ISB 2013 BRAZIL

XXIV CONGRESS OF THE INTERNATIONAL SOCIETY OF BIOMECHANICS

XV BRAZILIAN CONGRESS OF BIOMECHANICS

ASSEESSMENT OF MICRO SENSOR (SM-MAE) IN MONITORING OF CYCLING

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INTRODUCTION

The track cycling is an Olympic sport practiced on oval and tilted environment architecture utilizing differentiated bicycles in their geometry and mechanics. The fastest racing of this modality, requires that physical, technical and tactical condition of the athlete, result in a high acceleration capability.

Besides, variables such as power, speed, acceleration and cadence are essential to monitor the technical and tactical training of the cyclist, thus in this sports scene there is a ongoing search for methods for evaluating performance, which informs researchers and coaches, of the biomechanical and physiological variables of specific modality.

Therefore, technological advances favored the construction of sensors with physical characteristics (small and light) and functional (wireless) that provides monitoring of athletes in training environment and / or competition with minimal interference on athletic gesture, identify and use variables originating from of an instrument such as this one is relevant to the assessment and preparation of athletes in various sports.

Aiming such characteristics and applicability in the sport the Sensors Laboratory of Microelectronics Electrical engineering and Computing Faculty at UNICAMP, developed the inertial system called MS-MAE, and in partnership with Instrumentation Laboratory in Physiology of Physical Education Faculty of UNICAMP, this measuring instrument was used in track cycling in order to Identify Significant biomechanical variables to sports performance in velodrome races.

METHODS

The experimental procedures of the study were approved by the Research Ethics Committee of the institution where it was developed and included the participation of 5 cyclists of high performance, male, who agreed to cooperate by signing the consent form.

The athletes performed a standing start, 3 sprints of 30m sprints seeking maximum performance and had a minute of recovery between them.

Data collection occurred at Careiras / SP velodrome with a bike properly adjusted to volunteers characteristics but was kept the same gear ratio (48X16) for everyone. Two photocells (CEFISE ®, São Paulo, Brazil) were incorporated into the system for the demarcation of the beginning and ending of the sprint.

The inertial system possesses wireless standard communication to a network of sensors, based on micro-electro-mechanical sensors (MEN'S) acceleration and rotation, aiming to measure linear acceleration and angular velocity. This system is composed by an accelerometer (MMA7260 Freescale, Austin, TX, USA) and a gyroscope (Mass Vibrating Gyroscope, IDG IDG-300 and 1004, Bulk Sillicom, InvenSense, CA, USA) three-dimensional. The sensors are controlled by a microcontroller (HCS08QE64) powered by a 3.7 V rechargeable battery (Lithium Prismatic) The assembly has dimensions of 37x49x20mm and 40g weight.

This sensor system (SM-MAE) provides immediate quantitative information during sports practice via radio frequency (Xbee / Xbee Pro, Digi Xbee) with a 25Hz sample rate, with the receptor (manifold) adapted from the USB-RogerCom connected to a USB interface of a PC. The data is displayed and stored by an interface program constructed in LabVIEW ® platform (National Instruments). The SM-MSA was fixed in the central pipe of the frame forward of the saddle seat post (Figure 1) in a way that the axes x, y and z referred to accelerations antero-posterior, latero-lateral and longitudinal, respectively. Even though this instrument was a three-dimensional inertial system, in this research, only the signals from the accelerations of the first axis previously mentioned were analyzed, because they are related with bicycle performance directly analogous to the training prescription.

Thus, based on these curves we focused on the following kinematic variables: maximum acceleration (MA), average acceleration (AM), maximum velocity (MV), average velocity (AV), time of the first cycling (T1C), time of the first 2 cycling (T2C) and total time (TT).

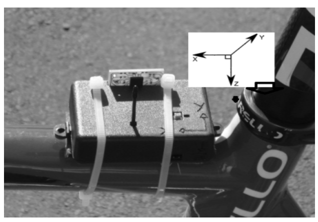

Figure 1: Fixing the accelerometer on the bicycle.

The statistical analysis (twoway ANOVA, Tukey post hoc test and Spearman correlation), signal processing and the routines to identify the acceleration curves and their integrals, were performed in Matlab ®. The data treatment was based on velocity and acceleration curves of x-axis. The level of significance adopted was $p \leq 0.05$.

RESULTS AND DISCUSSION

Observing the curves of acceleration on the axis chosen for analysis, tests phases were distinguished and presented in Figure 2. Baseline refers to the disengaged time waiting for the starting signal and the delay is the time the cyclist takes to respond to the start command. However, the biomechanical variables that refer to cyclist performance were observed in the interval time relating to displacement of 30 m (delimited by asterisks in Fig 2). Because the bicycles used had a fixed gear, for all cyclists it was observed a total of 9.5 cycling in all sprints.

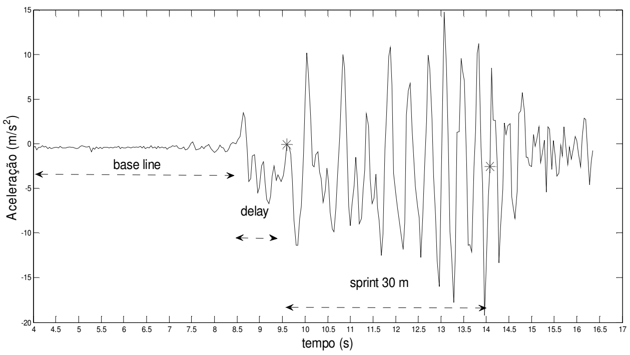

Figure 2: Acceleration in the anteroposterior direction on a 30 m sprint held on velodrome, in fixed gear bicycle.

Comparing the variables MA, AM, MV, AV, T2C and TT, significant differences were between volunteers, and applying the Tukey post hoc test, it was detected that cyclists 2 and 3 stood out from the others in MA variable, while cyclists 1 and 3 stood out in AM and AV.

In T2C and TT variables, 3 cyclists differed from the others. However, there was not a cyclist who excelled above any one in AV in by post hoc check , even with the statistical differences between them found by ANOVA**.**

Although it was detected that the accelerations, velocities, time spent by 2 cycling and elapsed time in the 30m differ statistically among athletes, the time spent by 1 cycling showed no significant difference, and also, no statistical differences were observed for all variables intra-sprints of each athlete. Such results may be accompanied by observation of Table 1.

Table 1: Mean values of kinematic variables on track cycling.

Variables	MA (m/s²)	AM (m/s²)	MV (m/s)	AV (m/s)	T1C (s)	T2C (s)	TT (s)
C1	14,33	3,03	13,97	7,00	1,86	2,51	4,56
C2	17,40	2,70	12,40	6,40	1,64	2,44	4,57
C3	18,53	3,13	14,53	7,10	1,45	2,47	4,55
C4	11,80	2,13	10,47	5,93	1,77	2,87	5,28
C5	15,17	2,07	11,73	5,87	1,57	2,65	5,11

MA - maximum acceleration, AM - average acceleration, MV - maximum velocity, AV - average velocity, T1C - time of the first cycling, T2C - time of the first 2 cycling, TT - total time of the sprint.

In the analysis of the correlation between variables, it was found significant direct relationship between all accelerations and velocities, however, for the time variables only among T2C x TT was observed statistical correlation. Likewise significant inverse correlation was found between MA and all the variables of time, whereas for AM, MV and AV this inverse relationship was observed only for T2C and TT.

With these results it is confirmed that cyclists 1, 2 and 3 possess superior athletic performance, in accordance to their ranking on the Brazilian Cycling Confederation. These data agrees with the values in Table 1, pointing cyclists 4 and 5 such as the slowest.

Although it was found statistical differences in performance between athletes, these did not present significant variability between 3 sprints performed by each athlete, which confirms the athletes as elite athletes.

The physical characteristics of the SM-MAE (small and light), facilitated their installation on the bicycle and wireless communication standard (wireless) provided to volunteers, allowed them to do the specific gestures inherent in cycling without any interference. The data transmission range of the movable plate, which made the acquisition of these data to the manifold, was appropriate for the selected event, allowing monitoring the experiment in non-laboratory environment.

CONCLUSIONS

We conclude with the present study that the use of SM-MAE accelerometer, did not interfere in the technical performance of the cyclist and proved that its use in a real training environment, as the velodrome, was able to provide biomechanical variables for speed cycling, providing information that helps the individual athlete's preparation for the improvement of their performance.

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