Detecting Type of Tennis Shots from Broadcast Video

91.423/523 Computer Vision Final Project, UMass Lowell

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Abstract

Watching professional tennis players play is the most important and fundamental way to improve one's own game. By observing certain statistics like the kind of shots hit during a tennis match, people can learn from what the professionals do and improve their own game. Shots could be classified by type so that they can be indexed and retrieved later for studying a particular shot technique. Video archives or old tennis matches could be data mined to provide a novice examples of the requested shot. Our goal is to create an application which can accurately and quickly categorize shots by various type.

1 Introduction:

Our program takes in a video of a tennis match, and determines the type of shot hit by the player.
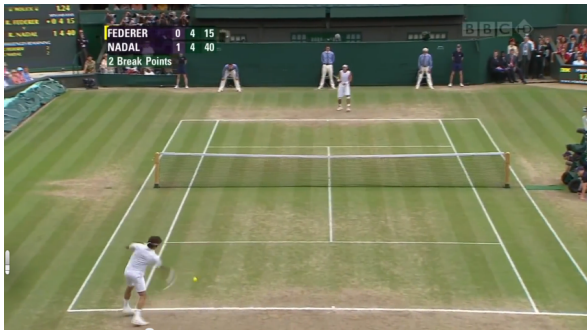
The motivation for this project comes from the need of match statistics which are often displayed after the matches. We think it is important to gather as many facts as possible because they can help in analysis and allow for degrees of improvement by learning from mistakes.

Although implementations exist that are detecting activity of players, we have followed a different approach towards this problem. We have explored and used OpenCV's inbuilt functions and unlike other existing approaches, we are not using any machine learning to solve this problem.

2 Background:

There are existing implementations that acheive the same goal:

2.1 CS229: Action Recognition in Tennis[3]

This method was developed by Aman Sikka and Rajbir Kataria at Stanford University in 2012. It learns the three Tennis actions by using Support Vector Machines (SVMs) classifier. Accuracy is inconsistent and so we planned to get better results from our method.

2.2 Player Action Recognition in Broadcast Tennis Video with Applications to Semantic Analysis of Sports Game[4]

This method was developed by Guangyu Zhu, Changsheng Xu, Qingming Huang, Wen Gao and Liyuan Xing in 2006. It considers the mapping relationship between relative movements of different body parts and the regions in the image plane.

2.3 Action Recognition in Tennis Videos using Optical Flow and Conditional Random Fields[5]

This proposed approach combines the application of video processing techniques for region of interest detection and feature extraction in tennis videos, and CRFs for action recognition.

3 Approach:

Our approach will be to first detect the position of the ball and the players. We are detecting the player using OpenCV's *HOG descriptor*[1] for people detection. And we are detecting the ball using *Hough Circles*. The ball and player are detected at all times, and by the change in y-coordinates of the ball, we come to know when the shot has been hit. After detecting a successful hit, our program analyzes the position of the player when the hit occurred to determine whether the type of shot used was a forehand, smash, or backhand shot. It is a backhand if the ball is hit from the right and a forehand if it is from the left[1].

4 Expected:

The application will take broadcast video as input and output the type of shot being performed for each successful hit. For a miss, it will report the type of shot used by the opposing player which caused it. It can also be scaled to track each point and keep a score of the entire match. Many other features can be added to it as well.

5 Evaluation:

We will use *C++* using the *OpenCV* framework to develop this project. We are planning to use the *ACASVA Actions Dataset*[6] to determine if a player has hit a shot or not. The dataset when fed with input, determines one of three values -- serve, hit or non-hit. After evaluating this, we know if the ball has been hit by the player or not. To know the position of the player, we are going to use OpenCV's `gpu::HOGDescriptor`[1] class. Then we can determine the stroke type from the position of the player and the ball.

References

[1] OpenCV Object Detection.
`http://docs.opencv.org/modules/gpu/doc/object_detection.html`

[2] Yan, F, Christmas, W and Kittler, J (2005) A Tennis Ball Tracking Algorithm for Automatic Annotation of Tennis Match In: British Machine Vision Conference, 2005-09-05 - 2005-09-08, Oxford, UK.

[3] Aman Sikka, Rajbir Kataria (2012) CS229: Action Recognition in Tennis, Stanford University, Stanford, CA -- 94305.
`http://cs229.stanford.edu/proj2012/KatariaSikka-Acti`

[4] Guangyu Zhu, Changsheng Xu, Qingming Huang, Wen Gao and Liyuan Xing (2006). Player Action Recognition in Broadcast Tennis Video with Applications to Semantic Analysis of Sports Game.

[5] Jośe F. Manera, Jonathan Vainstein,Claudio Delrieux and Ana Maguitman (2013). Action Recognition in Tennis Videos using Optical Flow and Conditional Random Fields.
`http://42jaiio.sadio.org.ar/proceedings/simposios/Tr`

[6] Adaptive Cognition for Automated Sports Video Annotation.
`http://www.cvssp.org/acasva/Downloads`

[7] `http://en.wikipedia.org/wiki/Activity_recognition`

[8] Terence Bloom and Andrew P. Bradley. Player Tracking and Stroke Recognition in Tennis Video
`http://espace.library.uq.edu.au/eserv.php?pid=UQ:892`

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[1] We have a flag for changing this for left handed players