Computer Vision

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1 Problem description

1.1 Introduction

Tracking aims to following objects or objects configuration in a video sequence, which is a significant element of many computer vision systems. Tons of applications such as visual surveillance, video compression, and visual content analysis. Among all these applications, we focus on building a system to track the ball in some sports videos. which can be applied in computer-assisted sports study and automatic annotation of sports video.

1.2 Challenge

Tracking has been an well-studied computer vision topic with various kinds of algorithms during the past decade. However, It is still non-trivial to realize the tracking of the balls because of the following challenges: 1) balls, as Small objectives, usually have less informative features to be used for detecting. 2) the speed of the balls are sometimes so high that they are blurred into backgrounds. 3) In some sports like tennis, the tracking of the ball is stuck with occlusion, out-of-view, shape distortion, false detection and dramatic change of motion direction.

2 Methodology

Inspired by [1], we implemented a ball detecting and tracking method based on particle filters.

2.1 Segmentation based detection

Various segmentation-based detection algorithms have been proposed, such as background subtraction, motion estimation and color estimation. In our case, color estimation was chose due to the fact that balls usually have a simple but distinct color distribution compared with background. Meanshift algorithm

based on color estimation was implemented to segment the balls from the background.

2.2 Particle filter based tracking

Particle filtering methodology uses a genetic type mutation-selection sampling approach, with a set of particles (also called individuals, or samples) to represent the posterior distribution of some stochastic process given some noisy and/or partial observations. The efficiency and accuracy of the particle filter depends on two key factors: the motion model and the appearance model. Motion model decides how a movement of particles are generated by a proposal distribution. Appearance model decide how these particles are weighted to estimate posterior state distribution. Different from the appearance model of the particle filter we implemented in assignment 7, we developed new appearance model based on the likelihood map of each image.

3 Implementation

We implemented the majority of the codes by ourselves using openCV on Python3. Steps of implementation are listed below.

It should be noted that the initial spot and the initial color of the tennis ball is extracted manually in the first chosen frame from the video.

3.1 Color Segmentation

Since tennis balls are generally green, a mask can be used to find the circles in the image.

This can be achieved by first extracting the color of the center of tennis ball and generate a HSV color range for the mask. Then using openCV package, the minimum enclosing circles could be found within the image.

As shown in Figure 1, two tennis balls can be detected accurately without confusion with the green court and yellow shirt.

However, if the color distribution of background are quite similar to the ball or the color of the ball changes during the video, the segmentation performance will drop with many false positives. Considering this, the moving distance and the change of radius of tennis ball in two frames is also taken into consideration. For those circles who fall into the thresholds of distance and radius requirement, the circle with the largest contour area is chosen as the most probable position of the tennis ball in current frame.

3.2 Ball detection

First, a rectangular area from the first frame of videos was cropped as the object. Then, we calculated the color bins histogram of the object. Each color channel was split uniformly into 8 bins. After generating the objective color histogram,

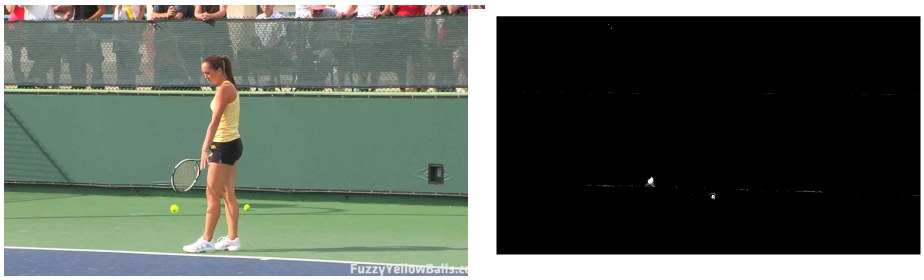

Figure 1: first frame of a video and the likelihood map of it

Figure 2: The likelihood of first frame of a video based on color distribution

we used it for computing the likelihood ratio of each pixel. By doing this, we can build a color likelihood map for every frame in order to detect the position of the objective ball.

3.3 Particle filtering

By initialize

3.3.1 Appearance model

Using the method as mentioned in 3.1, likelihood map, which contain the weight of every pixel in one image, was established for every frame of the video. We used these maps as the appearance model and updated the weight of pixels.

3.4 and motion model

As for the motion model, the Gaussian distribution is assumed. We also force the motion model

4 Experiment result

References

[1] Y. Huang, J. Llach, and C. Zhang. A method of small object detection and tracking based on particle filters. In *Pattern Recognition, 2008. ICPR 2008. 19th International Conference on*, pages 1–4. IEEE, 2008.