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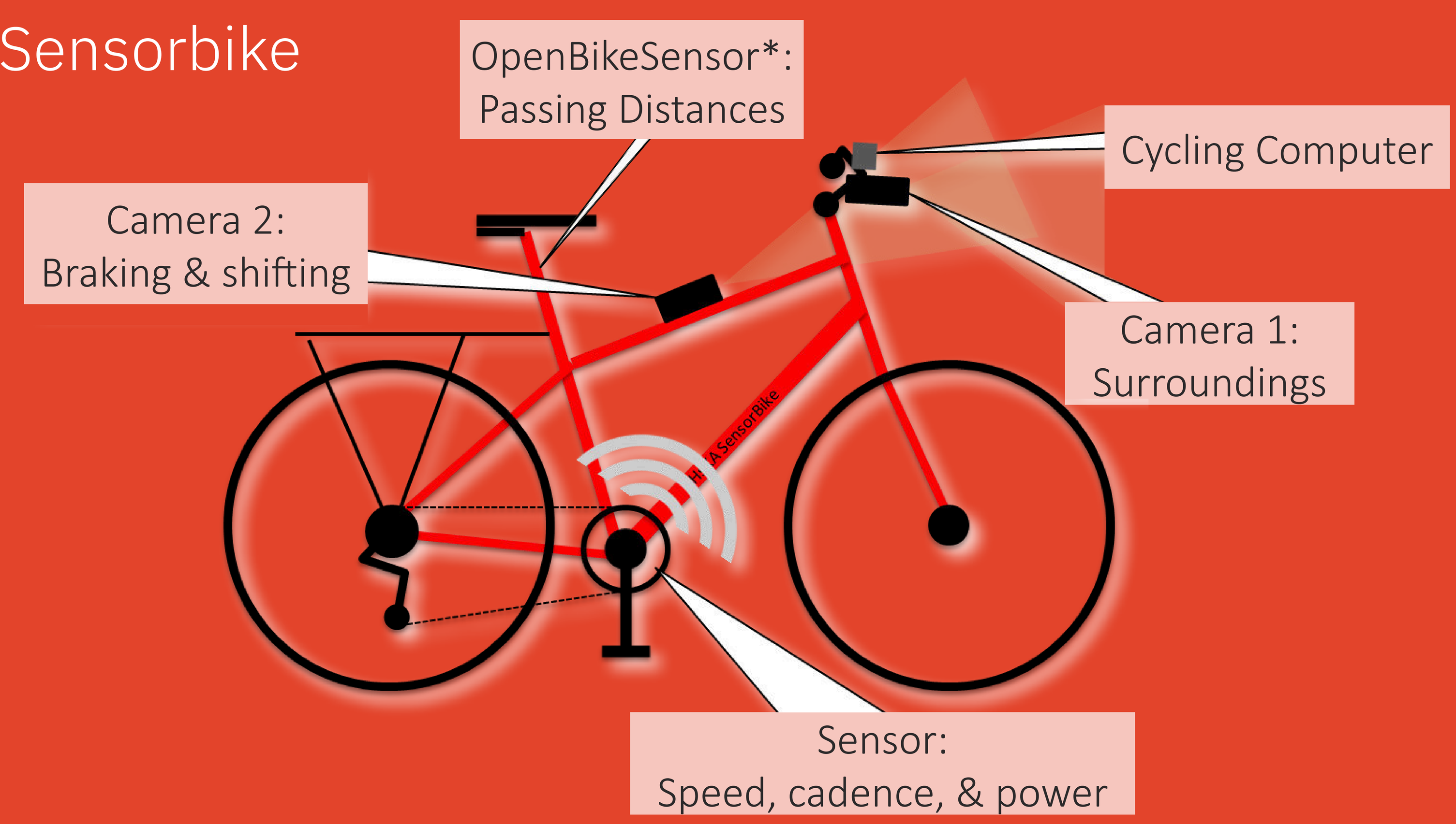
Understanding the cyclist's perspective

SensorBike as research tool for implementing new methodologies in transport planning

Abstract

Physical exertion (cycling comfort) and safe overtaking (increasing safety & cycling confidence) are crucial factors for cycling. The "SensorBike" was developed to study overtaking distances, speed, power, cadence, shifting, and braking. Test rides using the SensorBike compare cyclist needs & identify areas for infrastructure adjustment. Analyzing short test routes aids route planning, while extracting power and speed data informs biomechanical models. Standardizing diverse data supports infrastructure planning and sensor redundancy improves data reliability.

The Sensorbike



Goal

Understand and model cycling from the cyclists' perspective, including behavioural and biomechanical characteristics such as desired speed, riding strategy, and braking distances.

Method

Study captures patterns of cycling behaviour across 8 study participants cycling two routes with variable infrastructure. 180 km of observations collected so far (planned 300km) in Karlsruhe, Germany. We analyse the dynamics between three biomechanical variables: speed, power, and cadence.

Analysis

Examining physical variables such as power or speed in tandem, rather than in isolation, allows the identification, characterization, and analysis of behaviour under different cycling situations. Towards interpreting the relationship between speed and power variables, it is helpful to focus on a single section of a ride, between two stops.

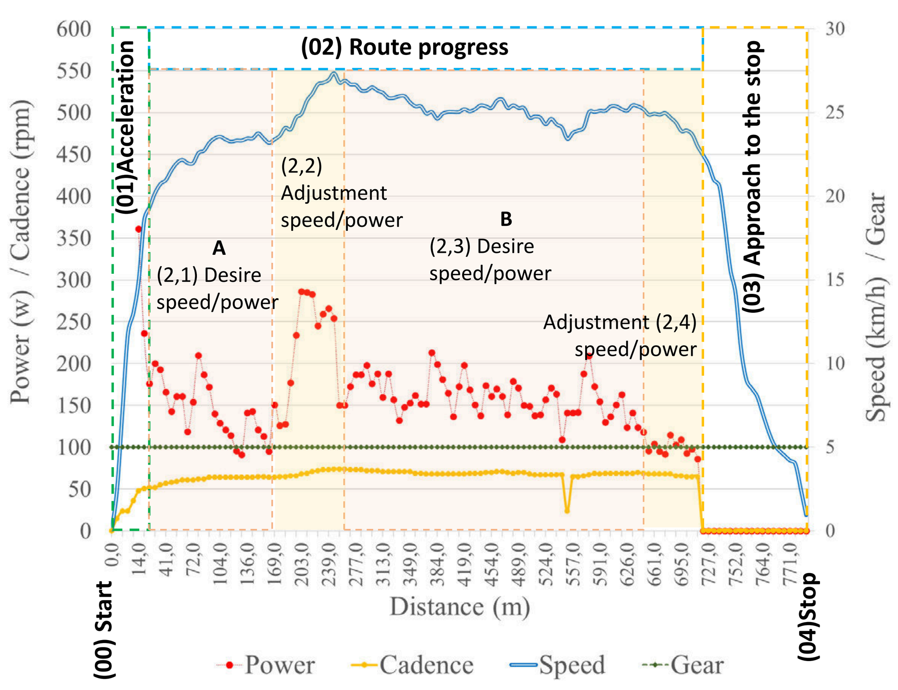


Figure 1. Analysis of cyclist behaviour for a section between two stops

"Riding Cycle"

One can visualize the speed, power, cadence, and shifting of a cyclist over the length of a bike ride. Here, we observe four phases of a bike ride:
01. acceleration,
02. route,
03. approach, and
04. stop.

Cycling can be described as behavioural phases between stops (often intersections): an acceleration phase, characterized by high power peaks; a route phase, which is subdivided into stages according to route conditions (constant travel, deceleration & intermediate acceleration, uphill & downhill rolling); and an approach phase to the stopping point.

Speed profiles help visualize the interactions, interferences, and sections of negative or positive slopes that can trigger modifications of cycling parameters and subdivide the route phase. Figure 2 represents two riding cycles between three signalized intersections, where the first does not have a route phase due to the short distance, and the second riding cycle experiences multiple turns and obstacles.

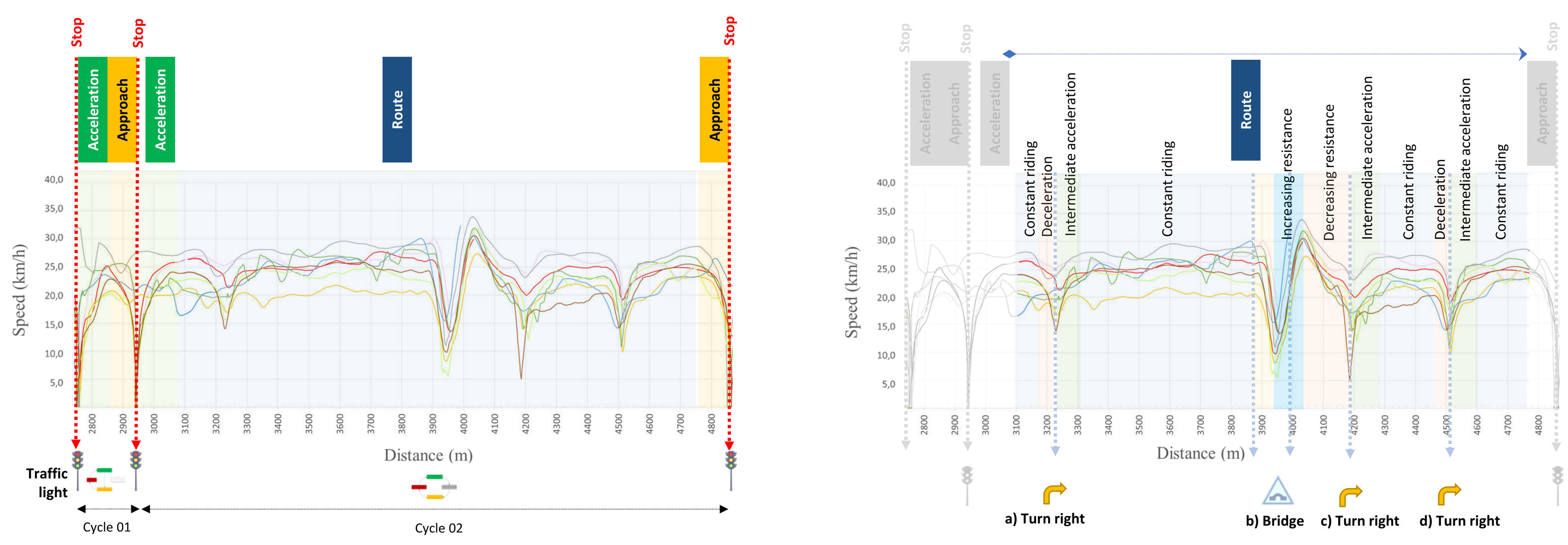


Figure 2. Observed speed profile of phases (left) and subphases of the route phase (right)

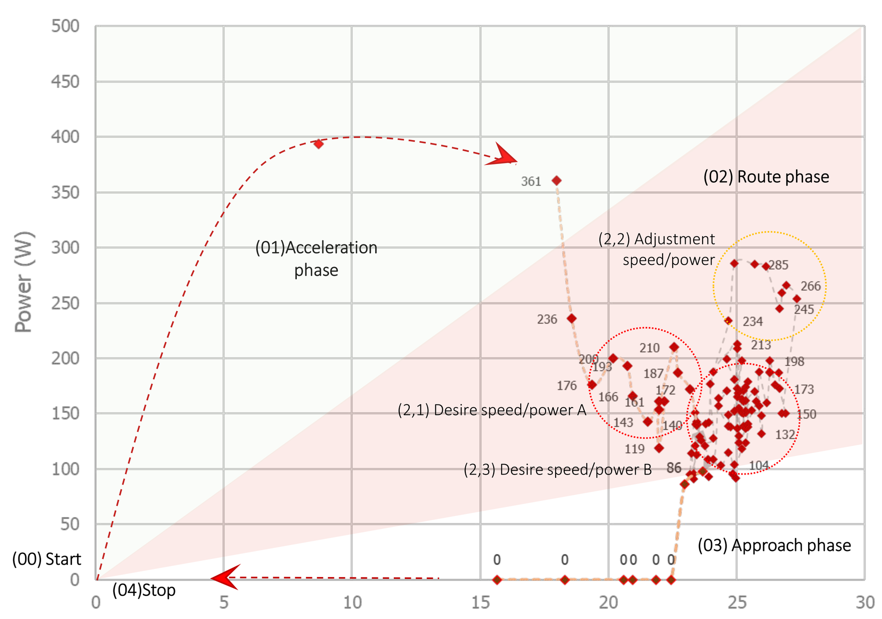


Figure 3. Analysis of speed and power adjustments for a section between two stops

Plotting the power against the speed of a cyclist on a scatter plot and following the chronological sequence of measurements allows one to identify clear boundaries between phases (Figure 3).

Closer inspection of the speed-power relationship across participants desired speed ranges of participants around 16-23 km/h.

Cadence plays an important role as a connecting element between desired speed and desired power. Shifting strategies, which differ between riders, affect the pattern of cadence and power as the cyclist increases speed. Figure 4 shows how mechanical profiles are affected by two moments of gear shifts.

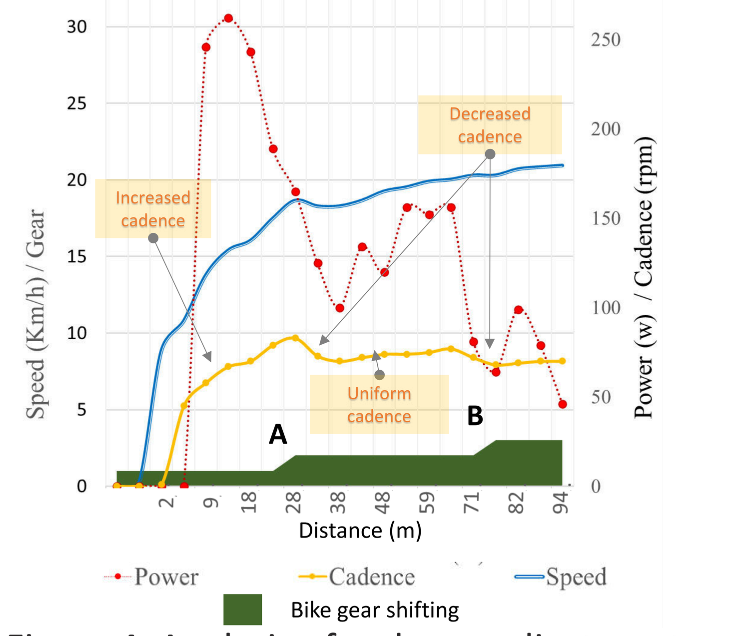


Figure 4. Analysis of cadence adjustments during acceleration phase with shifting

Conclusion

SensorBike test rides offer methodologies for measuring and comparing cyclist needs. Using the phases of a riding cycle, one can identify and systematically analyse cycling dynamics. Performing this analysis for varied infrastructure helps to better understand environmental influences, supporting route planning and network efficiency. This description of cycling as a mechanical process can serve as a basis for the development of a micromodelling approach to cycling behaviour, evaluate the effects of interations and interference from other traffic participants, and can consequently improve the planning and evaluation of cycling infrastructure.

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International Cycling Safety Conference 2024