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VALIDATION OF OPTIMAL PACING STRATEGIES FOR UPHILL ROAD CYCLING TIME TRIALS

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Abstract. *In simulations and laboratory studies, optimal pacing strategies have already shown their potential. We evaluated methods and tools for application of these strategies in the field in a first study with twelve subjects.*

1 INTRODUCTION

In road cycling, the pacing strategy may be decisive for the outcome of a race, especially in solo events like individual time trials. State-of-the-art modeling techniques and optimization algorithms can provide mathematical optimal pacing strategies. These strategies have shown their potential in simulations and laboratory tests. Field studies are more complex, requiring an interdisciplinary team, technology for rider feedback, and additionally algorithms for adaptation to actual weather and road conditons. Our study is the first of its kinds.

2 METHODS

Our optimal pacing strategies are based on a physiological model for the cyclist and a physical model for cycling and provide for a given position on track exhaustion and nominal output in terms of speed and power (Dahmen & Brosda, 2016). Visual feedback for the rider and adaptation to environmental conditions is provided by our mobile android application (Artiga Gonzalez et al., 2018) as shown in figure 1.

We carried out a first study on a short hill climb of 3.8 km with an average slope of 5.1 % (1.3 % to 9.3 %), resulting in a total climb of 198 m. Analogously to the preceding laboratory study by (Wolf et al., 2016), every subject had to do a spiroergometry, a familiarisation ride, a self-paced ride, a ride following the optimal strategy, and a ride with a validation strategy. For the validation strategy, a constant power offset was added to the self-paced strategy such that the finish time matches the finish time of the optimal strategy. For the last two rides, the strategy was selected by crossover design. The subjects were not aware what strategy they got and only instructed to follow the feedback and do their best following the feedback.

Six out of twelve subjects completed all rides. We provided a wheelset with a PowerTap Hub power meter, a Garmin ANT+ heart rate belt, and a smartphone with our mobile app to all subjects for their rides. During the rides with optimal and validation strategies, the adaptive algorithm (Wolf et al., 2018) of the mobile device guided the cyclist on the precomputed exhaustion strategy. The average time improvement given by the optimal pacing strategies was 24 seconds while the average finish time on the self-paced rides has been 10:38 min.

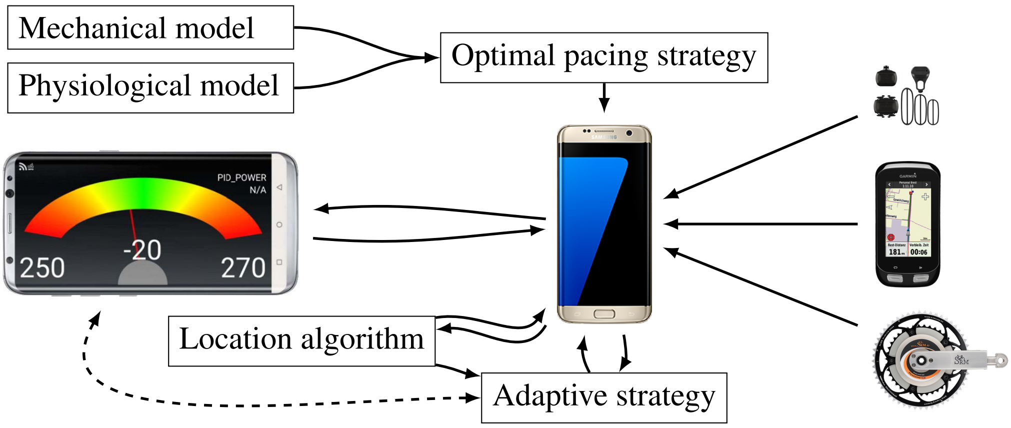

Figure 1: A Galaxy S8 smartphone is choosen as the central component that collects data, adapts the strategy for the current position and exhaustion state and displays the result to the cyclist.

3 RESULTS

Four of the six cyclist have been able to follow the optimal strategy without larger deviations from the exhaustion curve while two could not follow the whole strategy. In case of the validation strategies, only two cyclist, who also followed the optimal strategy successfully, have been able to follow them.

4 CONCLUSION

These results show that it is possible to compute optimal pacing strategies for uphill time trials and guide cyclists successfully on the precomputed exhaustion curve, thereby improving the finish time.

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