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Conference Abstract

Multi-Sensor Based Analysis of the Changeovers in Team Pursuit

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Abstract: More and more data is getting collected in sports. Also on the cycling track, a lot of rider data is available to be analyzed, such as timing data from measurement loops, sensor data of the cyclists' wearables and video data recorded by coaches. During BOSA 2024, the Becoming Outstanding in Sports Analytics winter school in Ghent, our participants were asked to develop a multimodal team pursuit analysis demo that can facilitate the work of the track cycling coaches of Cycling Vlaanderen. The proposed multimodal data analysis give coaches insights into how well the changeover between riders was performed by visualizing the key features of the change: the riding lines of the riders, the duration of the change, and the trends of the power data (which was collected using the WCN Wireless Cycling Network set-up). The video clips, in which the riding lines are visualized, are automatically generated using a change detection method that analyzes the Mylaps measurement loops data. Next, state-of-the-art object detection and tracking methods are used to show each rider's trajectory. For each changeover, we visualize the results in an interactive dashboard. These visualizations should provide coaches the necessary insights to better coach and improve their athletes.

Keywords: team pursuit; track cycling; sports data science; computer vision; machine learning

1. Introduction

Team pursuit, in its current format, is part of the Olympic programme for more than 100 years. In team pursuit, two teams of four riders start on opposite sides of the track and compete over 4km. The winning team is the one that manages to catch its opponents or that records the fastest time [1].

Many track cycling countries are currently optimizing their strategy to go for gold in Paris 2024. More and more, data plays an important role in this optimization process, as it also does in other cycling disciplines.

An important aspect of team pursuit is the changeover, where riders switch positions. But what makes a good changeover? Is it the changeover time that is most important, or the height on the track (riding ling), the loss of pedal power, the energy expenditure, or the transition back into the train? Literature does not provide a clear answer [2]. Maybe the data can tell us, and maybe it is also dependent on the type of rider/athlete. That is exactly what we want to investigate by collecting and analyzing the changeover related data of each rider: the riding lines of the front riders during the changeover, the duration (and length) of the transition, and the trends of the power data.

The data collection for this study was done at the Centrum Eddy Merckx in Ghent in collaboration with Cycling Vlaanderen. 4 male elite riders participated in our tests.

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2. Materials and Methods

The proposed solution, of which the general workflow is illustrated in Figure 1, combines video data from 2 camera angles (shown in Figure 2), focusing on the zones on the track where riders change, Mylaps timing loops and transponder data, and power data of the riders collected using the Wireless Cycling Network (WCN) [3]. The riders' cadence data is also collected using WCN, but is not used (yet) in the analysis.

In order to crop the video clips in which the changeovers take place, we use the Mylaps timestamps of the 4 riders over 7 measurement loops. At the moment a change in position happens in the Mylaps data, the video is cropped using the timestamps the group passed the previous and next measurement loop. On these video crops, the YOLOv8 based rider detection/tracking [4] is runned to extract the riding line of the lead rider. An example of the detection/tracking is shown in Figure 3.

The rider detection is also used to detect the exact begin/end timestamp of the transition (as this cannot be extracted from the measurement loops) and to measure the distances between riders. In this way, we get an accurate estimate of the duration of the transition and we can also measure the distance/length on the track of the transition.

From the timing info, we can also distill the lead rider and analyze his power profile. Figure 4, for example, shows the power profiles of 2 different changeovers.

Based on the collected data, the changeovers can be scored, ranked, and compared. Future work will further investigate this.

Important to mention is that also other information can be extracted from the collected data - because all coaches of course have their own vision on what is important and counts to improve the performance on the track. We can, for example, based on the Mylaps data, also provide lead and follow power of riders in absolute watts, as is shown in the flying start example in Figure 5. Furthermore, lap times and/or half lap times can also be extracted from WCN, as shown in Figure 6. Finally, also cadence variations can be studied, for example, using plots as the one shown in Figure 7.

3. Dashboard for Coaches

All the collected data, and the corresponding 'scoring' is presented in a dashboard to the coaches. Currently, two different versions of this dashboard have been developed by our BOSA participants. Those prototypes are presented in Figure 8 and Figure 9. User studies will be performed in to evaluate and further optimize them.

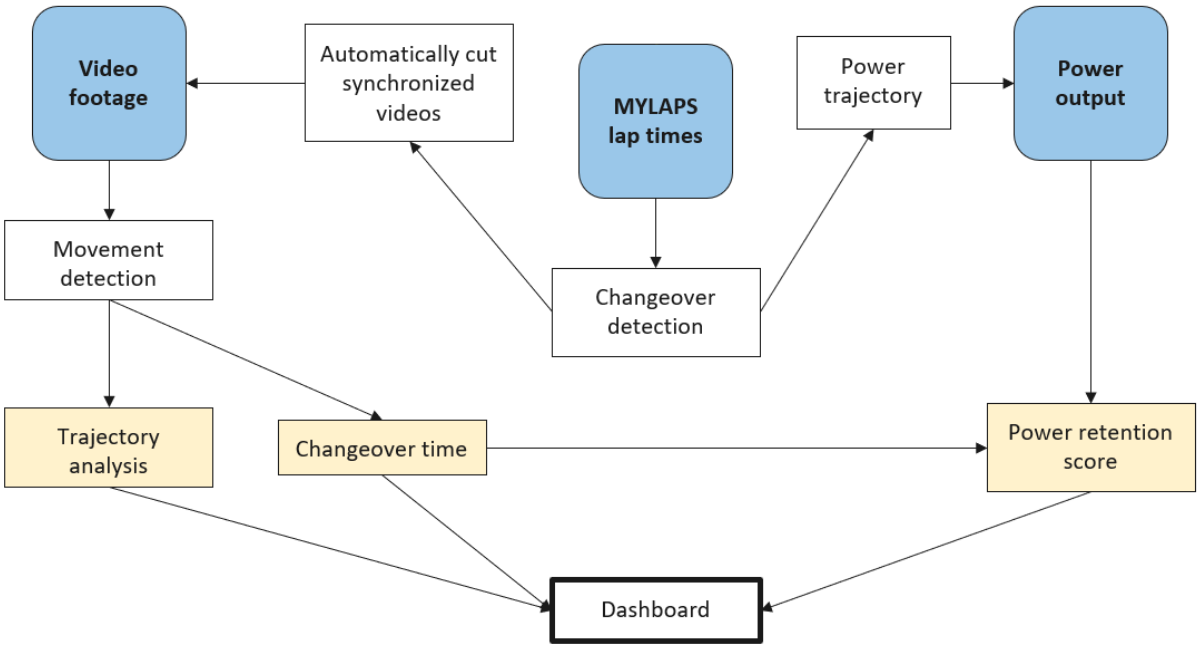

Figure 1. General workflow.

Figure 2. Camera views/angles used in our experiments to detect and analyze the changeovers in team pursuit.

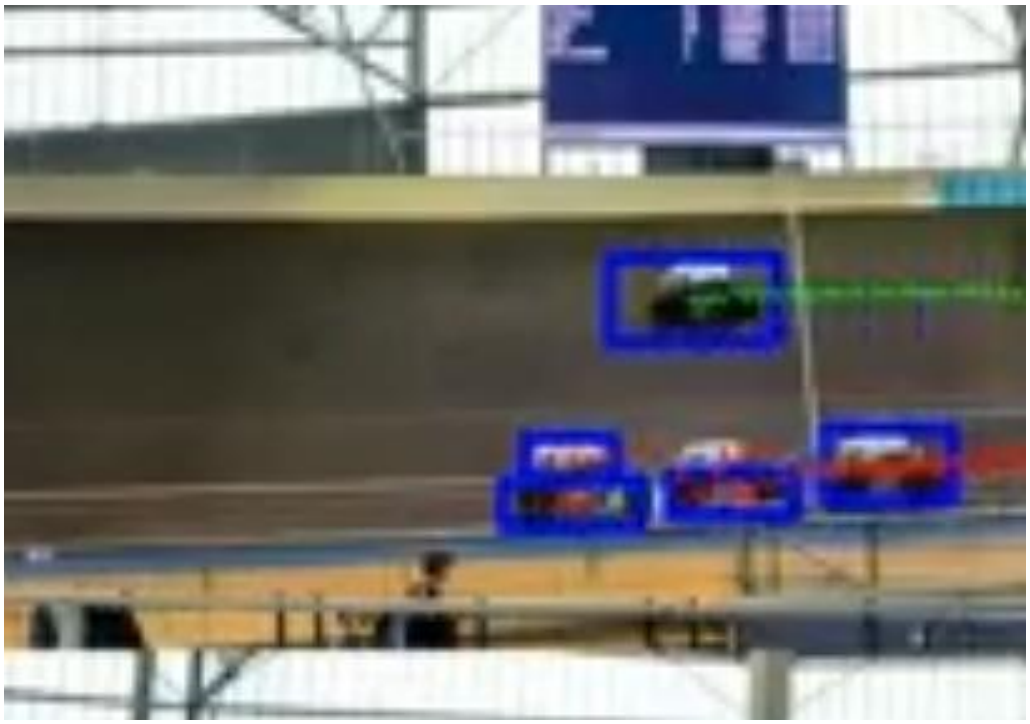

Figure 3. YOLOv8 based rider detection/tracking.

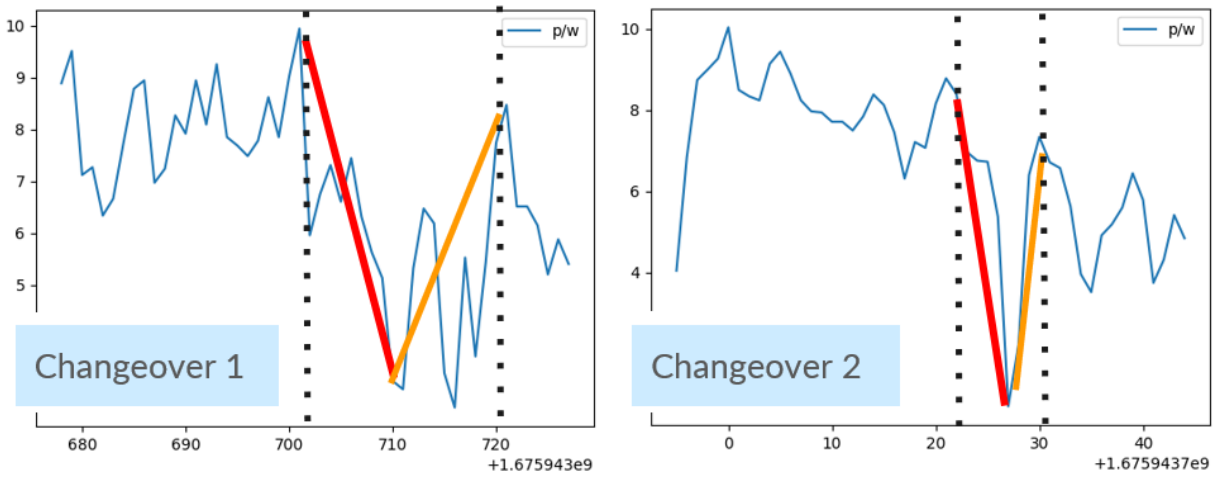

Figure 4. Power profiles of two changeovers.

Change 1 (BD-27-04-00):
- Rider 1: avg=0, std=0
- Rider 2: avg=0, std=0
- Rider 3: avg=0, std=0
- Rider 4: avg=0, std=0

Change 2 (70-2A-04-00):
- Rider 1: avg=620, std=88.16
- Rider 2: avg=479, std=76.35
- Rider 3: avg=411, std=81.95
- Rider 4: avg=435, std=186.81

Change 3 (BD-27-04-00):
- Rider 1: avg=637, std=97.58
- Rider 2: avg=502, std=78.18
- Rider 3: avg=416, std=91.17
- Rider 4: avg=479, std=128.03

Change 4 (70-2A-04-00):
- Rider 1: avg=467, std=66.96
- Rider 2: avg=411, std=148.32
- Rider 3: avg=398, std=127.98
- Rider 4: avg=483, std=136.4

Change 5 (70-2A-04-00):
- Rider 1: avg=564, std=162.18
- Rider 2: avg=508, std=99.19
- Rider 3: avg=461, std=134.88
- Rider 4: avg=438, std=62.0

Change 6 (70-2A-04-00):
- Rider 1: avg=629, std=31.57
- Rider 2: avg=497, std=61.96
- Rider 3: avg=446, std=86.37

Change 7 (70-2A-04-00):
- Rider 1: avg=572, std=94.24
- Rider 2: avg=472, std=82.42
- Rider 3: avg=474, std=131.63

Change 8 (BD-27-04-00):
- Rider 1: avg=524, std=97.73
- Rider 2: avg=392, std=67.44
- Rider 3: avg=438, std=87.93

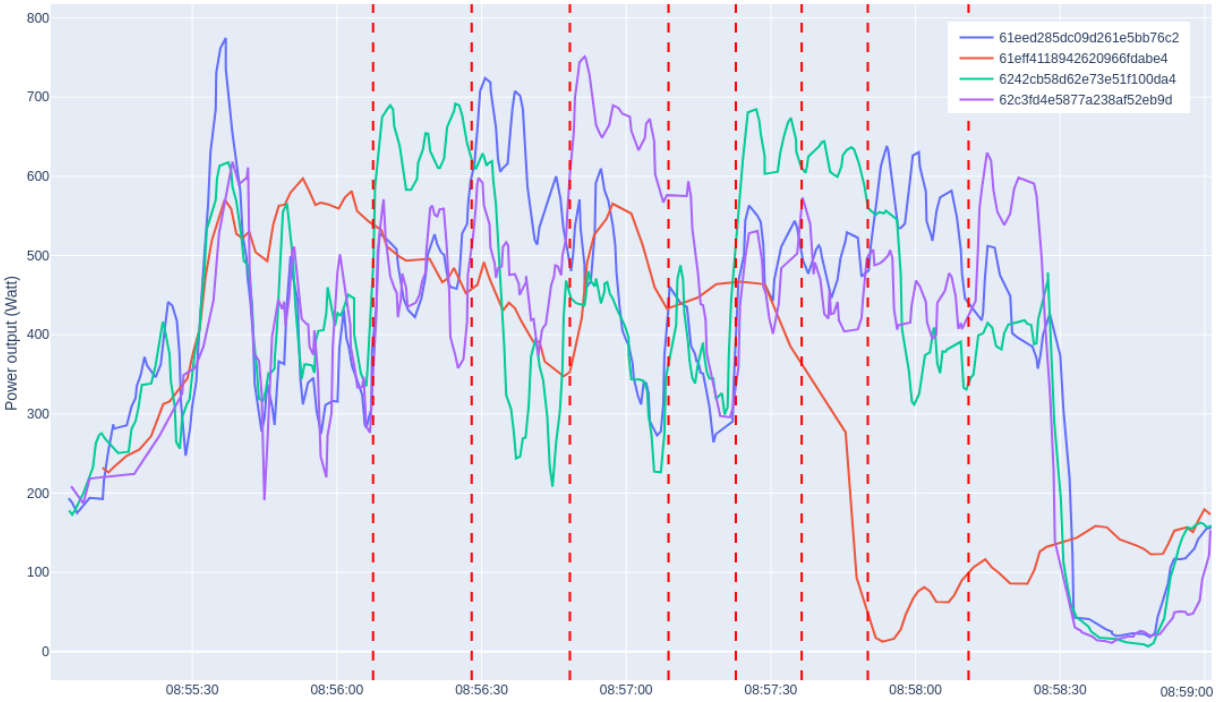

Figure 5. Lead and follow power of riders.

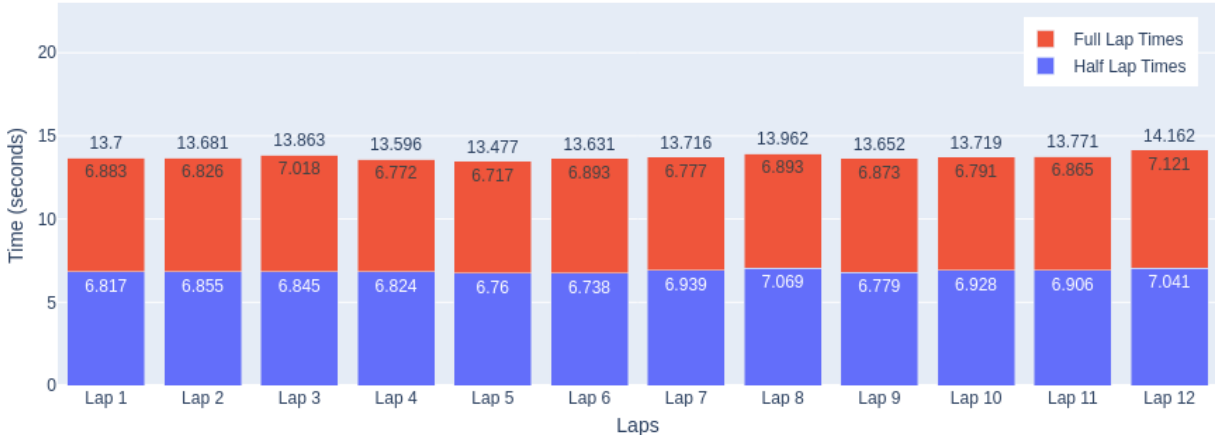

Figure 6. Flying start half lap and full lap times.

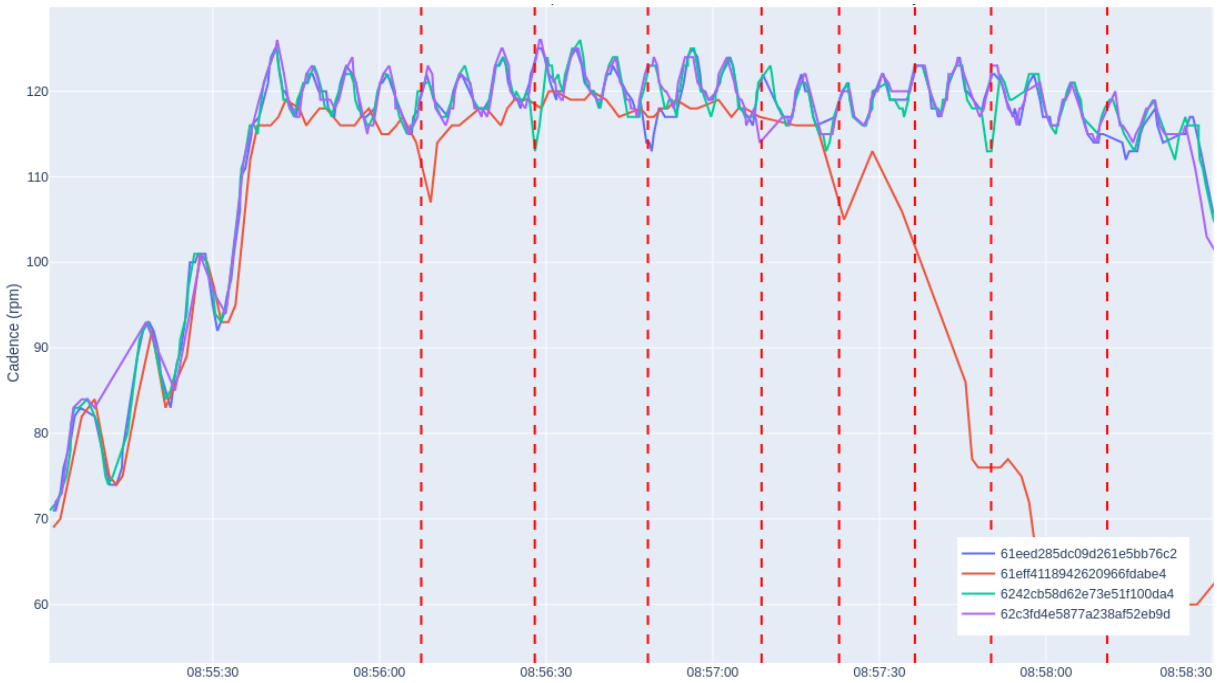

Figure 7. Cadence data of team pursuit exercise.

Figure 8. First dashboard design proposal.

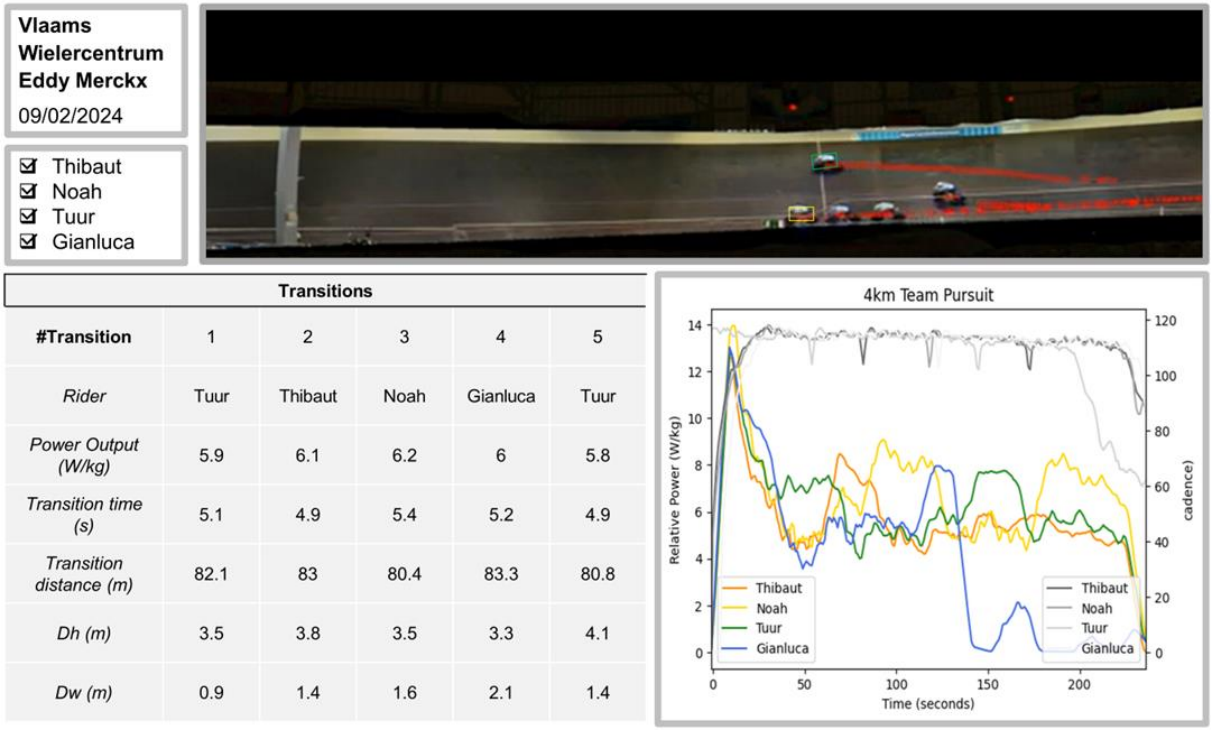

Figure 9. Second dashboard design proposal.

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Conflicts of Interest: "The authors declare no conflict of interest."

References

1. UCI Track Cycling. (2024). Retrieved from https://www.uci.org/discipline/track/5bBV0EMQvb3ZiTcXbKFLJz?tab=discover
2. Sigrist, S., Maier, T., & Faiss, R. (2017). Qualitative Video Analysis of Track-Cycling Team Pursuit in World-Class Athletes. *Sports Physiology and Performance*, *12*(10). doi: 10.1123/ijspp.2016-0596
3. Wireless Cycling Network (WCN), A dashboard to support track cycling coaches. https://www.victoris.be/projects/wireless-cycling-network/
4. Ultralytics Yolov8 docs - Pose Estimation, https://docs.ultralytics.com/tasks/pose/