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Performance Modelling Based on Submaximal Outdoor Training

Introduction

Exercising has a proven therapeutic effect on the cardiovascular system. To avoid overstrain, determining an optimal training dose is crucial. However, the right dose is strongly dependent on each individual and may change during training periods. Professional athletes therefore have a coach, trainer, sport scientist, or are under doctoral maintenance, so their exercise sessions are individually supervised and controlled by a professional.

Without supervision and regular executed performance tests, the actual performance level can hardly be guessed. In leisure sports, these tests are not sufficient and professional coaches are often not affordable. Therefore, the possibility of an adequate performance modelling without exhaustive tests and supervising coaches will be very interesting for amateur athletes and might be useful in rehabilitation practice.

Heart rate prediction based on physical activity is a useful tool in properly controlling and monitoring the strain that a smart training device imposes on a subject during exercise. Hence, accurately predicting heart rate from work load information is an essential part in models used for training control.

Approach

Based on a newly designed heart rate model, it might be possible to determine the actual performance level individually using heart rate training data. This idea will be analysed and validated.

To determine the individual performance based on submaximal performance training, influencing factors including psychological factors have to be analysed. Combined with further sensors (like EMG, LED-based lactate sensors or sensors measuring the respiration rate), submaximal strain can be compared to usual performance tests.

For the aspect of modelling training from outdoor training data instead of protocol test data, a first step will be to simulate usual protocol tests in real outdoor training sessions. An e-Bike combined with a motor-controller programmed for this purpose could lead to first comparable results.

Results

In [1] we show that it is possible to simply use outdoor data to simulate performance after data is preprocessed in a specific way.

[2] introduces a new model for accurate heart rate prediction of a complete training session instead of only some seconds into the future as most models do. Furthermore, we could give an idea of a possibility to use this heart rate model to determine an actual performance level.

Relevant Publications

[1] “Training Simulation with Nothing but Training Data”.
M. Ludwig, D. Schäfer, A. Asteroth. In: Proceedings of the 4th International Congress on Sport Sciences Research and Technology Support (2016).

[2] “A Convolution Model for Heart Rate Prediction in Physical Exercise“.
M. Ludwig, H. Grohganz, A. Asteroth. In: Proceedings of the 4th International Congress on Sport Sciences Research and Technology Support (2016).

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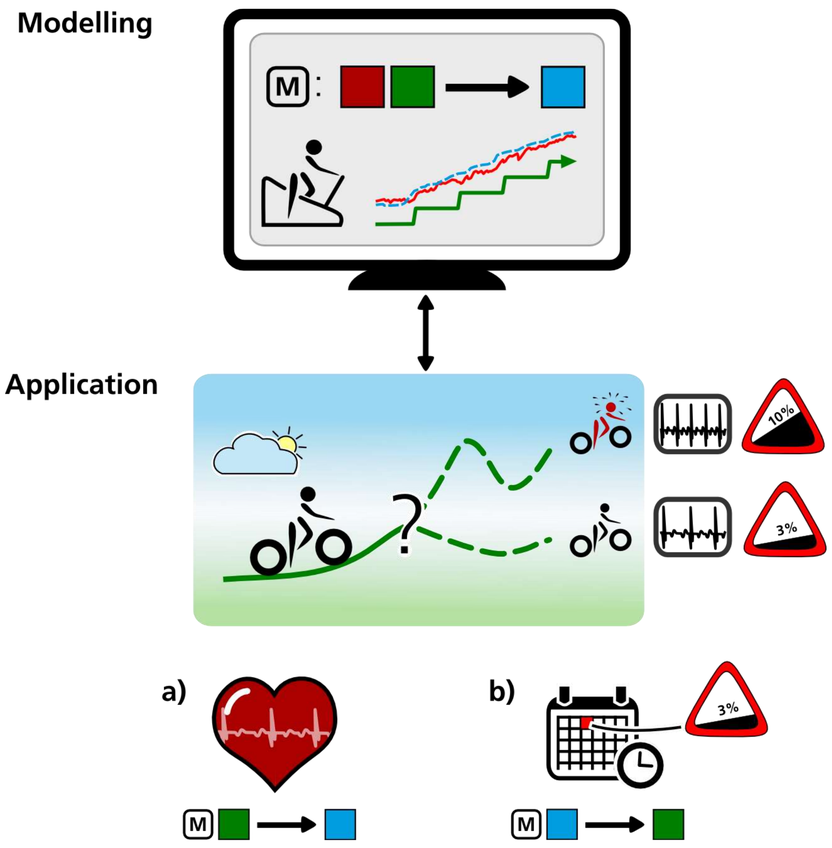
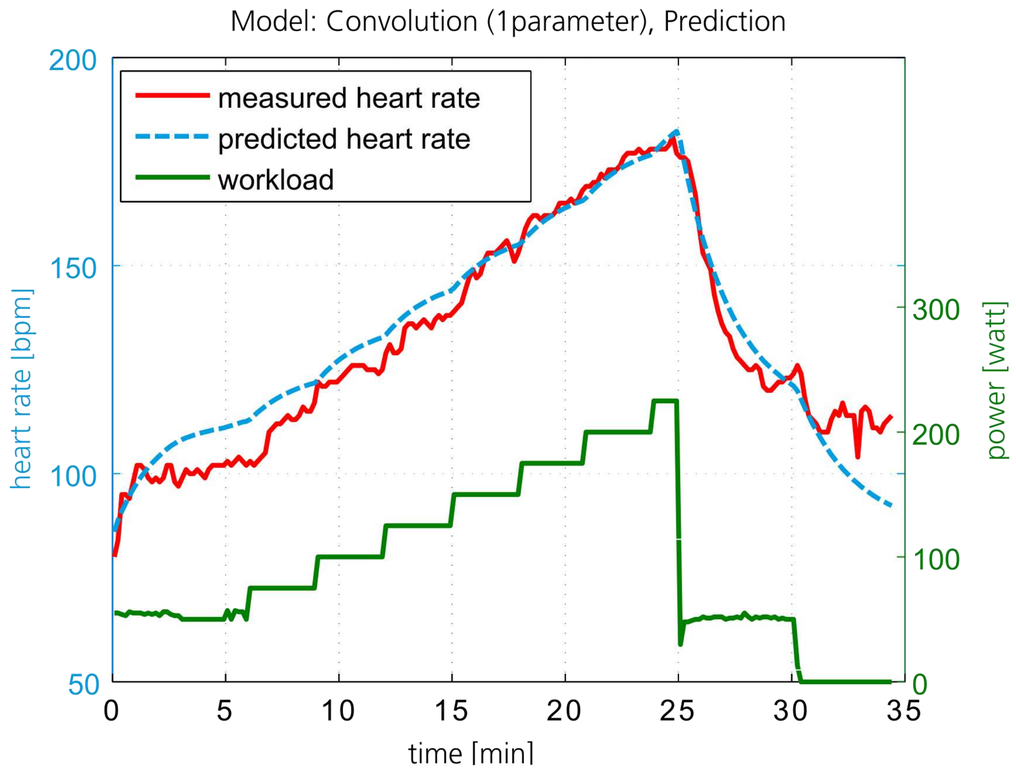


Draft of the approach regarding heart rate and performance modelling.
Instead of generic parameter values, individualizing the model needs a fitting of parameters. With fitted parameters, the model adapts to account for individual responses to strain.
The goal of the approach includes using outdoor training data
a) to control single training sessions and avoiding overstrain, and
b) to conduct individual and appropriate training plans.



Example of heart rate prediction for a complete training session performed on a cycle ergometer. Heart rate is computed with the reduced one-parameter Convolution model as presented in [2]. Model parameters were fitted to the subject beforehand. Wattage (green) is used as input and measured heart rate (red) is plotted for comparison, but has no influence on the predicted heart rate (blue).

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