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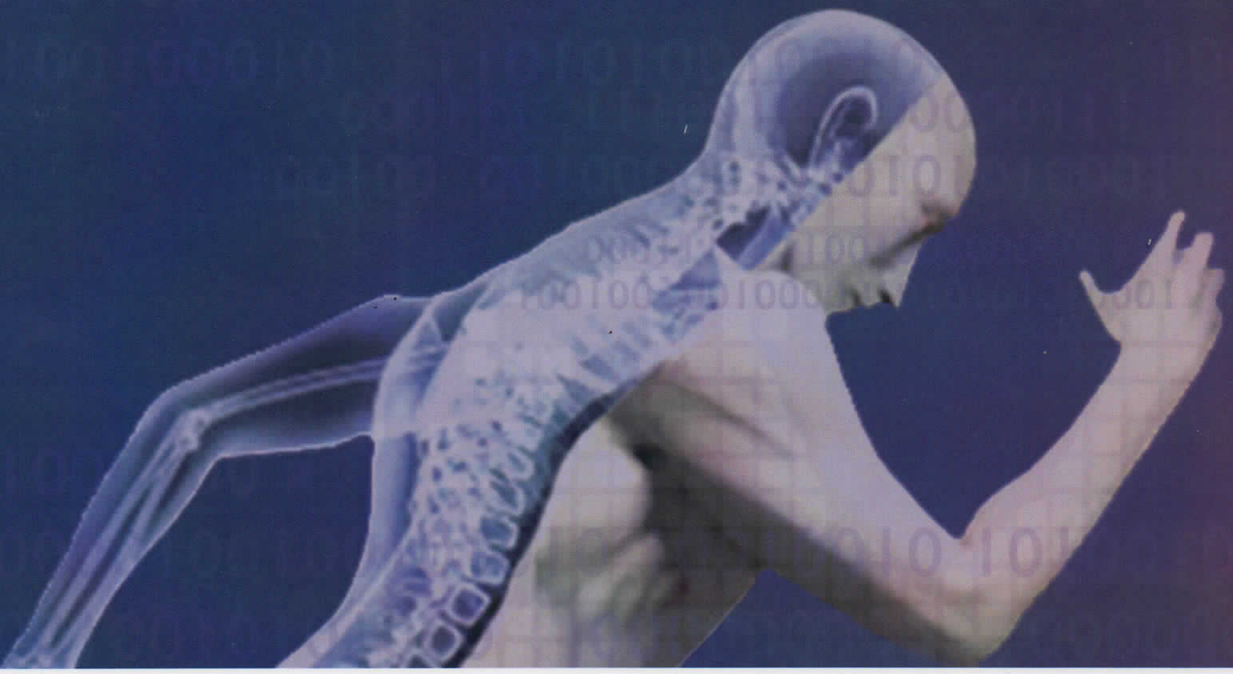

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Computer Supported Training
Analysis of the Environmental Conditions and Sports Performance

Roberto Bellasio[1], Alessandro Pezzoli[2,3] Jacopo Padoan[4], Matteo Moncalero[3,5] and Andrea Boscolo[3]
[1]Enviroware, Via Dante 142, Concorezzo(MB), Italy
[2]DIATI, Politecnico di Torino, C.so Duca degli Abruzzi 24, Torino, Italy
[3]MeteoSport, Sport Psychology Research Unit, Motor Science Research Centre, School of Motor and Sport Sciences, University of Turin, P.zza Bernini 12, Torino, Italy
[4]FLJ Sport Solution, Via Druento 208, Venaria Reale, Torino, Italy
[5]DICAM, Alma Mater Studiorum, Università di Bologna, Via Terraccini 28, Bologna, Italy
rbellasio@enviroware.com, alessandro.pezzoli@polito.it, info@fljsportsolution.com, matteo.moncalero@unibo.it

1 OBJECTIVES

Environmental and meteorological conditions have an important effect on outdoor sport performances. Wind direction and wind speed are important, for example, during marathons, rowing and sailing races (e.g. Pezzoli et al., 2012a). Temperature is also very important in long running events.

Considering marathons, the American College of Sports Medicine has established guidelines for preventing health effects due to extreme weather conditions (Cantu and Micheli, 1991). The guidelines are based on the wet bulb, globe, temperature index (WBGT index) which is based on the combined effects of air temperature, relative humidity, radiant heat and air movement. For example race cancellation or voluntary withdrawal are recommended when WBGT > 28 °C. Recently El Helou et al., (2012) found that air temperature and performance are significantly correlated.

Water temperature, for example, is an important factor in swimming during triathlon races. Indeed, below 13°C, the maximum swim distance is usually shortened (e.g. Rulebook of the British Triathlon Federation). Moreover, at temperatures below 11°C it is recommended that open water swimming does not take place.

Beside meteorological variables, other environmental variables play an important role, such as, for example, pollution levels. It is well known and demonstrated (Schwartz, 1996) that the air concentration of particulate matter (PM10 and PM2.5) has deleterious effects on the respiratory functions, even if they persist only for short times. The same statement holds for other pollutants. Notwithstanding the conditions of the outdoor environment are often not considered when evaluating sport performances - as if they were not important – the sport performances are strongly related to the environmental conditions.

The authors believe that environmental data will acquire increasing importance in analyse sport performances in the next future. Of course, such an analysis will require the assistance of a specific software tool, of which the main features are summarised in this document. The software tool would be very useful for athletes and trainers.

2 METHODS

The software is able to load the training data, for example time, position and heart rate, monitored by specific tools that are widely used even among non-professional practitioners (Garmin, etc.). The software tool also loads the meteorological data, and any other environmental data, measured by one or more monitoring station of interest. Other important data to analyse are those monitored on the athlete, such as for example his/her skin temperature or humidity (e.g. Pezzoli et al., 2012b). These last data are important when testing the features of particular clothing. All the above mentioned data are generally measured at different positions and at different times. In order to carry out the analysis all the external data must be time interpolated in order to get them on the same times at which the performance is available (synchronization process).

In a similar way, when the meteorological data are measured by more than one station, a spatial interpolation is needed to estimate the values at the same positions where the performance has been registered. There are situations where it is not correct to carry out the spatial interpolation, in such cases it is possible to indicate a radius of influence of each station, or to define areas of competence of each monitoring stations.

Of course the spatial interpolation may be more reasonable in some situations than in other ones. For example, if N stations are measuring wind speed and direction during a sailing race over a relative small water surface, the spatial interpolation is more than reasonable. On the other hand, if the same number of stations is measuring the same variables during a cycling race over a mountain region, the simple spatial interpolation might not be reasonable. In such cases a diagnostic meteorological model (e.g. CALMET) would do a better work, but it cannot be easily incorporated in a software as the one described here.

For other variables, such as temperature, specific algorithms are available to carry out spatial interpolation even in complex terrain (Bellasio et al., 2005). Indeed, air temperature at the ground depends on some variables, such as the altitude above sea level, the air temperature vertical gradient and the land cover type. The interpolation of sparse measurements of temperature over the domain should account for these parameters.

Other meteorological variables are calculated by the software if not available among the measurements. For example, solar radiation can be estimated starting from the geographic location of the athlete, which depends on the time, and on cloud cover, which can be obtained, for example, from METAR (Meteorological Aerodrome Report) data.

3 RESULTS

The software reproduces the training track on a map (the Open Street Map database is used), and for each point a lot of information is given as, for example, wind speed and direction in a specific training location, temperature, or important indices such as the wind chill or the Net Effective Temperature (Leung et al., 2008). Of course, each point is also related to the training data, as for example, the time elapsed from the start of the exercise, the total distance, the average and instantaneous speeds, the heart rate, etc. The user is also allowed to export the track in KML or KMZ format in order to view it on Google Earth.

The performances are also summarised in tabular format, and the user is allowed to export the tables in many formats in order to use them in presentations or for further analysis.

The first version of the software is still being developed as a desktop application for PCs. Future versions could be available also for Android and iOS tablets.

4 DISCUSSION

Generally the sport performance are analysed without considering the environmental conditions even if these are closely related to each other.

In this Abstract was presented an innovative computer supported training system that takes in account all the sport performance parameters and the environmental conditions. This tool, not yet developed in the Sport Technology, is useful for both athletes and coaches because it represents, with a synchronization process, the environmental and the sport performance values. This new technology "opens the door" to a new discussion because in the "environmental sensible" sports, coaches and athletes can record the sport parameters and compare their own performance with the environmental conditions in which this was carried out.

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