International Journal of Physical Education, Sports and Health 2018; 5(2): 10-14


**P-ISSN:** 2394-1685
**E-ISSN:** 2394-1693
Impact Factor (ISRA): 5.38
IJPESH 2018; 5(2): 10-14

www.kheljournal.com
Received: 05-01-2018
Accepted: 06-02-2018

**Izzo R**
School of Health and Sport Science, DISB, University of Urbino Carlo Bo, 61029, Urbino (Pu), Italy

**Vezzaro E**
School of Health and Sport Science, DISB, University of Urbino Carlo Bo, 61029, Urbino (Pu), Italy

**Hosseini Varde'i C**
School of Health and Sport Science, DISB, University of Urbino Carlo Bo, 61029, Urbino (Pu), Italy

**Correspondence**
**Izzo R**
School of Health and Sport Science, DISB, University of Urbino Carlo Bo, 61029, Urbino (Pu), Italy

# Quality study of some technical elements in artistic roller skating with use of new generation technologies

**Izzo R, Vezzaro E and Hosseini Varde'i C**

**Abstract**
The aim of this pilot study was to conduct a first analysis approach on athletic and technical features of artistic roller skating using latest generation hardware such as Inertial Measurement Unit (IMU) and 50 Hz GPS, in order to establish sport-specific parameters that could create usefull elements not present yet in scientific literatures to evaluate performance. Our protocol was divided into two parts, one using K-Track an 200Hz IMU (K-Sport Universal, Montelabbate, Italy) and with K-Shirt with GPS 50 Hz (K-Sport Universal, Montelabbate, Italy); tests were performed by 2 athletes, one male of high international level and one female of high national level. The use of the two different devices has enabled them to be able to analyze skating in a more objective way and to highlight, above all, the positive and critical elements of the instruments, also to give them specific validation. This study was made with help of ARGS (Advanced Research Group in Sport) founded in 2009 by Prof. Riccardo Izzo of School of Health and Sport Science at Carlo Bo University Urbino and ENG. M.Marcolini of K-Sport universal.

**Keywords:** artistic roller skating, GPS, IMU, sport performance

## Introduction
The use of dedicated technologies has given tremendous boost to the notational analysis that, albeit always useful, lacks performance that technology could provide more quickly and accurately. New technologies and performance analysis makes the results more scientific and reliable in order to help sports operators work [1]. First of all these technologies and their use were exclusive to sports with great financial possibilities like football, nowadays, with price cuts, they are spreading in many sports. This study is therefore a first scientific approach to performance analysis on artistic roller skating gestures through the use of two of the most advanced devices in performance analysis market the K-Shirt 50 Hz GPS and K-track an 200 Hz IMU. This work seeks, in essence and in the first instance, to test the references of the above-mentioned technology tools in the field of artistic roller skating. Taking into account some of the fundamental technical elements of this discipline With goal to be able to produce reliable parameters to build an optimized workout in accordance with the real performer needs of a skater, evety based on true data and not exclusively from experience evaluations [2]. This study was made with help of ARGS (Advanced Research Group in Sport) founded in 2009 by Prof. Riccardo Izzo of School of Health and Sport Science at Carlo Bo University Urbino and M. Marcolini of K-Sport universal. The use of inertial measurement units (Inertial Measurement Units or IMUs) in sports analysis has been analyzed in several studies like Henriksso *et al* [3]. 2016, Van der Kruk [4], 2015; Mapelli *et al.* [5], 2013. This technology has highlighted how video analysis, the use of baropodometric footrests and force transducers are not enough to precisely detect the temporal characteristics of the sport performance. Unlike other solutions, the IMUs are wearable hardware, so they allow 360 degree athlete analysis during sports performance without causing annoyance or limitations to sport-specific gesture[6]. The data obtained will be useful to analyse the sport specific technical gestures and consequently to produce the most appropriate training not only for the physical but also technical aspect. The data obtained through cross-measurements between IMU and GPS is therefore usefull in addition to improve athletes performance or also to reduce the incidence of injuries avoiding requests that can not be executed by the individual. A greater awareness and definition of biomechanical variables has in fact been useful to improve and maximize

athlete's functional abilities at various levels, ensuring a progression of their decisive sports mastery.

**Means and Methods**

The purpose of this pilot study was to use for the first time in artistic roller skating, performance analysis technologies (GPS, IMU) with the aim of identifying performance and significant and relevant parameters of discipline and setting a scientific goal in the skating analysis itself. The subjects examined for the research project were a male elite skater, gold medalist in the senior category at European Freiburg 2016 championships and a female national level skater.

- Elite (male): 20 years, Height: 1.70 cm, Weight: 66 kg, BMI: 22, 83.
- National (female): 24 years, Height: 1.64. Weight: 53 kg, BMI: 20.30.

IMUs are tools that can be applied in different parts of the human body in order to measure the acceleration of a body segment. The IMUs, are triaxial, therefore provide data on the three axes x, y and z (Fig. 1). K-Track is an IMU with 200 Hz sample frequency, it has inside an accelerometer, a gyroscope and a magnetometer.

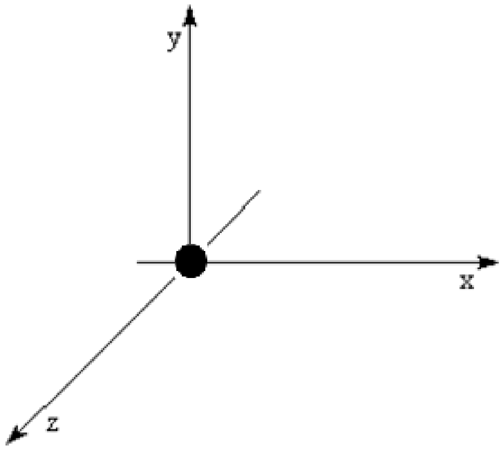


**Fig 1:** Examples of material point and expressions of its three-dimensional axes (x, y, z)

The device, which is absolutely non-invasive, is comfortable to wear: thanks to a special belt or general-purpose t-shirt, it can be positioned anywhere on the body so that it can monitor the movement of all the various bone and chain segments kinetics. The standard parameters of motion analysis and other experimental variables that have been considered in the study are: acceleration, direction, body equilibrium and jump analysis. The K-Track under detection is switched on and inserted into a chest, which the athlete uses when performing the analysis protocol or more generally in training. The device then connects to the PC as a common USB flash drive, allowing easy and immediate data transfer.


**Fig 2:** K-Track Device (Source: K-Sport Universal, ITA)

The technical features of K-Shirt (K-Sport Universal) are the following: GPS 50Hz, accelerometer, gyroscope and magnetometer both with 200Hz frequency, raw data live wireless transfert.

As mentioned, a first analysis was carried out using the K-TRACK inserted inside a band around the bust of the two analyzed athletes to test the effectiveness of the instrument.

**Executive Protocol**

The following technical exercises were performed in chronological order:

1. 5 jumps repeatedly in succession;
2. a half lap jump, that is, 180 ° inverted by the direction of travel;
3. A 360 ° full lap jump, without reversing the direction of travel;
4. an axel (one lap and a half jump of 540 °) followed by a skeating;
5. two laps jump (360° x 2) followed by skeating;
6. Three laps jump (360° x 3) followed by a skating;
7. A skeating figure at 8, clockwise and counterclockwise.

This protocol was repeated only once because both skaters performed the sequence without errors or. In the second stage of the protocol, a quantitative analysis was carried out using K-SHIRT of two specific technical elements such as: Camel spin followed by a Sit spin and the Lutz jump triple toe loop (combination of lutz jump followed by a toe-loop, pointed). This part of the protocol was only performed by the elite skater because the objective was to see what quantitative changes could be encountered during the performance of a repeated sport-specific technical gesture. The elite skater then performed for the two technical elements 10 times consecutively with a recovery time of 45 seconds between each repetition and 20 minutes between the trough and the Triple Toe-loop analysis. The athlete was therefore required to repeat the technical gesture while respecting the same preparatory phase each time, which included two pitch ride in simple skating, useful to obtain the speed required to perform the required technical element. Quantitative and qualitative analysis was carried out for each of the 20 repetitions and finally average and standard deviation were calculated.

**Data analysis and discussion**

The acceleration values analyzed by K-Track on all three axes give us important insights on the athlete's stability during exercise. The values found on the axes are expressed in m / s2 in the X axis to indicate right (positive values) or left (negative values), thus representing a lateral oscillation of the athlete; on the Y axis, the values turn to positive (upward) or downward (negative values), while on the Z axis we can recognize the results from the forward device (negative values) or backwards (values positive).

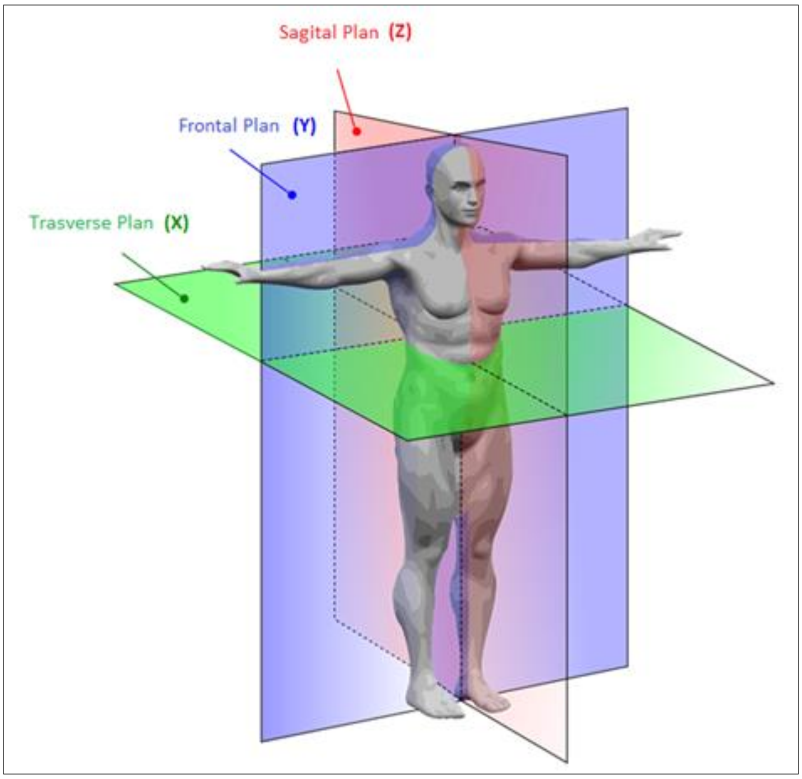


**Fig 2:** Example of axes and planes in relation to the human body (https://it.wikipedia.org/wiki/Piano_sagittale)

On the X and Z axes the regime value (acceleration value found when the athlete is stationary, waiting to start the exercise) is not constant while on the Y axis it approximates about 0 in both athletes under exam. These non-constant regression values on the X and Z axes may be due to a movement of the device during movement, or to a different inclination of the athlete after movement, so we have the influence of 1g (gravitational force, g = 9,789 m / s2) which is redistributed on the 3 axes in a different way. Instead, on the Y axis, the regime value is approximately around 0 m/ s2 in both athletes, because there are no marked movements on this axis (such as a jump), the feet remain attached to the ground and the value of acceleration returns, after movement, always around 0. These values give us important estimates of the stability of the skater, as low variations between the threshold value and the regime value could mean that the movements on the three analyzed axes were minimum, so the athlete did not generate high peaks of acceleration. The data obtained by K-Track during the development of the first part of protocol were charted (Fig. 3 and Fig. 4).

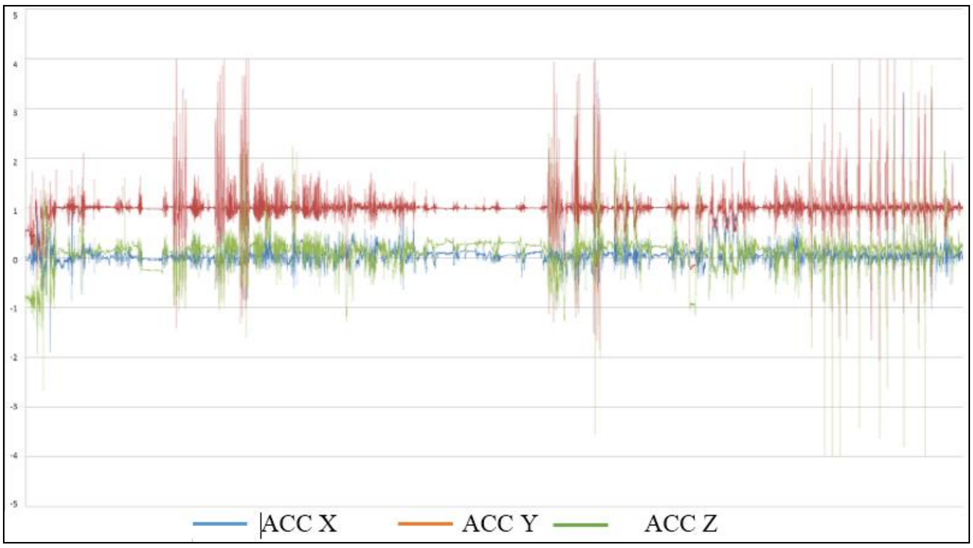


**Fig 3:** Acceleration on Axes x, y and z obtained by national skater

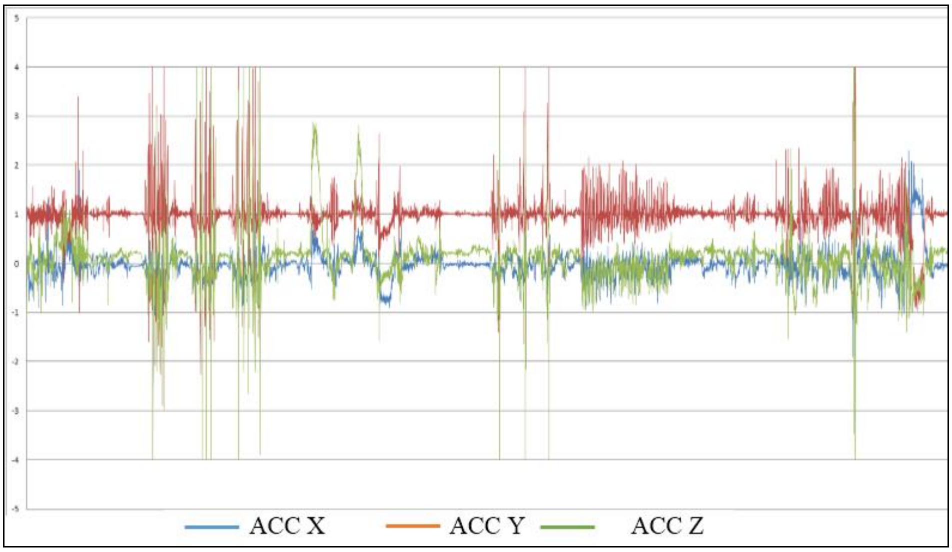


**Fig 4:** Acceleration on Axes x, y and z obtained by Elite skater

By comparing the two graphs, it can be stated that the international skater has higher peaks as regards the acceleration on y axis relative to jumping phases, while the national skater has higher peaks of acceleration in z axis on saggittal plane. In addition, the skater's graph shows more stability. Being both high-level skaters, there are no major differences with regard to basic exercises. The biggest difference in the movements, are that the international skater tends to have slightly more stable lines in transverse plane. There are no particular differences in the maximum strengths both reach maximum accelerations of 4 m/s2 (however, the skater shows a greater number of accelerations) while in the case of decelerations the international skater shows a greater number of major decelerations (> of -4 m / s2). In addition to the study of the acceleration charts produced during the protocol, we also analyzed the average values recorded in the positive and negative accelerations so we can also obtain a numerical comparison.

Table 1 contains the data of the maximum accelerations developed by the two athletes studied during the execution of the protocol, where we don't find particular differences in acceleration peaks. Between subjects the only discernible difference is related to X axis acceleration, which shows a difference of 1.4 meters per second in favor of the international skater, while in the other axes both acceleration and deceleration values are similar.

**Table 1:** Values of the maximum accelerations in the three axes x, y, z expressed in m/s2

| | HI-AC X | HI-DE X | HI-AC Y | HI-DE Y | HI-AC Z | HI-DE Z |
|---|---|---|---|---|---|---|
| National | 0,8 | 1,8 | 4 | 2,1 | 3,8 | 4 |
| International | 2,2 | 0,8 | 3,9 | 1,4 | 4,1 | 4,1 |
| | | | | | | |

**Table 2:** Average accelerations in the three axes x, y, z expressed in m/s2

| | A-AC X | A-DE X | A-AC Y | A-DE Y | A-AC Z | A-DE Z |
|---|---|---|---|---|---|---|
| National | 0,1 | 0,1 | 2,5 | 0,6 | 0,4 | 0,9 |
| International | 0,28 | 0,3 | 2,7 | 0,4 | 0,8 | 1,8 |

Legend:
HI-AC = high acceleration
HI-DE = high deceleration
A-AC = average medium acceleration
A-DE = average medium deceleration

Subsequently, the two technical gestures monitored by K-Shirt, namely Trotter and Triple Toe-loop, are shown in the following tables (Tab.3 and Tab.4).

The parameters considered are: Total Distance (meters, DT), High Speed Distance (> 16 km/h, DS_HI), High Acceleration Distance (> 2 m/s$^2$, D-AccHI), High Deceleration Distance (< -2 m/s$^2$, D-DecHI), Speed Max (m/s$^2$, Smax), DS1 = 0-10 km/h, DS2 = 10-14 km/h, DS3 = 14-16 km/h, DS4 = 16-21 km/h, DS5 = 21-24 km/h e DS6 > 24 km/h.

**Tab 3:** Quantitative-qualitative analysis of Camel spin by the elite skater.

| Trials | DT | Drel | DS_HI | D-AccHI | D-DecHI | Smax | D_S1 | D_S2 | D_S3 | D_S4 | D_S5 | D_S6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 86,0 | 140,3 | 26,0 | 9,0 | 10,0 | 5,6 | 10,3 | 26,8 | 23,5 | 25,4 | 0,5 | 0,0 |
| 2 | 72,0 | 139,4 | 34,0 | 7,0 | 8,0 | 5,6 | 3,7 | 13,4 | 21,3 | 33,9 | 0,1 | 0,0 |
| 3 | 81,0 | 93,5 | 28,0 | 8,0 | 8,0 | 5,4 | 10,0 | 14,0 | 28,9 | 28,3 | 0,0 | 0,0 |
| 4 | 70,0 | 133,8 | 22,0 | 8,0 | 9,0 | 5,6 | 9,9 | 13,3 | 24,2 | 22,2 | 0,2 | 0,0 |
| 5 | 82,0 | 138,7 | 33,0 | 9,0 | 9,0 | 5,8 | 7,3 | 14,6 | 26,8 | 31,9 | 1,1 | 0,0 |
| 6 | 78,0 | 141,8 | 35,0 | 9,0 | 10,0 | 5,8 | 7,8 | 12,2 | 22,3 | 34,1 | 1,2 | 0,0 |
| 7 | 68,0 | 128,2 | 19,0 | 6,0 | 8,0 | 5,6 | 9,1 | 16,4 | 23,8 | 18,8 | 0,0 | 0,0 |
| 8 | 82,0 | 146,3 | 36,0 | 7,0 | 8,0 | 5,7 | 7,8 | 14,9 | 23,7 | 34,8 | 1,2 | 0,0 |
| 9 | 80,0 | 132,0 | 35,0 | 9,0 | 9,0 | 5,7 | 9,3 | 11,5 | 24,4 | 34,3 | 0,7 | 0,0 |
| 10 | 67,0 | 157,4 | 22,0 | 11,0 | 12,0 | 5,8 | 7,3 | 19,1 | 19,0 | 19,8 | 2,0 | 0,0 |

| | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Average | 76,6 | 135,1 | 29,0 | 8,3 | 9,1 | 5,6 | 8,2 | 15,6 | 23,8 | 28,3 | 0,7 | 0,0 |
| Dev.St | 6,8 | 16,7 | 6,4 | 1,4 | 1,3 | 0,1 | 2,0 | 4,5 | 2,7 | 6,3 | 0,7 | 0,0 |
| Minium | 67,0 | 93,5 | 19,0 | 6,0 | 8,0 | 5,4 | 3,7 | 11,5 | 19,0 | 18,8 | 0,0 | 0,0 |
| Maximum | 86,0 | 157,4 | 36,0 | 11,0 | 12,0 | 5,8 | 10,3 | 26,8 | 28,9 | 34,8 | 2,0 | 0,0 |

**Table 4:** Quantitative-qualitative analysis of the Triple Toe-loop performed by the elite skater.

| Trials | DT | Drel | DS_HI | D-AccHI | D-DecHI | Smax | D_S1 | D_S2 | D_S3 | D_S4 | D_S5 | D_S6 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 | 90,7 | 120,5 | 23,6 | 3,8 | 3,8 | 6,1 | 10,8 | 13,0 | 43,3 | 23,6 | 0,0 | 0,0 |
| 2 | 93,6 | 132,5 | 24,4 | 4,0 | 4,0 | 6,3 | 11,1 | 13,5 | 44,6 | 24,4 | 0,0 | 0,0 |
| 3 | 97,3 | 146,9 | 25,4 | 4,1 | 4,1 | 6,6 | 11,6 | 14,0 | 46,4 | 25,4 | 0,0 | 0,0 |
| 4 | 56,7 | 80,9 | 14,8 | 2,4 | 2,4 | 3,8 | 6,7 | 8,2 | 27,0 | 14,8 | 0,0 | 0,0 |
| 5 | 85,1 | 109,4 | 22,2 | 3,6 | 3,6 | 5,7 | 10,1 | 12,2 | 40,6 | 22,2 | 0,0 | 0,0 |
| 6 | 75,6 | 141,8 | 19,7 | 3,2 | 3,2 | 5,1 | 9,0 | 10,9 | 36,1 | 19,7 | 0,0 | 0,0 |
| 7 | 98,9 | 150,8 | 25,8 | 4,2 | 4,2 | 6,7 | 11,8 | 14,2 | 47,2 | 25,8 | 0,0 | 0,0 |
| 8 | 89,9 | 118,3 | 23,4 | 3,8 | 3,8 | 6,1 | 10,7 | 12,9 | 42,9 | 23,4 | 0,0 | 0,0 |
| 9 | 91,5 | 126,4 | 23,8 | 3,9 | 3,9 | 6,2 | 10,9 | 13,2 | 43,6 | 23,8 | 0,0 | 0,0 |
| 10 | 83,2 | 103,2 | 21,7 | 3,5 | 3,5 | 5,6 | 9,9 | 12,0 | 39,7 | 21,7 | 0,0 | 0,0 |
| Average | 86,2 | 123,1 | 22,5 | 3,7 | 3,7 | 5,8 | 10,3 | 12,4 | 41,1 | 22,5 | 0,0 | 0,0 |
| Dev.St | 12,4 | 21,5 | 3,2 | 0,5 | 0,5 | 0,8 | 1,5 | 1,8 | 5,9 | 3,2 | 0,0 | 0,0 |
| Minimum | 56,7 | 80,9 | 14,8 | 2,4 | 2,4 | 3,8 | 6,7 | 8,2 | 27,0 | 14,8 | 0,0 | 0,0 |
| Maximum | 98,9 | 150,8 | 25,8 | 4,2 | 4,2 | 6,7 | 11,8 | 14,2 | 47,2 | 25,8 | 0,0 | 0,0 |

The analysis of the 10 Camel spin and the 10 Triple Toe Loops enabled us to verify the possible differences in the repetition of a technical execution. In our view, the surveys could greatly benefit by the implementation of a system that determines and uses the angular parameters of the technical gesture already described by Merni, Fantozzi and Querin (2010). By evaluating those parameters it would be possible to improve teaching and technical learning of technical gestures. Given the reliability of the technologies used in the future, it would be desirable to codify the discipline's technical and sporting gestures, in order to establish a sport Golden Standard to follow. It would then be helpful to make a specific gender comparison, which was not possible for recruitment issues. The systematic analytical monitoring (SAM)[7] of the techno-tactical gestures of all categories of rolling skating, even in youth activities, would establish a set of specific parameters useful for building a proper workout as well as optimized. It would also be useful to study the athletes during the exhibition, which would certainly give a more realistic answer to find specific elements and could be a turning point for the referee judgment too which would finally have an objective match. Technology like ones we used would provide real-time support to judges who can no longer give subjectivity judgments to technical elements.

## Conclusion

The results obtained following the protocol proved that in the sport of roller skating, it is possible to perform a performance evaluation linked to objective/mathematical values. Detection and subsequent data analysis allows us to influence and then individualize specific work-outs training plans and parameters for athletes, and set up training sessions optimized on correction of common and frequent errors. This is no longer mediated by a subjective/experimental analysis by training staff but with objective data. The combined use of GPS and IMU will enabled to ascertain the real figure values of some specific technical gesture in skating. This is a first stage project that tray to define a performance model for skating, that need to be refined in the future. This should therefore be seen as a starting point that can be followed by other future studies carried out with data collection over a longer period, in different contexts (including exhibition) and on different categories.

## References

1. Gwangjae Y, Young JJ, Jinhyeok K, Jin HK, Hye YK, Kitae K, Siddhartha BP. Potential of IMU Sensors in Performance Analysis of Professional Alpine Skiers, Sensors (Basel). 2016; 16(4):463.
2. Brodie M, Walmsley A, Page W. Fusion motion capture: a prototype system using inertial measurement units and GPS for the biomechanical analysis of ski racing; DOI: 10.1002/jst.6; Sports Technol. 2008.
3. Henriksson T, Vescovi JD, Fjellman-Wiklund A, Gilenstam K, Laboratory- and field-based testing as predictors of skating performance in competitive-level female ice hockey, Journal of Sports Medicine. 2016; 90.147.2.98.
4. Van der Kruk E, Schwab A, Van der Helm FCT, Veeger HEJ. Getting the angles straight in speed skating: a validation study on an IMU filter design to measure the lean angle of the skate on the straights; Biomechanical Engineering, Delft University of Technology, Mekelweg 2, 2628 CD Delft, the Netherlands; Procedia Engineering. 2015, 147.
5. Mapelli A, Rodano R, Fiorentini A, Giustolisi A, Sidequersky F. Body movement during the office execution of back spins in figure skating, Sforza C., Journal of Electromyography and Kinesiology, 2013.
6. Lockwood K, Gervasi PJ, Mccreary DR. Landing for Success: A Biomechanical and Perceptual Analysis of On-Ice Jumps in Figure Skating, Downloaded by [University of Nevada - Reno] at v2012; 12:42-30.
7. Izzo R, Gomez Paloma F, Raiola G. Effects of the strenghts capacity in basketball and consequences on the specific tecniques elements, International Scientific Conference, Perspectives in Physical Education and Sport, 13 Ed. Constanta, Romania, 2013.