NINTENDO WII CONTRIBUTION TO SPORTS BIOMECHANICS: A PILOT STUDY OF PUSH-OFF KINEMATICS IN BREASTSTROKE SWIM TURN

Morteza Shahbazi*, Benjaman Schogler, Ross Sanders and Farina Koenig

Centre for Aquatic Research and Education, the University of Edinburgh, UK
***School of Physics, University of Tehran**

WII, as accelerometer was used to study push-off phase in breaststroke swim turn. The accelerometer could not be used directly into the water; therefore necessary modifications had to be done in order to use it in water. The results have been compared with the results of Qualisys Motion Analyzer system and theoretical modelling. A comparison of three results showed that the Nintendo WII acceleration power was 0.978 (r=0.989) very near the theoretical one (r=1), while the digitized filming showed a poorer power of 0.443 (r=0.67).The main problem with WII system was the noise that in our pilot study was not properly coped. The results obtained were reasonable and opened a new window for the use of Nintendo WII system in future research.

Keywords: Nintendo WII, sports biomechanics, push-off turn, kinematic study

INTRODUCTION:

To analyze turns movements, video filming has been used and the motion analysis systems, relatively expensive, were needed. The WII's controller uses motion sensing technology to interact with the games and especially in sports games. For example, when we make small slashing gestures with the WII-Remote then this may be used as to swing a sword in a game or a baseball bat in order to hit a ball. WII Sports uses the WII-Remote in several ways as we play the mini-games it offers: Tennis, Baseball, Bowling, Boxing, and Golf. Surprisingly, the Wii-Remote appears as more responsive in some games on the WII Sport disc than others, ranging in accuracy from extremely good to mildly. For example, holding the baseball bat feels extremely responsive, and we can see how holding the controller differently results in holding the baseball bat differently in the game. We can consistently hit the ball up or down depending on how high we swing the bat, and it's evident that the WII knows where its peripherals are. On the other end of the spectrum is the WII Sport Boxing game. While extremely enjoyable, throwing a punch in boxing we can show our character to do what we want. The system consists of two main parts (Fig.3); WII sensor and Infrared transmitter and offering accelerations in three directions on X,Y, and Z axes. Having these possibilities, we tried to use the system for swimming and in push-off of breaststroke swim. As the controller was very sensitive to water, we sealed it so that water could not penetrate and the experiments could be done easily. The main aim of this study was to launch the WII for sports biomechanics and especially in swimming, while being very sensitive to water.

METHODS:

As the wireless Bluetooth signals couldn’t be transmitting through water, WII-Remote was dismantled and the sensitive part (chip) was removed and put into another water proof box with the dimensions of; 50mmx50mmx37mm, well sealed and attached to the back of swimmer. In order to get swimmer movement signals, a long cable (10 meters long) was used to connect the accelerometer and the Bluetooth transmitter which was out of water to ensure the data transmission to a computer located 20 meters apart. For our pilot study, simplest under water movement was chosen and therefore swimmer was supposed to perform the under-water push-off glides at the depth of 0.5 meter and try to keep his streamlined position during gliding. To validate the results of Nintendo WII, we used Ariel Motion Analyzer and for more justification, a mathematical model was also introduced.

MATHEMATICAL MODEL:

To justify the results achieved by WII, we modelled swimmers push-off release by solving the equation of motion Shahbazi and Sanders (2002, 2004):

$F_P - Cv^2 = Mdv/dt$ (1)

Where; F_P is the propulsive force (exerted by swimmer), C is the hydrodynamic coefficient, and M is swimmer's mass. At release, there is no propulsive force but just drag force, therefore equation of motion becomes:

$\int_{v0}^{v} dv/v2 = - \int_{0}^{t} Cdt/M$ (2)

Integrating Eq. (2) yields for the velocity at any instance after release:

$v=1/(1/V_0 + Ct/M)$ (3)

V_0 is the initial velocity at the instant of release and on the other hand is the velocity that swimmer gained at the instant where swimmer's toes just left the wall. Differentiating (3) yields a relationship for acceleration as following:

$a = -(C/M) / ((1/V_0) + Ct/M)^2$ (4)

In fact, what we achieve from WII system is the acceleration.

RESULTS AND DISCUSSION:

We first compared a free movement with both Qualisys Motion Analyzer and WII system, Fig.1. As can be seen, a remarkable matching was obtained and encouraged us to go for swimming. After bringing appropriate changes to the WII-Remote, the WII system was ready to be used in water. To justify the repeatability of the WII system, ten trials on push-off were recorded by WII-Remote and the results were quite satisfactory. The main problem with this system was the noise that unfortunately we could not cope in our pilot study with, (Fig. 2). The video data was digitized and the acceleration variation with time was obtained for comparison (Fig. 3). The best fitting for this curve was a quadratic one, showing a power of 0.443 (r=0.67). The theoretical model result, as can be seen on Fig. 4, a 100% quadratic fitting was achieved with a power of 1 (r=1). Finally the result obtained by Nintendo WII system (Fig. 5) came out to be remarkable as its quadratic fitting was very near the theoretical result with the power of 0.978 (r=0.989). As the Nintendo WII system provides three accelerations in three different directions, it is absolutely necessary to choose the data of proper axis in the proper direction. The frequency of sampling was chosen at 200 Hz in order to get a reasonable outcome.

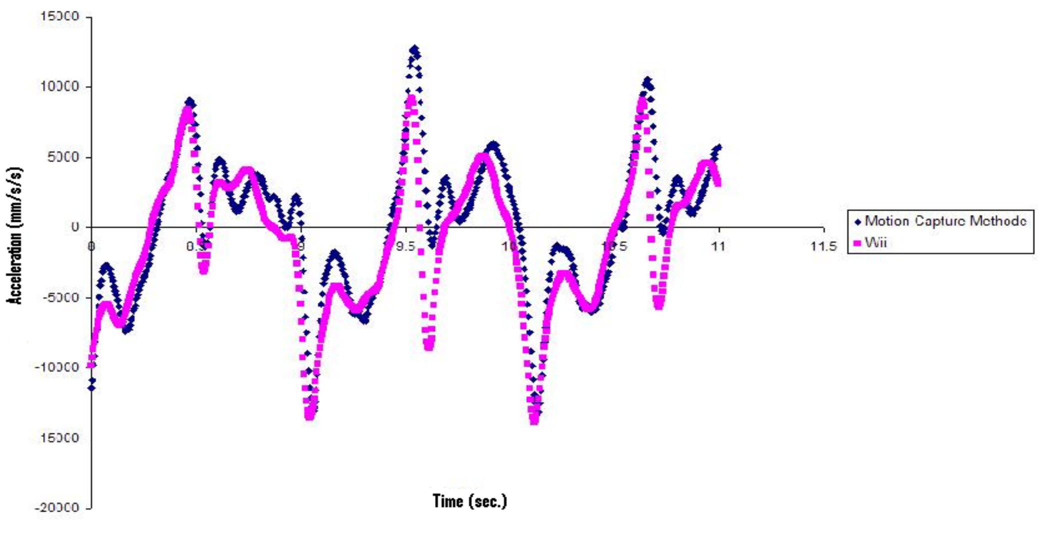

Figure 1: The comparison of raw results obtained by Qualisys Motion analyzer (dotted curve) and Nintendo WII (the bold curve)

CONCLUSION: A Nintendo WII system was used in push-off glide in breaststroke swim. In order to validate the results obtained, a Motion Analyzer system was engaged and a theoretical model was also introduced. The result of the Nintendo WII system was very near the theoretical result ensuring its relative reliability, although in a pilot study. The high sensitivity of WII-Remote introduced noise and should be coped; by effective filtering. We are very optimistic about the use of this system in our future research in swimming.

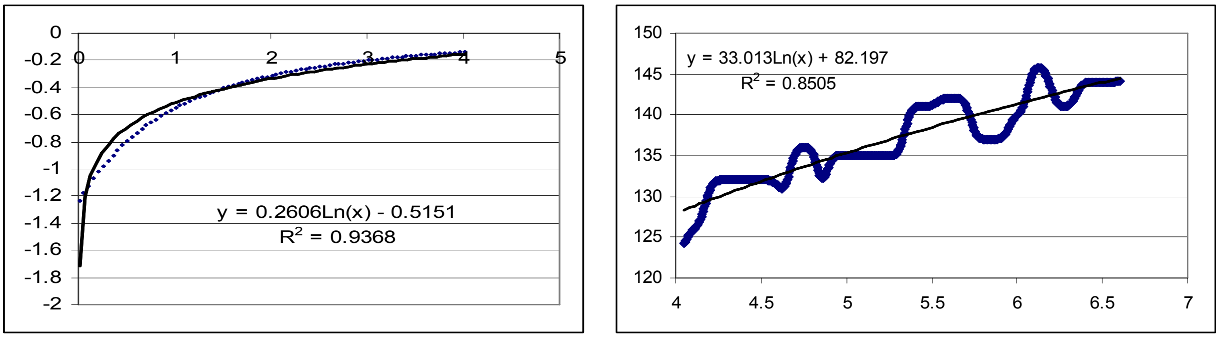

Figure 2: A comparison of two diagrams of velocities obtained by Qualisys (left) and WII system (right) in which the noise is remarkably shown.

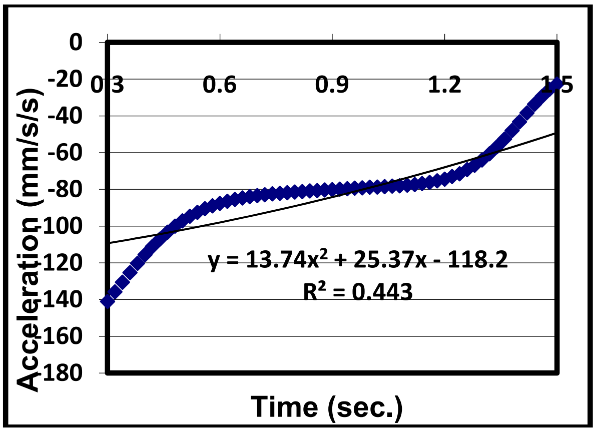

Figure 3: Acceleration obtained by digitized filming

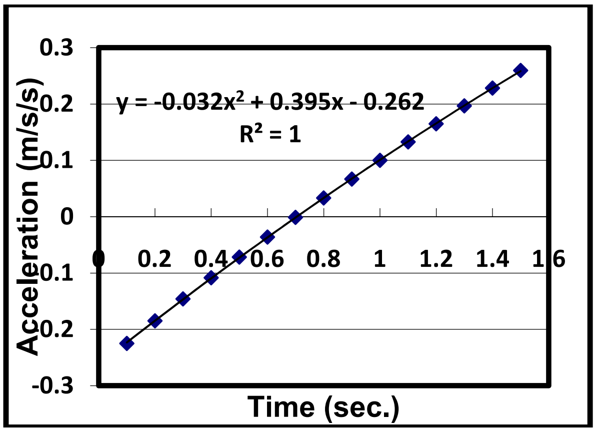

Figure 4: Acceleration obtained by mathematical modeling

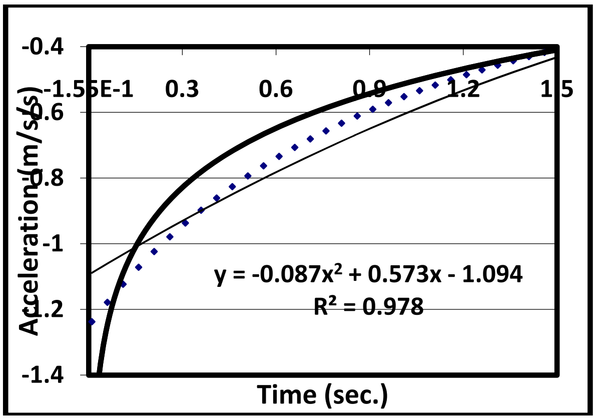

Figure 5: Acceleration obtained by Nintendo WII modeling

REFERENCES:

Shahbazi, M.M. and Sanders, R. (2002). Kinematic Approaches for Hydrodynamic Force Assessments. Pakistan Journal of Applied Sciences, 2, 8, pp. 895-902.
Shahbazi, M.M. and Sanders, R. (2004). A Biomechanical Approach to Force and Hydrodynamic Coefficients. Proceedings of XXII International Symposium on Biomechanics in Sports. Pp.225-228.