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Development of a test bench for assessing cyclists' aerodynamics in dynamic conditions

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Time trial cycling, a discipline focused on speed and aerodynamics, has gained popularity in competitive cycling. Extensive research has been conducted to enhance aerodynamic efficiency, including equipment optimisation and body position adjustments. Even marginal improvements in aerodynamics can significantly impact performance, allowing cyclists to maintain higher speeds with less energy expenditure. However, there are still gaps in understanding and addressing the dynamic nature of a cyclist's position during a race and the need for accurate motion tracking techniques for reliable aerodynamic assessments.

This study aims to address the gaps in the field of cyclist aerodynamics by focusing on the evaluation of aerodynamics in dynamic conditions that closely resemble real-life situations. To achieve this, several key aspects are investigated.

Firstly, the study examines the order of magnitude of equipment, specifically helmets, to assess their impact on aerodynamics. By analysing these variations, the study provides insights into the influence of helmets on aerodynamic performance.

Next, the variations in cyclist replacement without feedback are evaluated, along with their corresponding impact on aerodynamics. The results reveal that the drag error resulting from these variations is significant, making it challenging to accurately assess the isolated impact of helmets on aerodynamics.

To mitigate these variations, a motion tracking algorithm is developed to provide feedback to cyclists regarding their positions. Although the algorithm does not yield precise cyclist positions, it assists in achieving replacements with a reasonable margin of error. However, the margin of error achieved with the feedback algorithm is not significantly smaller than when cyclists perform replacements without feedback.

Finally, all the preceding analyses are combined to develop a dynamic evaluation of cyclist aerodynamics, utilising the motion tracking algorithm. From this comprehensive evaluation, it is concluded that evaluating cyclists in dynamic conditions is of primary importance. Furthermore, the study finds that body position and shape have the most significant influence on aerodynamics, followed by equipment and yaw angle. These parameters can still be evaluated, even if the motion tracking algorithm failed to assess positions for various reasons, and shows several areas for improvement.

Keywords: time trial cycling, aerodynamic efficiency, dynamic evaluation, motion tracking techniques, real-life conditions.