A new approach to biomechanical analysis in cycling to introduce science to future data acquisition

A SINGLE CASE STUDY BY FELIX IMBERY, ULRICH SCHOBERER AND PETER LEO

Introduction

Student at University of Applied Science Aachen

- Major: Biomedical engineering

1986: Invention of Powermeter for cyclists by Ulrich Schoberer

Powermeter in 1986

Powermeter in 2021

Development of power

More attentive through:

Bjarne Riis

Greg LeMond

German (track) national team

Further innovations:

Pedal Powermeter road

MTB Pedal Powermeter

Spiderpowermeter

- New prototype

Objects and equipment for the study

Male athlete, height: 187 cm, weight: 72.1 kg

Spiderpowermeter prototype of SRM

- Two modes: 1) IMU mode: 200 Hz recording; 2) Rotation based: Average after repetition

SRM internal beta Software for graphs

- Export to Excel for statistical analysis

BMC Teammachine SLR01 road bike and SRM SmartIT

Design and aims of the study

Design

Two parts to evaluate the new measuring method and acquired data

- Indoortrainer ride with oval and round chainrings
- Outdoor: 1) continuous ride, 2) interval ride

Aims

To determine the accuracy of the new measuring method

To show highly resolved data

To show possible research benefit

Evaluating measuring method – Test design

1 hour Indoortrainer ride with oval and round chainrings (56 teeth)

Two 30 minute parts with each IMU and rotation based mode

- each part divided in 5 minute parts alternating between chainrings
- To neglect flywheel acceleration only the last 4 minutes have been recorded

Rider had to aim for 250 W at 75 rpm

Evaluating measuring method – Results

IMU mode (200 Hz)

No	Chainring	Power /W	Cadence /rpm	Kin Energy Flywheel /J
1	Round	249	75	2024
2	Oval	247	75	2024
3	Round	251	74	1971
4	Oval	250	73	1918
5	Round	243	73	1918
6	Oval	243	72	1866

Mean of power:

- 248 ± 3 for round
- 247 ± 3 for oval

Deviation of 0.4 %

Rotation based mode (1/rep)

No	Chainring	Power /W	Cadence /rpm	Kin Energy Flywheel /J
1	Round	246	72	1866
2	Oval	248	71	1814
3	Round	250	74	1971
4	Oval	259	74	1971
5	Round	250	74	1971
6	Oval	260	74	1971

Mean of power:

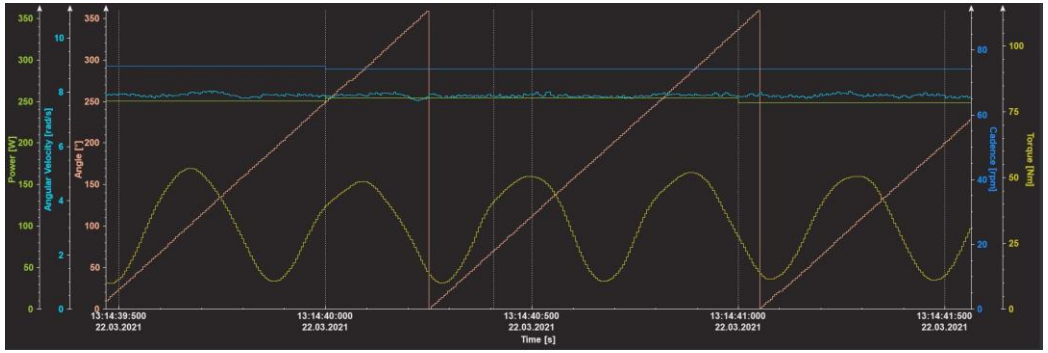
- 249 ± 2 W for round
- 256 ± 5 W for oval

Deviation of 2.8 %

Evaluating measuring method – Results

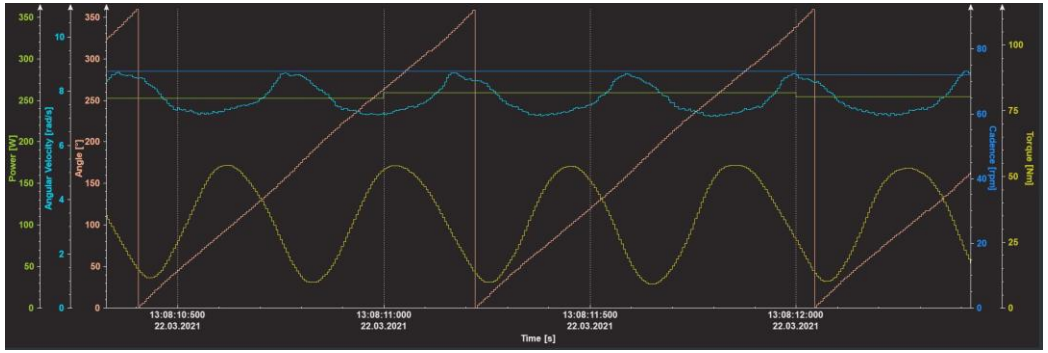
Round chainring

- Normal torque course (yellow)
- Angular velocity (light blue) without big variation



Oval chainring

- Torque incline is higher (yellow)
- Angular velocity (light blue) is wavy



Data acquisition – Test design

Ride 1

1:25:41 h continuous ride

Power: 217 W

Cadence: 84 rpm

Flat profile

Ride 2

1:24:03 h interval ride

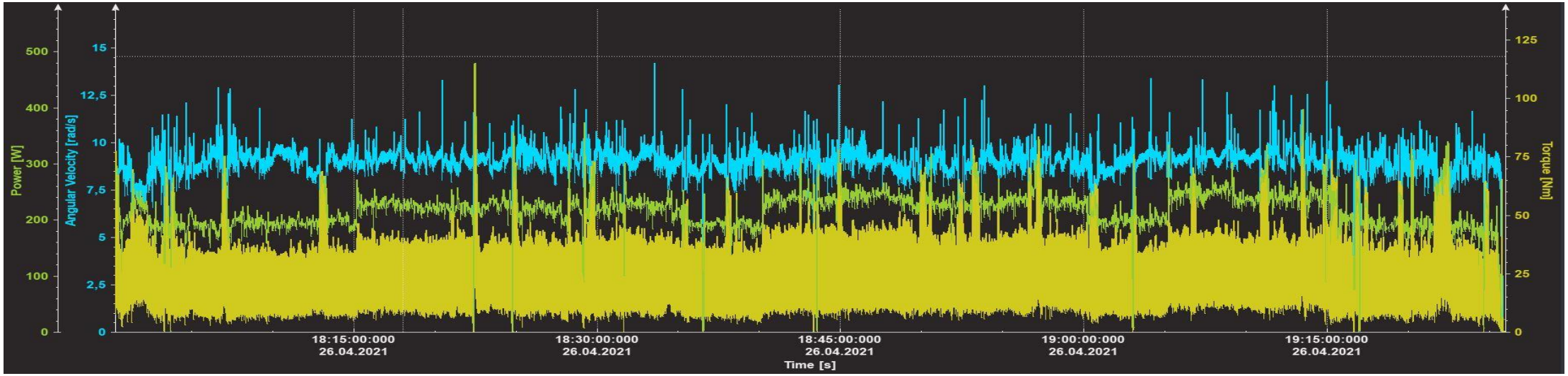
5x6 min at 369 ± 2.6 W and 89 ± 0.9 rpm
- Rest: 3 min at 227 ± 7 W

10 min at 322 W and 89 rpm
- Rest: 8 min at 203 W to last effort

Straight and flat roads

Data acquisition – Results Ride 1

1,029,519 datapoints of timestamp, torque, angular velocity and angle



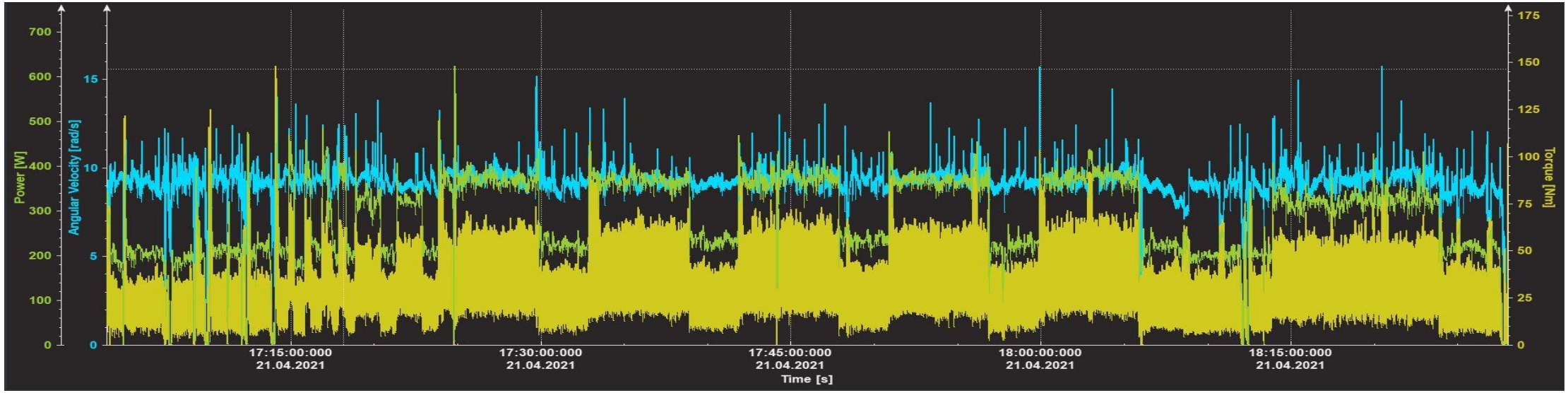
Constant power curve (green)

Torque (yellow) fluctuates in same range

Angular velocity (light blue) varies not a lot

Data acquisition – Results Ride 2

1,010,479 datapoints of timestamp, torque, angular velocity and angle



Constant power curve (green) for each section

Level of torque (yellow) raises significantly in intervals

Angular velocity (light blue) varies not a lot over whole ride

Data acquisition – Results Ride 2

No	Length/ s	Mean		
		Torque/ Nm	Angular Velocity/ rad/s	Power/ W
1	360.29	38.750	9.47	368
2	361.10	40.309	9.17	368
3	360.92	39.470	9.35	369
4	359.09	39.560	9.34	368
5	360.33	40.356	9.31	374
6	600.38	34.746	9.31	322

369 ± 2.59 W average in six minute efforts

- 47 W higher power output than in 10 minute effort
- Applied torque 4.943 ± 0.956 Nm higher

Torque has higher influence on power formation

Possible use of acquired data

Rethink or (re-)create parameters

- e.g. normalized torque or ratio of angular velocity to torque

Research in laboratory and field with same equipment

Medical sector

- Rehab progress or muscle function

Peaks could play a role in sprints or track cycling

- Lack of prototypes did not allow further research

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Thanks for your attention

Are there any further questions?