Extraction and Data Processing of Freestyle Skiing Based on Motion Biomechanics

Qi Zou, M.Sc
Qi Zou, Lecturer, Jilin Sport University, Changchun, Jilin, 130022, China
Correspondence Lec Zou; yeee1675300133@163.com

Objectives: Based on the principle of motion biomechanics, this paper studied the extraction and data processing of freestyle ski signals. Firstly, the algorithm of SLIC depth information and movement information was described in detail, and then the test and data collection methods were explained. Methods: Secondly, the algorithm was tested by this algorithm and traditional algorithm in the data set on the results of the comparison, the superiority of this algorithm was verified. Results: and starting from the characteristics of the underlying information of scene, consider in significant areas of the visual stimulus level. Conclusion: but at the same time the attention mechanism of human visual system was affected by the high-level features.

Key words: SLIC; Signal extraction; Information processing.
Tob Regul Sci.™ 2021;7(5-1): 2893-2901
DOI: doi.org/10.18001/TRS.7.5.1.57

Competition between various countries in the world has been increasing. Under the background of the development of computer technology, the information-based development of skiing competition has gradually become an important trend. The effectiveness of various types of data information contained in the skiing database must be effectively handled by data mining technology [1].Therefore, the application of data mining techniques in the tactical analysis of skiing competitions is of significance to the continuous and steady development of China's skiing industry [2]. Due to the continuous development of computer information technology, the continuous increase of data storage capacity makes it not only fast but also low in price when storing race data [3]. How to effective application of the numerous data, system comprehensive analysis, the main points of the game, when the team is of practical training can bring very effective basis for players and coaches [4]. Therefore, scientific application of data mining technology in skiing competitions has gradually become a key tool to improve competition level [5]. In this paper, the data of the competition data of the players are also used to make the data of the skiing movement, and the relevant rules contained in the data mining technologyare obtained.

Nowadays, most of the software-related are used for sports statistics, and the statistical principles and methods of sports statistics are applied [6]. The DVCoach system, designed by Australia, can be used to count the ball tactics, which plays a crucial role in the delicate Olympic Games in 2000. Italian Data research and design of the Project company to get related sports statistics and analysis software, in numerous national sports team and its application in the sports club, it can give the volleyball, skiing, tennis ball games of statistical analysis related to provide effective help and can bring the game to coaches on the objective level of tactical Data [7].The American coach took IBM's data mining tool, Advance Scout, to assist in the replacement of the players

and got a very good result. This part of the results has promoted the effective development of ball games information. Most ski tactical analysis software belongs to the typical American CyberSport company designed and developed to get BK, this software and volleyball technology information gathering and analysis methods exist difference, it did not put all kinds of ski tactical action coding, also did not take video binding technology to search for video files which focus on collecting all kinds of ski special technology, and then to comprehensive analysis the skiing games tactical execution problems. In this case, the ski technology also includes many types of intuitive technical data, such as cic, long-range investment, breakthrough, etc. It also covers technical data such as shooting point. The data collected from this system provide sufficient basis for the tactical analysis of ski racing. In addition, the software also selects the method of the tactics s acquisition, and gives a reference to the computer processing of forest field data collected by the competition. In combination with shooting point acquisition, it is necessary for the computer to expand the positioning and drawing of the shooting point and how to achieve the automatic processing of the computer belongs to the problem. Today, the software can only achieve semi-automatic processing.

METHODS

SLIC Depth Information and Movement Information Acquisition Algorithm

Firstly, the depth information of the scene can be calculated according to the parallax information, and then the depth information and the information of the light flow can further obtain the three-dimensional motion vector in the camera coordinate system. First is the depth of information access, in about two camera parallel to the optical axis, point P in the left and right as the plane for P1, P2, the x coordinate two XL, XR respectively, f is the focal length of the camera, B for both the baseline length of the camera, Z is the depth of the point P information, through the work can get the relationship between depth and parallax:

$$Z = \frac{B * f}{d} \tag{1}$$

The d is the parallax information (d =XL- XR), so that the baseline length between the two cameras and the focal length of the camera can get the depth information of the scene. Then the 3D motion vector is obtained from the camera coordinate system. The optical flow information represents the projection of the point motion in the 3D scene on the plane of the image. In the case of camera movement, the movement of the background is caused by the motion of the camera, which is consistent. But by Yu Guangliu just actual movement in the image plane, so the background in different regions in the direction of the optical flow vector and the size is different, this leads to the camera movement, using the optical flow is difficult to distinguish due to camera movement background region of campaign launched their own movement and objects in the scene, so can't significant targets extracted from the scene. Aiming at this problem, this paper combined with optical flow information and determine the depth information in the scene point under the camera coordinate system of 3 d motion characteristics of motion vector to represent the scene, the calculation method is as follows: 3 d scene point P on the front and rear frame as the plane respectively P1 (u1, v1), P2 (u2, v2). The camera frame of the previous frame image is O1, and the 3d coordinates of point P in this camera coordinate system are (x1, y1, z1). The light center of the next frame is moved to O2, the new camera coordinate system is the origin of O2, and the coordinates of P in the current coordinate system are changed to (x2, y2, z2). Is the inside of the camera projection matrix (type (2)), said the camera coordinates in the coordinates of the image coordinates transformation relations, the conversion relationship between the two coordinates such as type (3), type (4) :

$$P_{projection} = \begin{bmatrix} f & 0 & Cu & 0 \\ 0 & f & Cv & 0 \\ 0 & 0 & 1 & 0 \end{bmatrix} \tag{2}$$

$$\begin{bmatrix} u1 \\ v1 \\ 1 \end{bmatrix} = s1 * P_{projection} * \begin{bmatrix} x1 \\ y1 \\ z1 \\ 1 \end{bmatrix} \quad (3)$$

$$\begin{bmatrix} u2 \\ v2 \\ 1 \end{bmatrix} = s2 * P_{projection} * \begin{bmatrix} x2 \\ y2 \\ z2 \\ 1 \end{bmatrix} \quad (4)$$

Like plane points P1, P2 coordinates can be achieved by the optical flow information, combined with the depth of the front and rear frame information z1, z2, can determine the type (3), type (4) the two scale factor s1, s2, before and after the two type subtraction can get point P in two camera coordinates of 3 d motion vector:

$$3D\_Motion\_Vector(P) = \begin{bmatrix} x2 - x1 \\ y2 - y1 \\ z2 - z1 \end{bmatrix} = \begin{bmatrix} \frac{z2u2 - z1u1 - Cu(z2 - z1)}{f} \\ \frac{z2v1 - z1v1 - Cv(z2 - z1)}{f} \\ z2 - z1 \end{bmatrix} \quad (5)$$

Using three-dimensional motion vector's advantage lies in: the background points under camera coordinate system of motion is due to the rotation of the camera coordinate system or translation, so the point of three-dimensional motion vector is the same, and an actual motion in the scene point of three-dimensional motion vector is not only related to the camera coordinate system of geometric transformation, also related to its direction and size, so with the background of three-dimensional motion vector points there is obvious difference, the difference between the two can be used to effectively distinguish background region and future goals.

Then we derived the fusion of sports information super pixels segmentation algorithm, SLIC super pixel segmentation algorithm can well segment different objects, generated by the super pixels is compact and tidy, and the algorithm with high time efficiency. But the algorithm from the LAB color space to only consider the similarity measurement between pixel and outdoors under complex scene, if the target object and the background color had a low degree of differentiation, plus light shadow, the influence of such factors as the performance of segmentation algorithms are vulnerable to a larger impact, difficult to segment the well boundary of different objects. Similarly hereinafter a natural scene the direction and speed of the rigid motion target is consistent, so the motion characteristics can also be used as a one of the criteria of similarity degree between pixels, based on this point in this article, we will get handled in sports information into the segmentation algorithm, to improve the segmentation algorithm under complex scene.

The algorithm steps are similar to the SLIC segmentation algorithm, and the clustering seed points are first initialized in the form of grid. Then iterate in the seed point's neighborhood clustering, until convergence or reach the upper limit of the number of iterations, in this step in this paper, the clustering criterion, information fusion in the movement. SLIC algorithm clustering criterion, as shown in the type (6) is the pixels between the I and the seed point in LAB color space is the Euclidean distance, is the pixels between the I and the seed point in Euclidean distance, space position and is the distance between corresponding normalized factor, I is

a collection of all pixels in the image; The adjusted clustering criterion is shown in equation (7). The distance between the 3d motion vector between the pixel point I and the seed point is added, which is the corresponding distance normalization factor.

$$dist(i) = \sqrt{\frac{dist_c(i)}{N_c} + \frac{dist_s(i)}{N_s}}; i \in I \quad (6)$$

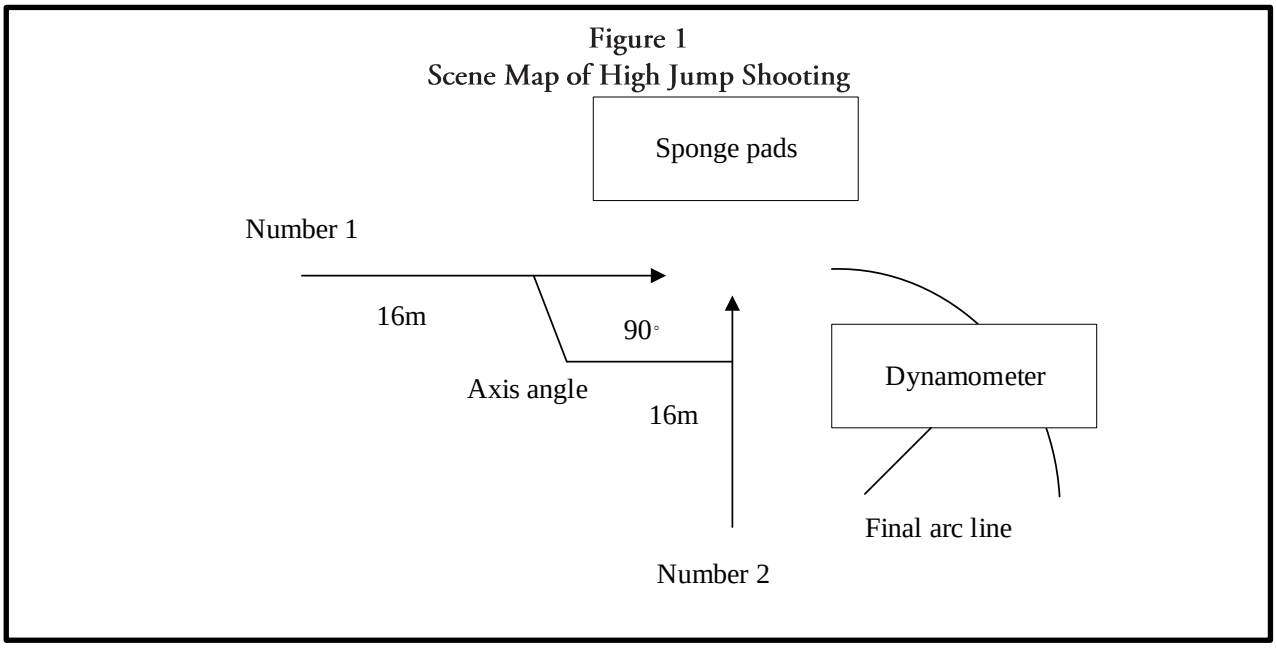
$$dist(i) = \sqrt{\frac{dist_c(i)}{N_c} + \frac{dist_s(i)}{N_s} + \frac{dist_m(i)}{N_m}}; i \in I \quad (7)$$

Iterative clustering process has been completed, the discontinuous pixel size and too small ultra-pixels is assigned to neighboring pixels, the resulting series of ultra-compact, uniform approximation pixels, the scene is divided into different areas. We concluded that SLIC algorithm and movement information with SLIC algorithm of segmentation results, through comparing (b) and (c) you can see the improved algorithm in the foreground and background colors similar to better the boundary of the object segmentation. In order to facilitate visual contrast, can look for the yellow border area, the original algorithm will vehicles and background segmentation to the same super pixels, and the improved algorithm can effectively be separated.

Test Methods and Data Collection

This experiment through the measurement of 3D force platform and high speed camera testing athletes get before takeoff swinging leg support phase, the kinematics and dynamics parameters of obtaining swinging leg support phase to the take-off phase of the image data from the ground. The instrument used in the experiment is the three dimensional measuring platform of KISTLER in Switzerland (figure 1).

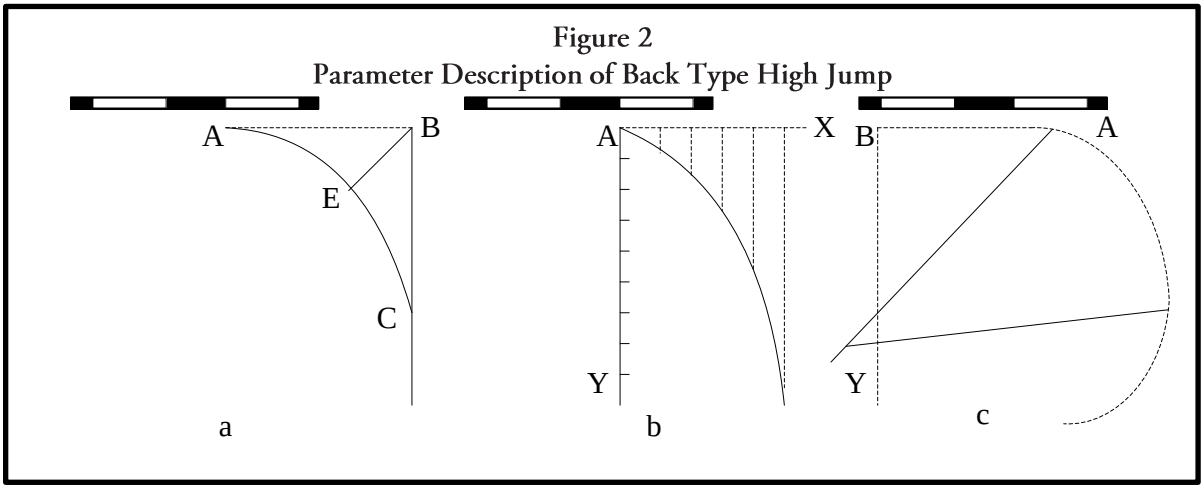
Figure 1
Scene Map of High Jump Shooting



Firstly, we will debug the aperture and focal length, so as to make the best effect of the shooting image, so as to analyze the analysis and reduce the error. Before the game, take a picture of the three-dimensional radio-three-dimensional framework of the radio-free 3d radiation that is placed in the center of the film, and then take another frame to prevent accidents from happening. We start the high-speed camera and

test bench before the athletes' race, collect the beginning and end stage of the surveillance video, the middle will not stop the machine, filming the required complete technology. In the actual measurement, we mainly tested the relevant data in figure 2.

Figure 2
Parameter Description of Back Type High Jump

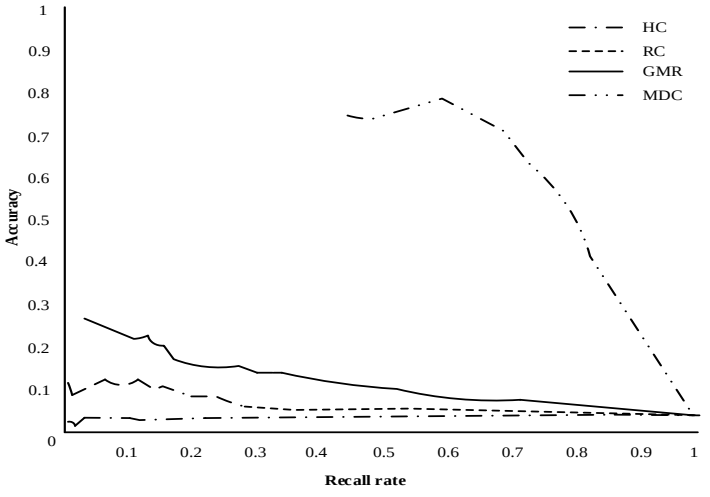


Use American Ariel biomechanics Analysis System of APAS (Ariel Performance Analysis System) to quantify the collected data processing, in the process of parsing, to adopt Japanese matsui, shows the human body inertia parameters of the model, and according to the definition of the human body model and the research need to select 19 key points, the second countdown step to takeoff leg swinging leg hit the parsing process the whole technology process, from the ground to parse the data through the low-pass digital filter method for smoothing, smoothing coefficient of 8. Using the BOIWAER software acquisition system to obtain the subject's f-t force value curve, the obtained raw data index was saved into the EXCEL software to obtain the first-hand materials about the research of the subject.

RESULTS

Based on the algorithm and data collected in this paper, we tested the algorithm. During the experiment, through to the participants indicate significant regional analysis, through the figure 3, 4, what time we have the following findings: one is the scenario consists of moving targets, the participants with the significance of regional basic were focused on the sports area, under the dynamic scene, movement is indeed a significant determinant; Second, in the absence of moving target, the conspicuous areas marked by the observer are more concentrated in the areas where the color or brightness contrast is strong. The third is a target that is very close to the observer and even in a static state can be marked as a significant area. These areas tend to be significant when pedestrians are present at the edge of the road or in the middle of the field. The discovery of the second point is verified in a static scene, the color characteristics is one of the significant factors decision, these findings are verified depth and motion information in the 3D dynamic scenarios to a large extent determines the significance, skiing signal extraction is associated with the high-level features of scenarios, that are not within this article discussion category.

Figure 3
Accuracy - Recall Curve (Horizontal and Vertical Coordinates as a Percentage)



Significance of these participants labeled according to the experiment data, select the significant region labeling is relatively consistent scene, using image processing software NI Visual Assistant for get the significance of each scenario Ground way data. Using the data set for this article obtained from the above algorithm (expressed in MDC below), at the same time and the previous studies of HC, RC, GMR, comparing the three algorithms of the three algorithms for static monocular scenarios of significant test can be obtained better effect. In order to carries on the quantitative evaluation of the performance of different algorithms, in this paper, the accuracy and recall rate under different scenarios, TPR, FPR to calculate and obtain the average, to map the different algorithm accuracy - recall rate curve and the ROC curve, at the same time, calculate the different algorithms F - measure value and AUC value to visually compare the overall performance of the algorithm. The results of various performance indicators are shown in figure 4.

Figure 4
ROC Curve (Horizontal and Vertical Coordinates As A Percentage)

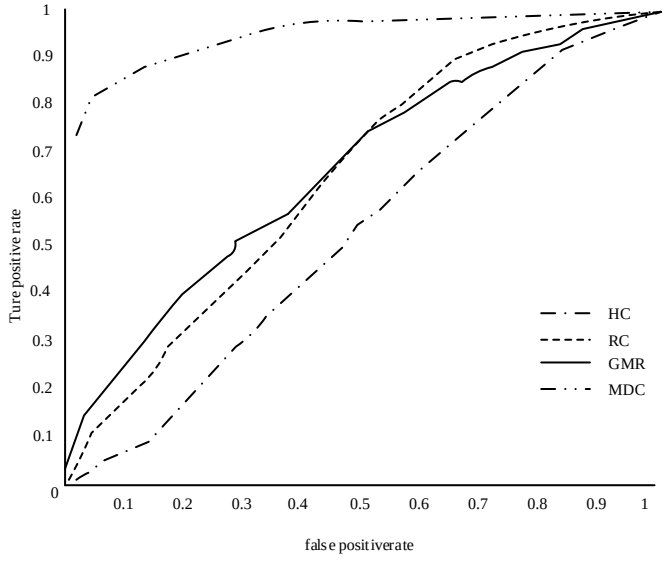
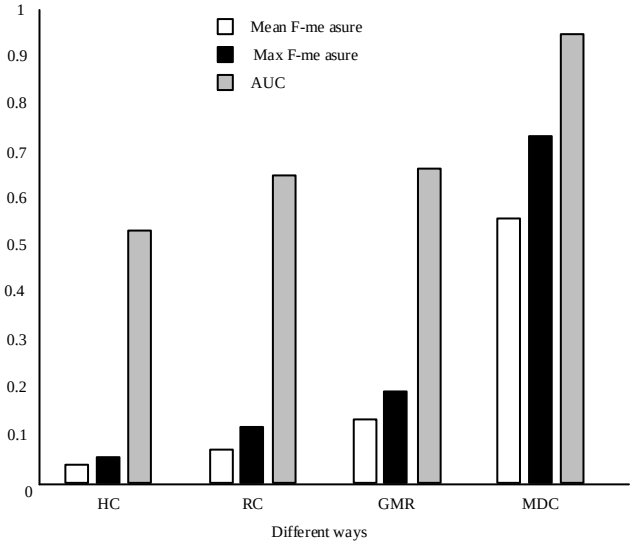


Figure 5
F-measure and AUC (Ordinate Without Unit)



The closer the recall curve is to the upper right corner (1, 1), the better the performance of the algorithm. The closer the ROC curve is to the upper left (0, 1), the better the performance of the algorithm; F-measure value is calculated according to equation (20). In this paper, beta 2= 0.3, the higher the F-measure value indicates that the algorithm performs better, and MeanF-measure is the average value of F-measure in all thresholds, and MaxF-measure is the maximum of all f-measure. AUC value is the area between the ROC curve and the horizontal axis, and the greater the AUC value indicates the better performance of the algorithm. It can be found from the evaluation indexes in fig.5 that the results of the three kinds of significant algorithms based on two-dimensional image characteristics

have obvious problems. The purpose of this experiment is to show that the traditional significance algorithm does not apply to the more complex real three-dimensional situations. These algorithms in static single purpose simple scenarios can achieve very good effect on significant test, but they only consider static image in the scene of the two-dimensional information on color, texture and therefore application scenario is very limited. The significance of human visual system is carried out in the real 3d scene, so it is obvious that the significance of the two-dimensional image plane is not in line with the visual attention mechanism of the human eye. Can be seen in the figure 7 visualization of results in this paper, the fusion of depth and movement information of significant algorithm groundtruth information closer to the data set, and the various evaluation index in the figure 8 is also verified in this paper, the algorithm is compared with other three kinds of algorithm has obvious advantages. In the real 3d scene, the information such as motion, depth and color is the important factor that determines the significance of visual significance. In view of the limitations of traditional visual saliency research, a 3D visual saliency algorithm integrating scene motion and depth information is proposed, which is suitable for salient object detection in 3D dynamic scenes, and is more suitable for human's visual attention mechanism. At the same time for the data set in the field of scarce problem, put forward the significance of 3D dynamic scenarios evaluation data sets, and by this algorithm and traditional algorithm in the data set on the results of the comparison, the superiority of this algorithm was verified. In this paper, starting from the characteristics of the underlying information of scene, consider in significant areas of the visual stimulus level, but at the same time the attention mechanism of human visual system is affected by the high-level features, such as the scene of the context semantic, observer observing scenes of purpose, etc. Research direction in this paper, the next step is to study the link between the high-level features and visual significance, and merge with the underlying characteristics of the model, get a calculation model is more close to the mecha nism of visual attention in human eyes.

DISCUSSION

In recent years, China's skiing has been greatly developed; the intensity of competition between various countries in the world is increasing and computer technology has gradually been used ski training and competition. In this paper, based on the principle of the sports biomechanics of freestyle skiing signal extraction and data processing were studied. Firstly the SLIC depth information and motion information acquisition algorithm was expounded, based on the parallax scene depth information, information can be calculated using the depth information and optical flow information can be further access to various points in the camera coordinate system of 3D motion vector; Secondly the test and data collection methods were expounded, through the measurement of 3-d force platform and high speed camera testing athletes get jump the kinematic and dynamic parameters of the swinging leg support phase before testing; Finally, the algorithm was tested based on the algorithm and data collected in this paper. The algorithm was superior to the traditional algorithm based on the data set. And starting from the low-level feature information of the scene, considering the visual stimulus saliency level, joined the attention mechanism of human visual system was also affected by the high-level features, such as semantic context, the scene to observe the purpose of viewing the scene.

Human Subjects Approval Statement

This paper did not include human subjects.

Conflict of Interest Disclosure Statement

None declared.

References

1. Dzimbova T, Kirkova M. Original Article Impact of training and competitions in alpine skiing on the anaerobic capacity of adolescent athletes. 2020.
2. Emilia G, Constatin F, Vlad G, Mircea O, & Cornelia P. Using emwave2 in biathlon skiing in order to increase sport performance. 2020.
3. Jing H E, Qiu S, Guang P, Q I, Jia Z Y, Qiu Z Y, & University, B. S. International discourse right of winter sports in china——taking the freestyle skiing project in

pyeongchang winter olympics as an example. *Journal of Beijing Sport University*.2019.

4. Losnegard T. Energy system contribution during competitive cross-country skiing. *European Journal of Applied Physiology*, 2019, 119(3).
5. Matej Supej H-C, & Holmberg. Recent kinematic and kinetic advances in olympic alpine skiing: pyeongchang and beyond. *Frontiers in Physiology*.2019.
6. Pawlyta M, Hermansa M, Szczsna A, et al. Deep Recurrent Neural Networks for Human Activity Recognition During Skiing. 2020.
7. Potolitsyna N, Nutrikhin A, Bojko E. Vitamin status in athletes of different sports before competitions. *Human Sport Medicine,* 2019, 19(3):20-27.