The Mobile Motion Advisor
An Intelligent Real-time Feedback System

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1 OBJECTIVES

Athletes and coaches require effective methods to support and guide the training process. As a consequence of advances in technology, systems are constructed, which present relevant sports specific feedback information during and shortly after training and competition. Such feedback systems are primarily designed to assist sportsmen and to monitor their training for the purpose of achieving better performance but also for avoidance of excessive fatigue and load.

Our intention is to combine mobile data acquisition methods with centralized analysis routines and feedback functionality for supporting athletes. The approach is based on a feedback system providing mobile and almost real time solutions for wireless body sensor data transmission, processing and feedback provision.

Together with the use of appropriate technologies (hardware and software) the following goals can be achieved:

- Assistance during sport activities
- Improvement of training performance
- Avoidance of overload
- Increase of motivation by individual feedback (e.g. for school-classes)

2 METHODS

The concept of the system (Baca et al., 2010) provides interactive communication technology to coaches and athletes and helps to adapt and evaluate certain performance parameters in respect to the individual performance level. Characteristic parameters of the physical activity can be supervised continuously. In this way coaches are able to guide a number of athletes individually and the athletes get feedback of the quality of their motion which helps to interpret the body's reactions to physical load. The athletes' performances are recorded and so the

bodily changes during a certain time are documented. Positive effects of physical exercise are highlighted. For such purposes, sensors, carried by the person or mounted onto the sports equipment, are used to measure different parameters like heart rate, velocity or reactive forces of an exercising person. These parameters are sent to a smart phone application via ANT+™ (ANT+ is an already well-established standard for wireless sensor data transmission used by many manufacturers of technological sports-equipment).The measured data is then transmitted to an application server using wireless communication technologies (UMTS, HSUPA). Based on the collected data (e.g. presented as Flash charts on a web interface), feedback instructions can be generated by experts and sent back to the exercising person.

In addition, sub-modules may be integrated into the server application thus implementing intelligent algorithms for processing the acquired data. In this way, peculiarities in the data may be detected and subsequently be considered by the expert when providing feedback. Alternatively, feedback instructions may automatically be generated.

3 SAMPLE APPLICATION

3.1 Running – PerPot

The actual implementation of the MMA for running includes an intelligent feedback module for guiding further execution (Tampier et al., 2012).

Load-based performance development is predicted by applying the antagonistic meta-model PerPot, which has been developed by Perl (2005). This meta-model was created to qualitatively analyze phenomena like delayed reaction on load or collapse effecting overload. Applying the model to data from practice, it turned out, however, that PerPot was able to even provide quantitative results and to predict load-based performance development

very precisely. Extensions of PerPot are now able to determine the individual anaerobe threshold (IAT) by simulation, enabling optimization of speed and heart rate profiles in endurance sports (Perl and Endler, 2006).

The meta-model PerPot describes physiological adaptation on an abstract level as an antagonistic process: A load input flow is identically feeding a strain potential and a response potential. The response potential increases the performance potential by a positive flow, while the strain potential reduces it by a negative flow. All flows show specific delays, thus modeling the time the components of the modeled system need to react. In particular in endurance sports delays play an important role for the process of fatigue and recovering (Perl, 2005).

3.2 Experiences

In order to examine the system regarding the optimization of the target time in running, an experimental pre-test has been conducted in a first step. For this purpose, a number of (hobby-) athletes were asked to perform the following sequence of runs:

1. Calibration run: In order to determine the individual performance parameters (strain potential, response potential) of an athlete required for the PerPot module, a run similar to a step-test had to be performed. Based on these parameters, the system is able to calculate the optimal goal time and speed for a given distance thereby forming the basis for the generation of feedback.

2. Free run of about 10 kilometres or at least 40 minutes (without feedback messages).
   The athletes were instructed to perform this run to the best of their ability.

3. Run over the same distance as the second run, but this time with consideration of the automatic feedback messages of the PerPot module.

In order to limit side effects, all runs were carried out on a flat track. Moreover, the athletes had to complete the three runs within 2 weeks and without doing any other physical sport activities in between in order to avoid training effects.

As shown in Table 1, the results between the three runs and athletes are quite different and do not always follow a clear trend. In consideration to several factors like actual weather conditions, the athletes' condition and motivation – which all have influence on the results – this may not be unsuspected.

Table 1: Pre-test results. T1: Time of free run. T2: Time of run with feedback messages.

Nr.	Distance	T1	T2
1	10.000m	47:46	50:36
2	8.000m	46:46	45:08
3	9.250m	44:40	43:35
4	7.950m	45:55	44:31
5	9.600m	54:45	54:11
6	9.400m	49:26	41:36
7	9.200m	50:19	47:02

However, six out of seven athletes reached a better target time when using the MMA – with improvements from one up to eight minutes. Consequently, the MMA shows promising tendencies for improving performance data of runners.

Another observation is that some of the athletes, who did not reach the predicted target time, did not give the responsibility to the system, but rather to other factors such as their actual condition on the day. Overall, however, athletes seem to trust in the developed system – even in the case when they did not reach the predicted target time.

It appears that the athletes try to follow the feedback messages as good as possible – although the frequency of feedback messages can be quite high (up to 15 seconds interval). It usually takes about 15 seconds for the athlete to react to the feedback. This may be an indication for the acceptance of the MMA, as athletes who do not trust in the system would not have enough motivation for following the feedback messages.

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