VIBOT MSc. Thesis
Acquisition of 3D tennis ball trajectory and velocity from monocular vision systems

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Abstract

Video annotations are successfully used in many sport related areas, including training, the media coverage and sport science. The key advantages of automatic annotation over conventional manual are speed, and robustness of gathered data. However, current automatic annotations systems are not always practical due installation cost and media rights. The proposed solution provides this kind of data from broadcast videos and single camera shots.

The main contribution of this work is acquisition of 3D trajectory and velocity of tennis ball, including players' positions. The 3D trajectory acquisition is based on ball detection, field lines recognition and prior information about field dimension. The accuracy is tested on all four Grand Slam tournament matches, by available ground-truth data.

Research is what I'm doing when I don't know what I'm doing. . . .

Werner von Braun

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Chapter 1

Introduction

Consider ball tracking in tennis, which is still manually done or skipped in cases of insufficient budget. The main advantage of ball tracking is that it provides key information necessary for tactics analysis, training improvement, personal progress tracking. The goal of every tennis player is to advance and at the beginning to compare personal performances with top players. The system that can support this needs to have 'tennis' knowledge, and one of the best way to gain this knowledge is through video analysis.

Let's consider, tennis trainer who wants to improve his player game, and compare it with more advanced players. Significant technique that video analysis can provide is to compare positions and shots of novice player with more advanced players. The first issue in this case is lack of available advanced video statistics related to professional players. Second significant problem is that to provide this statistics for own player, its is necessary to setup expensive environment with multiple high speed cameras.

The lack of advanced video statistics can be solved using the following method: instead of using multi camera environment, it is possible to use single camera to extract key information: players position and 3D ball trajectory. The solution will be explained further in this document. The same solution can be applied on archived tennis video matches, in order to extract advanced statistics about professional players.

This paper will present solution for automatic annotation of broadcast videos. The main contribution of this paper are:

- Automatic tennis players recognition and tracking based on initial labeling (Section ?)

using monocular camera.

- Automatic generation of tennis ball 3D trajectory and velocity (Section ?) using monocular camera. We prove that extracted 3D ball trajectory has more than 90% accuracy comparing with manually extracted ground truth for Grand Slam matches.

Chapter 2

Problem definition

Chapter 3

State of the art

In [3] the focus is on players tracking. The blobs, after background subtraction, are grouped in a connected graph. Graph nodes contain spatial information (size, color, shape) about blobs, and edges contain distance between blobs, movement of the player in consecutive frames. The player trajectory is found using minimal path searching.

The [4] proposed a new method for generation of background scenes, which enables to remove foreground objects without human assistance. The background scene is created using shots of completely visible playing field. Difference between generated background scene and current frame enables to segment foreign objects. The segmentation of players is enhances using automatic alpha matting technique.

The [5] uses Kalman filter and Minimum Spanning Tree based clustering to improve performances of field lines detection. The tracking objects are represented in real-world frame, after computing homography between image and world coordinate system.

Ref	Task	Image Stream	Feature extracted	Method	Comp. costs
[1]	Volleyball ball tracking	352x240 MPEG-1	Nearest neighbor to the estimation in the next frame		
[3]	Football players tracking	720x480 MPEG-2	Blobs from background substraction	Graph of components	
[4]	Automatic annotation	720x480 Broadcast videos	Score box, Ball hit sound	Kalman filter	
[5]	Football's tactic pattern recognition	704x576 MPEG-2	Field lines, Ball	Global Motion Estimation, Kalman Filter, MST Clustering	
[2]	Player tracking				

Table 3.1: A review of works on ball detection

Ref	Focus	Image Stream	Method	Comp. costs
1	2	3	4	5
1	2	3	4	5

Table 3.2: A review of works on ball tracking

3.1 Ball tracking

3.2 Player tracking

Ref	Focus	Image Stream	Method	Comp. costs
1	2	3	4	5
1	2	3	4	5

Table 3.3: A review of works on players detection

Chapter 4

Methodology

4.1 Methods

4.2 Data Collection Methods

4.3 Analysis

Chapter 5

Results

Chapter 6

Conclusions

Appendix A

The first appendix

If you need to add any appendix, do it here... Etc.

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