Appearance-based Multiple Hypothesis Tracking: Application to Soccer Broadcast Videos Analysis

M. Manafifard, H. Ebadi, H. Abrishami Moghaddam

www.elsevier.com/locate/image

PII: S0923-5965(17)30067-X
DOI: http://dx.doi.org/10.1016/j.image.2017.04.001
Reference: IMAGE15208

To appear in: *Signal Processing : Image Communication*

Received date: 4 May 2016
Revised date: 31 October 2016
Accepted date: 3 April 2017

Cite this article as: M. Manafifard, H. Ebadi and H. Abrishami Moghaddam Appearance-based Multiple Hypothesis Tracking: Application to Socce Broadcast Videos Analysis, *Signal Processing : Image Communicatio* http://dx.doi.org/10.1016/j.image.2017.04.001

Appearance-based Multiple Hypothesis Tracking: Application to Soccer Broadcast Videos Analysis

M. Manafifard[a], H. Ebadi[b], H. Abrishami Moghaddam[c]
[a]PHD Student, Dept. of Photogrammetry and Remote Sensing, K.N. Toosi University of Technology, Valieasr Street, Tehran, Iran
[b]Professor, Dept. of Photogrammetry and Remote Sensing, K. N. Toosi University of Technology, Valieasr Street, Tehran, Iran
[c]Professor, Dept. of Electrical Engineering, K. N. Toosi University of Technology, Seyedkhandan Street, Tehran, Iran
mmanafifard@mail.kntu.ac.ir
ebadi@kntu.ac.ir
moghadam@eetd.kntu.ac.ir

Abstract

Soccer is a popular sport in the world with the growth of demand for automatically analyzing matches and tactics. Since players are the focus of attention in soccer videos and they manage the entire game, player tracking is fundamental to most soccer video analysis. An efficient implementation of the multiple hypothesis tracking algorithm by evaluating its usefulness in the context of soccer player tracking is introduced in this paper. In contrast to the inherent linear assumption of multiple hypothesis tracking (MHT), which ignores appearance cues and occlusions, our approach relies on an appearance-based MHT (AMHT) framework by incorporating particle swarm optimization (PSO) to account for appearances, nonlinear movements and occlusions. Experimental results demonstrate the efficiency and robustness of the algorithm.

Key words: PSO, appearance, MHT, soccer, player, tracking

1. Introduction

According to the growing popularity of soccer around the world, automatic soccer video analysis is required to facilitate semantic extraction demanded by sports professionals and fans. Soccer video analysis has been applied to a broad range of applications, such as player trajectory and covered distance extraction, content retrieval and indexing, summarization, highlight detection, 3D reconstruction of the soccer match, animations, replays of goals from arbitrary views, virtual content insertion, visualization generation, editorial content creation and content enhancement, content based video compression, tactical analysis, pattern of attack or goal analysis, statistical evaluations, player action recognition, verification of referee decisions, adapting the training plan and evaluating strengths or weaknesses of a team or player. These high level applications are significantly based on player detection and tracking, which can provide significant convenience and information for viewers, trainers and sport professionals. However, soccer player tracking remains a challenging topic due to factors, such as motion blur, similar appearance of players, complex interactions and severe occlusions (e.g. during a corner scene), noise and clutter, unconstrained outdoor environment, player appearance change, lack of pixel resolution especially on small distant players, changing background, varying number of players with unpredictable movements, edited broadcast video and abrupt camera motion and zoom.
Motion capture in commercial applications can be achieved with tracking reflective, magnetic markers or GPS [1] on player body which are not always possible in sport domain, where the player movement can be affected, or markers are not allowed. As a solution, computer vision techniques aim to dispose of such markers.

2. Related works

Player tracking methods are very diverse, and most of them are not totally ideal. Point trackers [2-5] performed well through partial occlusions, but it might be hard to detect and match interest points for distant or blurred players. The limitations of snakes [6-8] were also their sensitivity to parameters, contour initialization, occlusion or non-smooth shape varying process. On the other hand, player tracking can be performed by searching optimal path in a graph [9-15]. Accordingly, a minimal path searching was applied in [3]. Although graph provided a beneficial tool for occlusion resolution, the number of look forward or backward frames should be increased in case of long term occlusions. In [16], a neighborhood graph was built, and the specific structure of the graph was exploited to reach the optimum trajectories using PSO algorithm. Multi-object tracking based on appearance cues was also formulated as a multi-commodity network flow problem (MCNF) on a direct acyclic graph (DAG) [17]. The estimation was