

Herzratenregelung am Fahrradergometer

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Automatic feedback control of heart rate during exercise is a great way to improve cardiovascular health and fitness. The aim of this study was to compare first- and second-order dynamic models and their corresponding controllers which set the work rate on a cycle ergometer to control the participants heart rate.

Introduction

The Institute for Rehabilitation and Performance Technology at Bern University of Applied Sciences is working on developing advanced process control methods to automate the Monark LC7 cycle ergometer. These methods are designed to automatically adjust the intensity of exercise according to the subject's heart rate.

Hypothesis

The hypothesis is that a second-order model (P2) will have a higher goodness-of-fit and lower RMSE than that of a first-order model (P1). Additionally, it is hypothesized that feedback controllers based on P2 will give a more dynamic performance with better heart rate tracking than those of P1.

Methods

A sample size of $n=27$ participants will complete four tests on the Monark LC7 cycle ergometer. The first two tests are to identify the plant model. These models will be cross-validated using the participant's second test. The P1 and P2 model with the higher goodness-of-fit and heart rate RMSE will be chosen to design two controllers (C1/C2). The resulting heart rate RMSE and average control signal power from both controllers are compared for evaluation.

Results

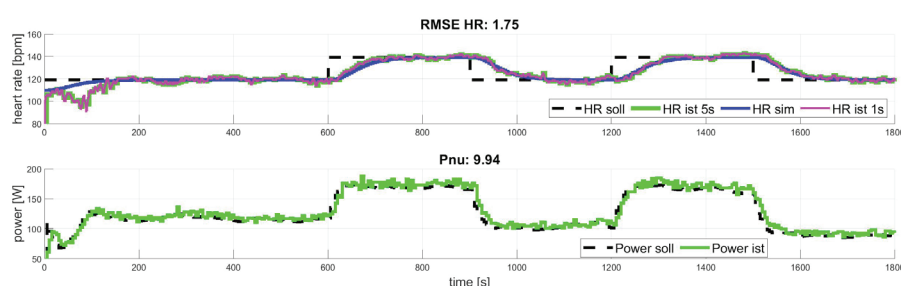
All 27 participants have completed both identification tests and feedback control tests. The results compare C1/P1 vs. C2/P2 with a significance level of $p=0.05$. A significant difference in the model's heart rate RMSE ((P1) 3.21 bpm vs. (P2) 2.93 bpm, $p=2.0 \cdot 10^{-11}$) and in the plant model's goodness-of-fit (47.88% vs. 51.90%, $p=7.1 \cdot 10^{-14}$) was found. The feedback control test showed that the controller C2 is significantly more dynamic with higher average control signal



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Cycle Ergometer, Monark LC7



Feedback Control Test Evaluation