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New approach for planning the mountain bike training with virtual coach

SAMO RAUTER

Abstract
Virtual technologies make a big step forward also in the world of mountain bike sport. Monitoring the progress of performances during sports training is the eternal desire of each competitive mountain biker. They can measure or analyse data directly from their trainings. As some previous study shows some sophisticated data analytical methods such as data mining are becoming increasingly useful tools in analysing sport performance and also by supporting decision making. For example on the basis of this specific data it is able to create algorithm for planning the sport specific training sessions. In this way sport applications may help also coaches to develop more sophisticated training program for their athletes. All this virtual technologies has led to the idea that they can put the concept of a complex computer system, which is virtual coach, which is based on the principle of cyclization/periodization of sports training. That will be also main focus in our study to show how virtual coaching may work for example for endurance athletes in our case mountain bikers.

KEYWORDS: virtual coach, new technologies, mountain bike, sport training.

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Corresponding author: samo.rauter@fsp.uni-lj.si

University of Ljubljana, Faculty of Sport, Ljubljana, Slovenia

Introduction

The development of virtual technologies has an impact on all areas of human life. Virtual technologies allow us to use the information anywhere and anytime [7]. Together with the ascendancy of smart mobile devices, mobile-applications have been developing rapidly. Nowadays, a lot of online applications, like news bloggers and many different social networks, have become part of our everyday life [8]. This technology dramatically affects also the sport world with a large amount of sport mobile applications as they are encountered several sports watches with GPS data. The rapid development of mobile technology has made this desire realistic. Nowadays, you cannot imagine the athlete without tracking devices either sports watches (e.g., Garmin, Polar) or mobile devices (e.g., smart-phone) during its workout, on which data about sports activities are saved [7, 9]. Some of the sport mobile applications also enable some kind of social network during the sport activities in the sense of virtual friendship or virtual competition. Social interaction also plays an important role in sport activity [19]. Specific sport watches or smart mobile phones were really one of the important tools for a majority of mountain bikers of all levels. Currently a major companies make serious efforts to develop additional options in order to meet the needs especially of athletes of outdoor sports worldwide [7]. For more and more serious mountain bikers/cyclists is instalment of such sport applications never under discussion, because they put "the cycling world" at the forefront of their life. It was explained that many people who engage in sport activities in their leisure time or practise a specific sport very "seriously" soon become completely focused on their most popular sport [10, 24]. In any case, they put the selected sport activity at the

forefront of their life. They often experience a feeling of belonging, while also joining an environment and choosing a company where everything revolves around their preferred sport. Enthusiastic runners, cyclists or triathlon athletes often consider such sport equipment a status symbol. Top sport equipment is not only part of the "image" but also helps boost the athletes' self--confidence and feeling of competence while engaging in a selected sport. From this point of view, having the most up-to-date and trendy sports equipment is very important for them. Also the newest technology took place in the mind of "serious" cyclists. In these sense sports applications, such as web portals Strava, Endomondo, Garmin Connect and many others are perfect tools for them [6].

The use of sport mobile applications can change the whole cyclist aspects to their rides and the importance of virtual technologies and this kind of sport mobile applications have a huge advantages over previous generation of mountain bikers/cyclists. With help of virtual technologies "modern" cyclists can measure or analyse data directly from the trainings and uploads to the computer software. Sport specific data have an increasing rate also in scientific area. With large sport specific databases is beyond the usual capacity of interpretation and analysis of information also possible to generate the need for new tools and techniques for automatic and intelligent evaluation [2]. In this context the data mining technique is one of the most component alternatives to assist in extracting knowledge from large volumes of data, discovering hidden relationships, patterns and generating rules to predict and compare data, which can help institutions in decision making or even achieve a greater degree of confidence. Such sophisticated data analytical methods like "data mining" are becoming increasingly useful tools in analyzing sports performance and supporting decision making that is crucial to gaining success in elite sports. Data mining is a problem-solving methodology that finds a logical or mathematical description. Using data mining techniques, useful and previously unknown information can be extracted from archived or streaming data. The extracted information may be in the form of prediction of future events according to known attributes [15]. In this context decision making process with the help of data mining tools and with the installation of such kind of software to the sport mobile applications may also help coaches to develop more sophisticated training program for endurance athletes such as mountain bikers. The main aim of this article is to show the idea of virtual coaching for endurance athletes (mountain bikers/cyclists) with the help of virtual technologies which supporting the data mining. Unfortunately, when someone reviews an existing literature about the related research topics, he/she can realize that there is a lack of research tackling the data analysis and data mining of sport activities [2, 7].

Virtual technologies in sport training process

Sport science is widely held to be the major contributor to progress in sport, and in particular to the enhancement of athletic training. The main objective of sports training is based on scientific and pedagogical principles of the planned systematic activities or processes in order to obtain the highest achievements of the trained in the particular sports discipline [3, 4]. The process of sport training is the some kind of rules for athletes (training plan) under which the athlete's organism adapts to a given load in the process of controlled exercise [6, 23]. These loads are dependent on (1) the type of exercise; (2) the quantity of exercise; (3) the intensity of the exercise, and (4) the frequency of workouts. Training plan prescribes how the training must perform as part of a sports training to achieve the aim. Management of the process of sports training is the most important task of the coach. This process sport training in all kind of sport disciplines consists of four stages (1) planning, (2) implementation, (3) monitoring, and (4) evaluation [3]. With the rapid development of mobile and ubiquitous technology, which allows tracking of athletes indicator load during training process became manageable the third and fourth stage in this process (monitoring and evaluation).

Some previous studies which are connected with the data mining process in sport identified that a training quantification is the key for success for smart planning [6, 7, 9]. The sports training quantification has always been a goal to be achieved by researchers in sport sciences. There are a lot of publications [4, 5, 21, 23, 25] with the purpose of validating or proposing methods for measuring and controlling the training load.

There are several methods of quantifying the dose of exercise. At this stage there is no absolute gold standard method of defining the training load that is applicable. The simplest and most inexpensive way of measuring training load is self-reported information. Diaries can be designed to get information about training load on a daily basis. For measuring the sport training intensity most athletes uses heart rate frequency monitors, where the time duration of the exercise by the average heart rate serves as a measure of the intensity. This is the simple method for monitoring the difficulty of sport training [3].

In an attempt to get composite measure of training load, Bannister [21, 23, 25] made a step forward in the smart training analysis of training sessions by using the method TRIMP. They used the heart rate response during exercise as an indicator of intensity, and the exercise duration as the external load. In order to quantify training load, this method used so-called *training impulses* that take into consideration the intensity of exercise as calculated by the heart rate (HR) and the duration of a training session.

A modified version of the Summated Heart Rate Tone equation has been used in is sometimes referred as "Lucia's TRIMP". In this method the duration spent in each of three heart rate zones is multiplied by a coefficient relative to each zone and the adjusted score are then summated [21]. Beside the physiological parameters (HR) of the monitoring exercise intensity, some other parameters also like power meter, can be used for monitoring the difficulty of sport training [12, 16]. Mountain bikers or cyclists especially use these devices very often, where a measure Training Stress Score (TSS) is proposed as a way of expressing the workload from a training session. These measure is the product of the workouts intensity and duration.

Another method of quantifying the training load called the Session RPE also combines the external and internal load into a single score. Session RPE uses a subjective score of the "hardness" of the training session. A simple practical method measures the training load with acceptable accuracy, based on subjective scores after each training session [6].

Principles of training for top level mountain bikers

Olympic format cross-country mountain bike racing (XCO) is fairly different sport in comparison to road cycling. In this way changed also the basic principles of training of mountain bikers and not only develop endurance. It can be characterised as high intensity, intermittent activity that require riders to compete over varying terrains including rocky paths, a technical single-track, and open forestry roads; it also includes frequent obstacles such as jumps and vertical drops, with high-intensity, high-power ascending sections that are separated by relatively lower intensity descents [1, 11, 13]. It is necessary that mountain bikers adapt and simulate competitive conditions during their trainings. Especially there are a lot of short accelerations. Within 90 minutes of racing they have to overcome up to 120 such of accelerations. From this kind, it is necessary to pay special attention to the development of speed (with emphasis on high intensity training) as well as developing specific strength (special strength training) and coordination, which comes particularly evident during the downhills [16, 17]. In order to illustrate how the sports training plan looks like in practice, a sample from cycling sport is presented in this section. This training was prescribed by cycling coach and it is devoted to a professional mountain bikers. Table 1 present specific training process of this mountain biker that used a different methods of training type. For long low intensity aerobic training they often used road or easy gravel routes. Priority in the last few days before the main competition has specific short high intensity

Table 1. Example of last week training for mountain bike race (XCO)

DAY	METHODS – type of training	DURATION	INTENSITY
7 MONDAY	hill climbing interval 6 × 4' very fast; between sets 3-4 of easy riding (DH) (MTB) + strength training (activation exercise – legs and core stability)	2 h	low and high intensity
6 TUESDAY	long distance training (MTB or ROAD)	>3 h	low to middle intensity
5 WEDNESDAY	rest day with short easy ride	30'	low intensity
4 THURSDAY	mountain bike interval training on the similar race profile for 2 × 20' race simulation; between sets 5-8' of easy riding (MTB) + strength training (activation exercise – core stability)	2 h 30'	low and high intensity
3 FRIDAY	rest day with short easy ride (ROAD)	30'	low intensity
2 SATURDAY	easy riding on the race course with some acceleration 3-4 times up to 2 minutes (MTB)	1 h	low intensity with short intensity blocks
1 SUNDAY	RACE DAY	1 h 30'	high intensity

training sessions with the lot of rest periods in between. These type of training must be performed with the racing mountain bikes on the very similar profile and terrain conditions. In summary, the athlete increased the intensity of training before and decreased it after the competitions.

New approach to planning the process of specific mountain bike sport training

Today, we cannot imagine any cyclists training session without technology aids. These technologies on the bicycles are composed of: (1) GPS devices; (2) power and cadence meters; (3) heart rate devices and many more. These devices have the following functions: (1) monitoring the total duration; (2) current, maximum and average (heart rate, power, cadence, speed); (3) current elevation, temperature etc. This means that producing sports training data does not represent problem anymore. However, difficulties have arisen when these big amount of data need to be analysed. A lot of web applications offer users some kind of sports activity data visualization, where usually the movement of the athlete is visualized on Google Maps together with some statistical measures like average heart rate during sports session, velocity, length of the performed course, etc. Unfortunately, this visualization typically encompasses only one sports session [6]. Although some sport applications allow users a certain kind of automatic planning for training sessions, this planning is based on a lot of input parameters, which cannot be changed during the process of training. Therefore, additional effort in developing the artificial sports trainer is expected that will be capable of dynamically planning sports sessions [20].

However, the main question is how sport applications can contribute in the more effective process of sport training. All this can lead to the idea that they can put the concept of a complex computer system, which is called virtual sports coach. In computer science, the data mining is a method, where the main goal is extraction of information from a data sets and conversion of these data to a form understandable by humans [6]. In the sports domain, data mining methods have generally been used to model the inter-relationship of performance measures and attributes and to also extract athlete performance patterns from previously exercises or competitions. This can be used in the decision making process to support for example strategic planning [2]. The more frequently used methods in data mining are: clustering, classification, regression, association rule mining. With these kind of methods sports applications can analyse the data of our training sessions, organize virtual competitions or even help us in sports training advertising [6].

On the example of mountain bikers we want to show how the process of generating a training planning procedure is working. From each training a lot of data are collecting in training datasets, where in depth information can be obtained: GPS location, elevation, duration, distance, average and maximal heart rate, while some workouts also include data obtained from power meters [12].

For the smart planning of sports training, quantifications, regulating the intensity of a workout is the key for success as indicated as basic knowledge in sports training literature [4, 5, 23]. Essentially load quantification measurement is important to propose an intelligent planning for endurance trainings. In previous chapter we mentioned several methods of load quantifications of endurance training for mountain bikers like a TRIMP, Lucia's TRIMP or TSS Score. It starts with a set of base trainings characterized by different durations and average intensities determined by the average heart rate or power during the cycling. Typically, treatment of the sports activity data consists of three steps: (1) data preprocessing, (2) data processing, (3) data visualization [20]. On the basis of these expected data, the plan of sports training for specific mountain bikers is performed using a bat algorithm. The proposed algorithm for planning the training session is able to create the training plan for a given training period of a specific athlete. It is capable of forecasting the training plans on the basis of previous training data of specific athlete. The obtained results of previous study [6] showed that the algorithm for planning the sports training is capable to create plans for sports training sessions of the similar quality as those of the coaches' plans. This fact also holds for strength training program. Which is very important for success also in endurance sport (5). As an estimate of the intensity of workout and simultaneously planning the strength training program suggested we three main measures like a: (1) the number of repetitions per set of exercises (NR); (2) the maximum amount of weight that can be generated in one maximum contraction (1RM) and; (3) quantifying the training load called the Session RPE as a subjective score of the "hardness" of the training session. Based on the original bat algorithm, we have developed a modified bat algorithm for planning strength workout sessions. Development of this algorithm demanded the following four steps: (1) determining the fitness exercises; (2) defining constraints; (3) modifying the original bat algorithm; (4) representing the results and their visualizations.

Conclusions

In the article we briefly present the fundamentals of sports training of mountain bikers to computational intelligence community and present a short description on recently released sport activity datasets for data mining and data analysis. When we made the literature review about data research in sport showed we realized lack of data research of sport activities. As mentioned earlier, sports applications can analyse the data of our training sessions, organize virtual competitions or even help us in sports training advertising. However, the main question is how sport applications can contribute in the more effective process of sport training. In future, these applications may also be intended for planning the further sport training sessions, as discussed earlier in some previous research.

Virtual coach might be based on the principle of cyclization/periodization of sports training, where the athlete defines the objective which it seeks to achieve by means of artificial coach in the longer term (season) to the short term (single training unit). The aim is to achieve the best preparation of the athlete for a specific competition. Virtual coaching produces a robust training plan, depending on the specifics of the sport discipline (mountain biking) which comprises a series of training sessions for endurance, speed and power.

Finally, there are some hints beyond the development and design of applications that could be interesting for coaches in the future like a: (1) optimization of sports' training planning; (2) predictions of overall times in different competitions; (3) detection of an athlete's crisis during endurance competitions; (4) avoiding pains and over-training.

What kind of training session, when and how many times it need to be performed? These kind of questions was mainly reserved to the domain of coaches. However, it could be different in the near future. We made some conclusion and present how some kind of artificial intelligence can be used for planning the training session for mountain bikers.

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