The use of inertial measurement units for swimming practice control: A pilot study

Pedro Santos[12], Beatriz Gomes[12], Ricardo Fernandes[3], Luís Rama[12]
[1]University of Coimbra, FCDEFUC, Coimbra, Portugal
[2] University of Coimbra, CIPER, Coimbra, Portugal
[3] University of Porto, FADEUP, Porto, Portugal
Email: panrisantos@hotmail.com

Summary

Inertial measurement units have been widely used across various sports to monitor movement dynamics. However, their application in swimming is scarce. As technology continues to evolve, there are increasing opportunities to gain better understanding of swimmers' movement in the water, during each stroke, as well as to use these devices for easier practice management, such as tracking lap times, stroke rate, and other key performance metrics.

Introduction

Incorporating inertial measurement units (IMUs) in swimming has the potential to enable a kinematic analysis of the swimmer in near real-time. Their use allows the evaluation of acceleration generated by stroke movements in all three axes [1], allowing coaches to provide timely and valuable feedback during practice. This pilot study aims to demonstrate the effectiveness of these devices for training control in swimming, enabling quick and efficient assessments of each swimmer's individual technique and performance - unlike traditional video analysis, which can be considerably time-consuming, or relying on a stopwatch when a coach is managing many swimmers simultaneously. Moreover, advancements in AI technology enhance the ability to identify each athlete's swimming pattern besides identifying lap times, turns and strokes. This provides significant information to coaches, without overwhelming them with tasks.

Methods

The pilot study evaluated 9 swimmers, 4 male and 5 female (age: 13.78±0.76-year-old) with at least three years of competitive swimming experience. Free written consent was obtained from participants' caretakers on a consent form previously approved by the Ethical Committee. Each of them did a task of 3x 50 m front crawl at max speed, with a rest time of 5 to 1 of work time. During each repetition, swimmers wore a specially designed neoprene belt developed by Janga®, which did not limit or alter their natural swimming movements. The IMU (Wimu Pro Device, WIMU®) was placed on the belt, and positioned next to L5. The first two repetitions of 50 m were considered adaptations. To analyze the data collected by the IMU, namely the acceleration in the Y axis (longitudinal to swimming) and total acceleration, a routine was developed in MATLAB® with an algorithm for automatic detection of the 25 m lap time, number of strokes, stroke rate, acceleration peaks and turning duration. For comparison, the 50 m were recorded. Lap time, number of stroke cycles and stroke rate at each 25 m were collected by video analyses on Kinovea software [2]. The data is shown as mean ± standard deviation for each 25 m of lap time in seconds (LT (s)), number of strokes (N), stroke rate in cycles per minute (SR (CPM), turn time in seconds (TT (s)) and stroke cycle peak acceleration in meters per second squared (PA (m.s^{-2})). The results are presented for both data collection methods: video analyses (VA) and MATLAB routine (MR). Statistical analyses using Bland Altman and Wilcoxon tests were performed, using ρ=0.05.

Results and Discussion

Table 1 presents the data collected with both methods for all athletes. The difference between averages (Diff) is presented. Values marked with * have statistically significant differences (ρ=0.05).

Data	Lap	0-25	25-50
LT (s)	SW	16.44±1.06	16.86±1.05
	MR	16.21±1.21	16.84±1.21
	Diff	0.23	0.02
N	SW	21.33±1.76	23.44±1.50
	MR	21.33±1.76	23.44±1.50
	Diff	0	0
SR (CMP)	SW	51.76±4.53	48.49±3.79
	MR	51.40±4.38	48.81±3.75
	Diff	0.36	-0.32
TT (s)	SW	2.62±0.15	
	MR	2.41+-0.59	
	Diff	0.21*	
PA (m.s-2)	MR	1.12±0.39	1.07±0.39

Table 1: Comparison between both collection methods for all athletes.

Conclusions

As seen by the comparison in Table 1, the values of LT, N and SR collected are not statistically different. As that, the accelerometry data can be successfully used for practice control, helping coaches controlling a large group of swimmers. Although being a significant conclusion, it is important to test this method more extensively with other swimming paces, distances and more athletes.

References

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