Transilvania University of Brasov
FACULTY OF MECHANICAL ENGINEERING

COMAT 2020 & eMECH 2020

Brasov, ROMANIA, 29-31 October 2020

ANALYZING SKI JUMPING IN AN INEXPENSIVE WAY

Raul Cosmin Vrabie[1], Mircea Mihălcică[1]
[1] Transilvania University of Brasov, ROMANIA
raul-cosmin.vrabie@student.unitbv.ro, mihalcica.mircea@unitbv.ro

Abstract: *In this work, we aimed to find if a cheap motion analysis system.is suitable for analyzing a sport like Ski Jumping. We recorded the performances of 19 local and international athletes, focusing mainly on the take-off. The study is mainly based on the posture and geometry of the body. The finding might improve the technique of the jump for junior, aspiring athletes*
Keywords: *Ski jumping, video analysis, Kinovea, sports analytics*

1. INTRODUCTION

Ski jumping is a sport that is very popular in some areas of the globe (mainly Northern Europe). While things are great where Ski Jumping is considered a popular sport, aspiring athletes from many other countries lack proper means of training and performance analysis and would greatly benefit from cheaper methods and systems which would aid in analyzing their performance.
This study proposes an inexpensive motion analysis system that would help young and aspiring athletes better their performance. The idea was to record the jumps of some of those athletes and then analyze their performance in comparison to the data from the literature.
In order to achieve the proposed objective, an observational, retrospective study was carried out, which included a group of 19 male subjects participating in the World Cup competition.
The data for the analyzed study were obtained between 20.02 - 23.02.2020, on the trampoline Valea Cărbunării, Râșnov, Brașov County, during the World Cup competition organized by the International Ski Jumping Federation (FIS Ski Jumping).

2. MEANS AND METHODS

In order to analyze the jump of the 19 male subjects, the following equipment was used:
- A 60fps camera
- Support for video camera stabilization
- Some form of data interpretation/analysis software – we used Kinovea, an excellent free, open-source software for analysis in sports
- A laptop computer to run the software in which the videos will be studied.

Figure 1: The angles of the jump

The camera was placed on a fixed support, perpendicular to the direction of the jump.

The study is purely postural and takes into consideration the take-off, split into four positions, focusing on the variation of three angles during the jump:
Description of angles:

- The angle α marked in red - formed by the head - trunk - ankle;
- β angle marked in yellow - formed by the knee - ankle - skis;
- The angle γ marked in green - formed by the trunk - knee - ankle;

For each subject, a video material was recorded. In order to extract the above-mentioned angles, the video materials were analyzed using Kinovea. The angles were then compared with a set of reference angles, extracted from the top performers in the sport. We considered as significant any deviation larger than 5% (+-) and marked it with red in **Figure 2**.

3. RESULTS

Considering the above methods, the results can be synthesized in the image below:

	α1°	β1°	γ1°	α2°	β2°	γ2°	α3°	β3°	γ3°	α4°	β4°	γ4°
Subiect 1	2,7	-1,1	5,4	4,2	-6,1	-2,4	-2,5	4,6	-2,8	-3,8	6,4	-2,1
Subiect 2	6,3	12	15	6,7	1,9	4,4	7	-10	-1	3,7	-13	-2,1
Subiect 3	15	0,7	9,7	10	-9,3	1,3	5,6	4,6	-2,2	1,6	11	-0,4
Subiect 4	4,5	14	4,4	3,4	-1,2	-1,7	-0,2	3,3	4,3	1,6	3,2	-0,4
Subiect 5	-4,5	4,6	4,4	-5,5	-11	-14	-12	6	-5,3	-7,3	13	0,1
Subiect 6	-10	26	18	-8,8	6,7	5,2	-3,2	6	0,1	-1,1	11	3
Subiect 7	-2,7	12	18	0,9	3,5	9,1	-1,7	10	0,7	-3,1	16	-3,3
Subiect 8	-1,8	18	15	-3,1	3,5	4,4	-6,2	1,9	-1	-5,2	11	-3,3
Subiect 9	-6,3	8,5	1,2	-7,2	-1,2	-6,3	-6,9	1,9	-1,6	-3,8	-4,8	0,1
Subiect 10	7,2	2,7	18	8,3	-7,7	2,1	3,3	3,3	0,1	0,2	0	-3,3
Subiect 11	-6,3	16	0,2	-6,4	-1,2	-1,7	-9,8	3,3	-1,6	-3,1	-13	-2,7
Subiect 12	-12	2,7	6,5	-3,1	-7,7	-10	-3,2	1,9	0,7	0,9	-8	-2,1
Subiect 13	-0,9	14	11	-2,2	10	-6,3	-1,7	16	4,3	-3,8	6,4	1,8
Subiect 14	9	-5	8,6	5,9	-1,2	4,4	4,8	-7,7	0,1	3	-4,8	-1,6
Subiec 15	7,2	10	14	0,9	6,7	7,5	4,8	-2,2	3,7	5,1	0	3
Subiect 16	-0,9	0,7	-8,2	-1,4	-11	18	-0,2	0,5	1,9	0,9	-8	-3,9
Subiect 17	-2,7	10	2,3	-1,4	10	6,8	-3,9	12	5,5	0,2	0	1,8
Subiect 18	6,3	-5	-1,8	4,2	10	15	2,6	7,4	3,1	-3,1	3,2	-1
Subiect 19	6,3	6,5	-1,8	-2,2	12	1,3	-2,5	3,3	3,1	1,6	-16	0,1

Figure 2: Results table for the 19 subjects - the % deviations to the reference angles

On the rows we have the jumps for the 19 subjects and, on the columns, we have the deviations of the 3 α, β, and γ angles versus the reference angles, for the 4 positions.
By analyzing results like these, athletes and trainers can draw important conclusions about the jumps and fix eventual mistakes or even tendencies which are detrimental to the performances of the athletes.

3. CONCLUSION

In this paper, we wanted to check if satisfactory results can be obtained using a cheap motion analysis system for a sport like Sky Jumping.
The conclusions which we reached are presented below:
- a cheap system for Sky Jumping, like the one presented in this paper, can present a series of results regarding the performances of the athletes. These results are mainly postural, involving the geometry of the posture during the phases of the jump.
- for kinematic results, involving velocities, accelerations, etc., better equipment is needed, the trajectory of the motion was difficult to track using such a low frame rate
- the system is affordable for any sports club, as it involves commonly used devices and free software
- the information delivered by the analysis is useful for athletes and trainers

Many things were not considered in our analysis: the take-off velocity, which is important, the posture during the whole jump, which also affects performance, and, in the end, we did not correlate the results with the length of the jump. The system which we propose is by no means to be compared with a professional recording and analysis system for sports, but it is really inexpensive, portable, and adaptable to different stages of the jump (we can analyze the mid-air posture or the landing, etc. by repositioning the video camera).

REFERENCES

[1] Dželalija, M., Rausavljevicˇ, N., & Jošt, B. Relationship between jump length and the position angle in ski jumping. Kinesiologia Slovenica, 70-79, 2003

[2] Schmölzer, B., & Müller, W. Individual flight styles in ski jumping: results obtained during Olympic Games competitions. Journal of Biomechanics, 38, 1055–1065, 2005

[3] Virmavirta, M., Kivekäs, J., & Komi, P.V. Take-off aerodynamics in ski jumping. Journal of Biomechanics, 34, 465–470, 2001

[4] Yamamoto, K., Tsubokura, M., Ikeda, J., Onishi, K., Baleriola, S., 2016. Effect of posture on the aerodynamic characteristics during take-off in ski jumping. J. Biomech. 49, 3688–3696

[5] Jošt, B., Vaverka, F., Kugovnik, O., & Čoh, M. Differences in selected kinematics flight parameters of the most and the least successful ski jumpers of the 1996 World Cup competition in Innsbruck. Biology of Sport, 15(4), 245–251, 1998

[6] Zanevskyy, I., & Banakh, V. Dependence of ski jump length on the skier's body pose at the beginning of take-off. Acta of Bioengineering and Biomechanics, 12, 79–87, 2010

[7] www.eurosport.com