Smart Trainer Homologation System

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Background and Motivation

The COVID-19 pandemic caused the competitive cycling community to pivot their focus to online racing [1]. These virtual races were implemented using internet connected “smart trainers.” These online race formats dramatically increased in popularity, causing many to see a need for homologation of the smart trainer equipment such that virtual races remained fair regardless of smart trainer manufacturer or model.

Smart trainers measure cycling power output which is sent to a real-time online racing simulation that converts the power data into a virtual speed. Variables such as road gradient, rider weight, and drafting status contribute to this virtual speed. The simulation calculates the appropriate resistance the virtual rider should feel, and sends this to the smart trainer to adjust the resistance the rider feels. Within this simulation feedback loop, it is vital that both the power measurement and resistance delivered are accurate in order to facilitate fair virtual racing at a high level.

System Design

The patent pending homologation apparatus was designed to test the both the power measurement accuracy and resistance command accuracy in various race conditions covering both low to high power and resistance conditions [2]. Others have performed similar power meter accuracy analyses, but none on smart trainers [3], [4].

The smart trainer was connected to the apparatus (Figure 1) using a standard bike chain and derailleur, in the same method a bike would attach. A motor was used to input power into the trainer with an inline torque and rotational speed sensor to determine the precise power input to compare to the power read by the smart trainer. To calibrate for power loss in the chain, an electromagnetic brake was used to determine chain efficiency at various run conditions and applied as a correction to smart trainer testing results.

The homologation apparatus was controlled through a custom Python program which executes prescribed testing recipes. The motor and brake were controlled over serial via microcontroller, while sensor inputs (torque, rpm, temperature) were connected to the controlling computer via serial. The smart

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trainer connected via the ANT+ protocol for setting parameters and reading data. The testing dashboard interface allows loading of recipes, running manual warmup sequences, and monitoring sensor values in real time. The testing results were used to quantify the quality of various smart trainers in terms of power measurement and resistance accuracy, resulting in a tiered system to sort smart trainers.

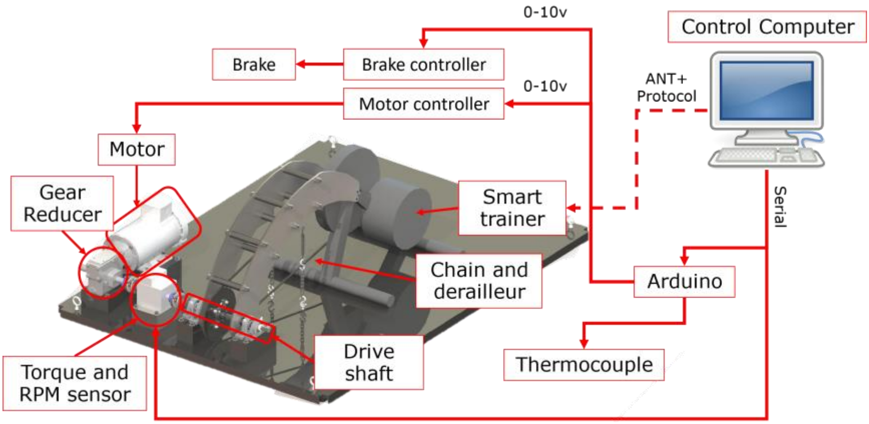

Figure 1: Trainer Homologation Apparatus Render

The testing dashboard reports the following data in real time:

- Torque
- Power
- Ambient temperature
- RPM
- Wheel speed
- Trainer temperature

Acknowledgements

We thank Purdue's Ray Ewry Sports Engineering Center for collaboration and financial support for this project, and the Union Cycliste Internationale (UCI) for their guidance and partnership. Additional thanks to Eleanor Dyas for her work.

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