collected HD video data at a real sports event and engineered a system that tracks soccer players at about 21 fps [1] at HD resolution, which is a significant achievement.

References

[1] April 2008. Communication with authors.

[2] S. Blackman and R. Popoli. *Design and Analysis of Modern Tracking Systems*. Artech House Publishers, 1999.

[3] Y. Cai, N. de Freitas, and J. J. Little. Robust visual tracking for multiple targets. In *ECCV*, 2006.

[4] A. Elgammal, R. Duraiswami, D. Harwood, and L. S. Davis. Background and foreground modeling using nonparametric kernel density estimation for visual surveillance. In *Proc. of IEEE*, volume 90, pages 1151–1163, July 2002.

[5] M. Isard and A. Blake. Condensation - conditional density propagation for visualtracking. *International Journal of Computer Vision*, 29(1):5–28, 1998.

[6] P. Nillius, J. Sullivan, and S. Carlsson. Multi-target tracking – linking identities using bayesian network inference. In *In Proc. IEEE Computer Vision and Pattern Recognition (CVPR 2006), New York City*, 2006.

[7] K. Okuma, A. Taleghani, N. D. Freitas, J. J. Little, and D. G. Lowe. A boosted particle filter: Multitarget detection and tracking. In *European Conference on Computer Vision (ECCV)*, 2004.

[8] M. Piccardi. Background subtraction techniques: a review. In *IEEE International Conference on Systems, Man and Cybernetics*, volume 4, pages 3099–3104 vol.4, 10-13 Oct. 2004.

[9] C. Stauffer and W. Grimson. Adaptive background mixture models for real-time tracking. In *Proc. 12th IEEE Computer Vision and Pattern Recognition, Santa Barbara, CA*, volume 2, pages 246–252, 1998.

[10] J. Sullivan and S. Carlsson. Tracking and labelling of interacting multiple targets. In *In Proc. 9th European Conf. on Computer Vision (ECCV 2006)*, 2006.

[11] T. Zhao and R. Nevatia. Tracking multiple humans in complex situations. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 26(9):1208– 1221, September 2004.