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Conference Abstract

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Automated Data and Video Processing in Track Cycling

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Abstract

Recent advances in sports data analytics have driven the development of integrated performance monitoring systems. This abstract describes the implementation and uses cases of integrating a pan-tilt-zoom (PTZ) camera into the existing Wireless Cycling Network (WCN) deployed at the Wielercentrum Eddy Merckx in Gent, Belgium. WCN combines a precise timing system, ANT+ sensor data collection and an anaerobic capacity (W') estimation. Automated PTZ camera tracking and recording enables immediate visual analysis by coaches. AI-computer vision models are used for detection and qualitative analysis of team pursuit changeovers. In addition to elite use cases, general engagement can be improved with event-specific real-time data display and personalized videos and session reports. These integrated capabilities and the modular design streamline coaching workflows and provide a platform for future applications across various track-based sports. Future work includes further development of analysis tools to support coaches, production deployment of the complete system and implementing it at additional tracks.

Keywords

track cycling; team pursuit; sports data science; computer vision; object tracking; multi-modal analysis; video processing

1 Introduction

Recent advances in sports data analytics have emphasized the need for multi-source performance monitoring systems. While data analytics has long played a role, the integration of different sources, e.g., timings, physiological metrics, and video footage, remained largely manual and time- consuming. The use of separate systems requires significant effort from the coaches and analysts to prepare and

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interpret results. In particular, synchronizing and timely presenting video footage for analysis is a major bottleneck, especially if manually recorded, distracting coaches from real-time athlete observation.

Within the context of track cycling, where timely video review is critical for tactical and technical adjustments, this gap was bridged with the Wireless Cycling Network (WCN). WCN, developed to automate this workflow, integrates precise timing, sensor data, video recording, athlete tracking, an anaerobic capacity estimation algorithm, and dedicated analysis methods for the team pursuit discipline into a single synchronized system [1].

2 Material and Methods

The WCN setup, introduced in [3] and [4], is deployed at the Wielercentrum Eddy Merckx track in Gent, Belgium, comprising:

- A MyLaps timing system with 3 ms accuracy for precise time measurement.
- WASP-N nodes enabling wireless transmission of ANT+ sensor data (e.g., heart rate, power and cadence).
- A pan-tilt-zoom (PTZ) camera.
- An anaerobic capacity (W') estimation algorithm to assess high-intensity efforts [2].
- Event-specific analysis methods, such as changeover detection during the team pursuit.
- A central app for customized analysis.
- A large LED display shows live metrics and session footage via a web page.

Building on the component-level exploration of PTZ camera tracking in [5], the focus of this work is on the integration of automated PTZ camera recording, tracking control and video processing into the WCN workflow for two main use cases: performance and engagement. It ensures coaches receive immediate footage and performance insights and enables facilities to target user engagement by creating personalized outputs.

3 Results

Figure 1 illustrates the WCN setup, where the asterisk sign (*) indicates this work's additions aimed at automating workflows for performance (coaching) and general user engagement.

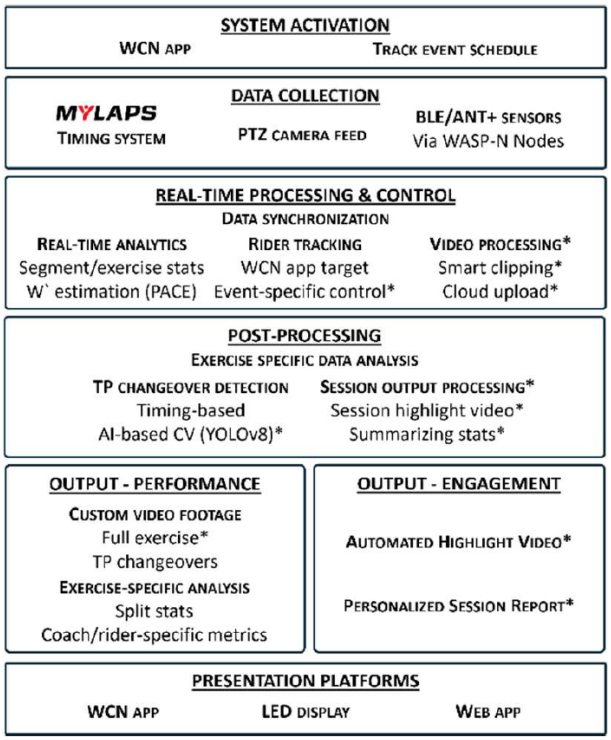

Figure 1. An overview of the Wireless Cycling Network (WCN) setup with integrated PTZ camera-based video processing. Items with the asterisk sign (*) are novel additions of this work. TP = Team pursuit, CV = computer vision.

3.1 Performance

The coach starts an exercise in the WCN application, and the controller determines the tracking target based on exercise type and active athletes. After an exercise, relevant footage is uploaded and presented on a web page (to be shown on the LED display or on a staff member's device) and in the WCN app, with only seconds of delay.

AI-based analysis further extends WCN's capabilities. We explored a YOLOv8 object detection model, trained on a limited dataset of 150 images, to detect team pursuit changeovers. Figure 2 shows an example of resulting YOLOv8 bounding boxes, with Y-coordinate traces used to detect changeovers (Figure 3).

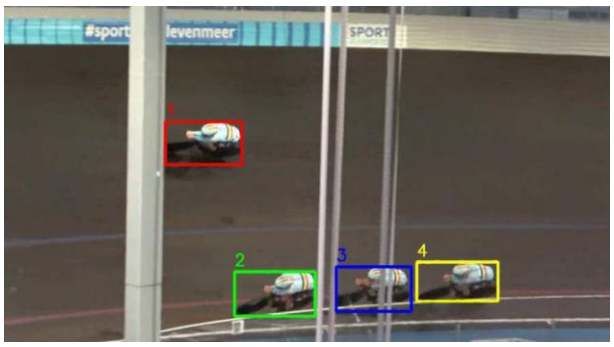

Figure 2. YOLOv8-based rider detection during a team pursuit changeover.

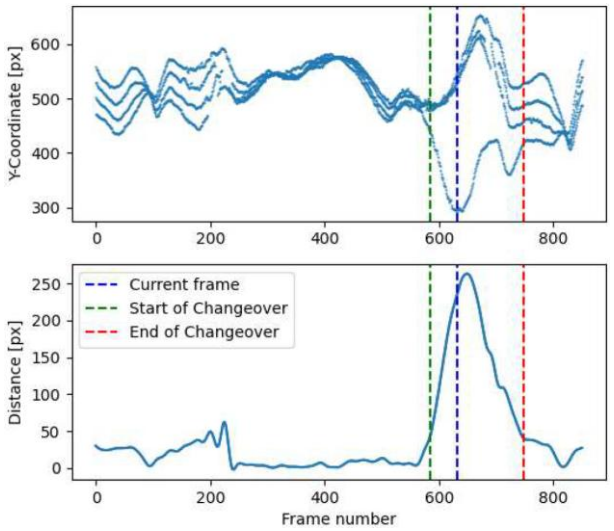

Figure 3. Y-coordinate traces of all riders (top) and maximum distance between traces (bottom) over one lap. Data represents the full lap of the changeover shown in Figure 2.

3.2 User Engagement

Beyond elite sports applications, WCN improves rider engagement through live data and personalized outputs. The LED display shows live metrics and videos based on activity type and schedule, while highlight videos and reports summarize sessions and provide key insights for performance tracking and recreational activities.

4 Practical Applications

Automated video tracking and real-time analytics enhance coaching workflows. It allows coaches and technical staff to focus on technical and tactical adjustments in real-time and instantly review the footage with athletes. Since technique (e.g., changeovers in team pursuit) and tactics (e.g., race plan and acceleration lines in sprint) are crucial factors in track cycling, the consistent nature of automated video footage presents a unique way to build a rich dataset.

Video-based team pursuit changeover detection can be used to analyze footage and extract changeover timings and quality [3].

Next to performance, track facilities can use the system to improve events by targeting user engagement, providing riders with personalized results.

The design enables component-level deployment to other track-based sports such as (ice) skating and athletics. Future work includes streamlining the existing set-up towards production, expansion to other facilities and implementing coach and athlete requests.

5 Conclusions

The WCN system now integrates automated PTZ camera rider tracking and can be deployed for real-time data and video processing in both recreational and competitive settings. It streamlines sensor data and video collection and processing, providing instant actionable insights for coaches and athletes, and enables projects to improve user engagement with personalized outputs. The system's modular design allows implementation on various track-based locations.

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