**Approach for Data Acquisition Based on the Homogeneity of the Playing Field**

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**Abstract.** Nowadays, tracking and identifying actors in many areas and especially in team sports video has become a real challenge. In this paper, we propose a distributed real-time solution that tackles this problematic. This solution has the ability to supports the probabilistic fusion of different information sources, structures the incoming perceptions by automatically building models of the tracked players and adapting these concepts online. Regarding the identification of players we used adaptive methods based on positions and appearance, a method for summarizing team behavior from spatio-temporal data. This opens tremendous possibilities of applications of mixed and augmented reality for sport events and soccer games on TV at real time.

**Introduction**  
Nowaday, Database in economic and industrial sector are growing at a very high rate and are constantly increasing and creating a strong interest in automated summarization and semantic indexing of video content in different areas notably in teams sport. For this we need computer systems to capture, recognize and interpret all data and activity included in the video which opens the way for applications of new sports technologies. This problem is so complex and difficult due to many reasons such as: 1) Multiple targets interact and need to be monitored at the same time, 2) while simple occlusions of common players occur frequently, the movement of human players is complex, 3) the position of invisible athletes can be predicted for a limited period of time, hiding the process of cutting out the scattered material, 4) players of the same team are hardly distinguishable and similar in appearance, which complicates their re-identification after an interruption of the video stream, and 5) lighting conditions or the number of teams traveled or characteristics of players are not known in advance and can be added or changed during the game which increases the complexity of computing to be done in real time.

The contributions of this paper are (1) a distributed real-time solution for computer aided analysis (2) an player multi-target algorithm (PMTTA) that is founded in stochastic process, SIR filter and an important number of targets, (2) adaptive methods to identify players based on localization and appearance, and (3) the implementation of the PMTTA for soccer games likes football.

**Review on Tracking**

We present some studies on single and multi-target tracking that has been presented in various researches.

According to Gordon and al. [1] Single-target tracking can be defined as a method to faces the problem of how to fuse different measurements with the predicted state of a single target to estimate its trajectory over time correctly.  
The Kalman filter [2, 3] constitutes an optimal maximum a posteriori estimator if the state prior and measurement noise follow a Gaussian distribution and the process as well as the measurement
model is linear. An optimal Bayesian solution called optimal algorithm solves the problem of recursively calculating the exact posterior density.

The particulate filter is also known as condensation or survival of the fittest [4, 5]. It’s a tracking method that approaches arbitrary probability distributions and can handle arbitrary models measurement and process. It’s simple implementation as well as appealing speed and performance explain the wide usage in the field and it has been successfully applied to various tracking tasks [6].

Multi-target tracking approaches were used to solve the data association problem:


The Joint Probabilistic Data Association Filter (JPDAF) is an extension of Probabilistic Data Association Filter (PDAF) to multiple targets by evaluating the probabilities of the joint association events [13, 14].

A real-time variant exists and allows the tracking of variable dimensions inside the Markov chain Monte Carlo (MCMC) framework. The Markov random field (MRF) Particle Filter was brought to MCMCDA (Markov Chain Monte Carlo Data Association) for tracking football players.

Proposed Solution

The end of the last decennium was marked by the emergence of ambient computing with Mark Weiser in 1993 which brought about the evolution of technologies in all fields as well as the appearance of ubiquitous and distributed systems. Hence, by analogy to the layered structuring of software architectures and distributed systems we propose a distributed real-time solution whose components are classified into five layers visualized as blocks (figure 1) for computer aided analysis: The first layer is the sensor that makes it possible to quickly process the raw data to the enhanced data and provides it to various sources of information via multicast. Since, this layer is tightly coupled to the pretreatment layer which contains Foreground Segmentation, Camera estimation and Event detection components. Information layer contains two important components: Player localization and identification which offer probabilities and spatial measurements to the tracking layer. To estimate the maximum a posteriori position of all players the fusion of information follows a Bayesian approach and the integration of semantic and tactical sports video analysis was integrated seamlessly in the framework. To refines the extracted trajectories for later retrieval and provides arbitrary knowledge discovery tools we use the remaining analysis layer. Concerning the synchronization we used the technologies of the network. So, it is ensured by the tracker via queued TCP/IP (synchronous protocol) connections on top of the network. For multicast we use UDP (asynchronous protocol).

Figure 1. Distributed Real-time Solution Architecture.
In this paper, we present a novel approach based on the local variance image of a video frame, exploiting the homogeneity of the playing field (figure 2). We have applied foreground segmentation to different types of outdoor sports that take place on grass fields by applying a local variance filter to segment players, knowing that the playing field is an important and homogeneous area. For that, different foreground segmentation approaches are applied to video frames captured by static and dynamic cameras [15].

![Figure 2. Complete foreground segmentation for static cameras.](image)

The Player Multi-Target Tracking Algorithm (PMTTA) forms a recursive estimator of the complete formations including all player positions and this estimation is advanced to the time of the current measurement scan by predicting the locations according to a given motion model. The PMTTA is depicted in figure 3. Particles for the current estimate are gathered from the previous ones by sampling associations between the current measurements at a rate proportional to the former weights and the predicted formations and fusing the corresponding positions in an optimal way: max-likelihood. So, the probability densities are determined by the frequencies of the samples that resulted in the same association, as well as the likelihood of this association.
Simulation and Evaluation

The simulation for the proposed Player Multi-Target Tracking Algorithm was based on an important concept which is the ability to handle a very large number of targets and measurements. We adopted a simulation to investigate the ability of the proposed method of tracking a high number of targets with multiple measurements through clutter. Hundred targets are initialized to positions, which are uniformly distributed in $[-2000;2000]^2$, and velocities drawn from the distribution $N(0;20^2)$. The time between the measurement sweeps is set to 1, the targets being monitored for 100 measurement sweeps. These measurements are taken independently on the basis of the true target positions, whereas each position measurement has an independent error which is distributed according to $N(0;20^2)$. The number of measurements generated by a single target is Poisson distributed with $\lambda = 3$. The Clutter is thus drawn according to a Poisson distribution with $\lambda_c = 100$, which is uniformly distributed over all tracking area $M = [-4000;4000]^2$.

Conclusion

In this paper we have proposed an approach for data acquisition based on the homogeneity of the playing field. However, some problems are discussed such as transformation of pixels to real-world coordinates and the preprocessing phase must calculate the segmentation of all potential player regions in the current video frame. The location of similar players in the regions considered at the real world must be determined since the segmented foreground whatever the equipment used or technology. In addition we have proposed the Player Multi-Target Tracking Algorithm as an approach for probabilistic real-time multi-target tracking which is a challenge for every multi-target method, solving the problem of building consistent estimates of trajectories from noisy, cluttered measurements. This approach is designed to track multiple targets of similar appearance and the performance of PMTTA was evaluated on several demanding applications, proving its effectiveness and real-time capability.

References


