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Abstract

Automated PTZ framing of track cyclists using timing loops

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Abstract: Track cycling coaches are mostly busy focussing on what their athletes are doing live. Therefore, they often lack the time to capture videos of the performances of their athletes during practice or competition from which the athletes can learn a lot. We propose a system that can automatically capture track cyclists using a PTZ camera and timing loops while limiting the amount of work for the coaches and technical staff.

Keywords: PTZ camera, timing loops, automated tracking

1. Introduction

Video feedback is becoming more and more mainstream in many sports [1]. These videos help to discuss the technical performance and the tactical decisions of athletes made during exercises and competitions. However, capturing good-quality video often requires additional manpower, which might not always be available. Moreover, video operators need to focus heavily on the task to create a good-quality video. Mixing up the athletes is prone to happen when they are all similarly dressed, which is often the case for athletes of the same team.

In sports such as track cycling where the riders perform multiple laps at different speeds, it is possible to automate the task of video capturing by programming a PTZ camera such as the Panasonic AW-UE150 (figure 1) [2]. This camera can be controlled in such a way that it is rotated horizontally (pan angle) and vertically (tilt angle) to observe a part of the space around its position. Moreover, the size of the objects in the video frame can be controlled as well by adjusting the focal distance (zoom).

Figure 1. Panasonic AW-UE150 at the cycling track

Another commonly available piece of technology in track cycling is the use of timing loops, such as those from MyLaps. In essence, each rider has a transponder attached to the bike that crosses one or more loops around the track. Each of these loops requires a dedicated decoder and is connected over ethernet with a central computer that processes all incoming data (identification + time) in real-time.

Combining the timing loops with a PTZ camera creates the possibility to capture video footage of the riders automatically without the need for a video operator.

2. Challenges

Although the idea of controlling a PTZ camera by using timing loops may be clear, there are a number of practical challenges that occur. These challenges are:

1) the camera location w.r.t. the track,
2) the smoothness of the video motion,
3) the latency of the timing decoders,
4) the speed prediction of the athlete.

Each of these challenges requires a specific solution which will be discussed shortly in the remainder of this section.

2.1. The camera location w.r.t. the track

In order to calculate the pan and tilt angles of the camera, it is vital to exactly determine the position and orientation of the camera w.r.t. the cycling track. We calibrate 4 points of the track: the middle of each straight and the middle of each corner.

We zoom out the camera and calibrate the intrinsic parameters of the camera once (using a checkerboard pattern) [3]. We initially determine the position of the camera in the world coordinate system by using a tape measure and refine the camera position by lining up the projected track (using geometric projection) with the track in view of the camera.

2.2. The smoothness of the video motion

Controlling a camera to defined positions using the camera's API is straightforward. However, we are not only interested in pointing the camera in the right direction, we also want the camera to move smoothly from one position to the next. Position-based controlling leads to unstable images because the camera is constantly making small movements and standing still for small amounts of time. We tackled this problem by using speed commands instead of position commands which are supported by the Panasonic camera. It means that the camera is steered based on a speed calculation of the current position and the next desired position. Such a speed command consists of a horizontal and a vertical speed directive. Also, the zoom is controlled using speed commands. Timing is key with speed commands.

2.3. The latency of the timing decoders

The timing decoders register the passing of transponders over the loops positioned under the track. There is a small time delay between the registration of the timing and the reporting of the results over TCP/IP. We take this into account by steering the camera slightly further than the loop that the athlete just passed.

2.4. The speed prediction of the athlete

The biggest issue is predicting the speed of the athlete in the next section (quarter lap). Luckily, multiple time loops are available under the cycling track, which means that we can update the speed multiple times per lap. Decelerations and accelerations cause the PTZ movements to be too fast or too slow respectively. Adding more context and some feedback using computer vision may further improve rider tracking.

4. Evaluation

To evaluate our solution, we measure the distance from the center of the subject that we are tracking to the middle of the image (Figure 2). Assuming perfect prediction and camera calibration, the cyclist should always be in the center of the produced image. We annotated about 500 frames from different cyclists at different speeds and measured the horizontal and vertical offset towards the center. We noticed an average horizontal offset of 255 px and an average vertical offset of 237 px. The root-mean-square error shows an average diagonal offset of 320 px. It means that the subject is successfully tracked in the FullHD video (1920x1080 px). Moreover, the cyclist's bounding box measures 150.3 x 140.6 px which means that the position of the cyclist in the video frame corresponds on average to only 1.5 times the size of the cyclist in the frame.

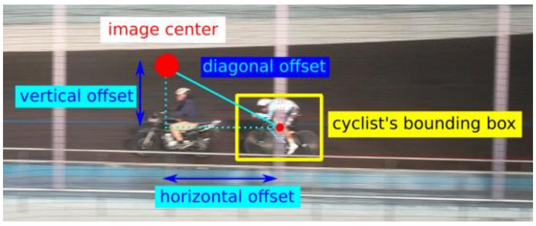

Figure 2. Evaluation process

5. Conclusions

We proposed a PTZ camera controlling system that can automatically track riders on a cycling track using transponder times from multiple timing loops in real-time. We predict the next section's time and control the camera using speed commands for smooth video footage. The results show that the tracked cyclist is kept close to the center of each video frame.

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