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DIAGNOSTIC AND CORRECTION METHODOLOGY OF SHOT PUT TECHNIQUE USING MODERN VIDEO ANALYSIS TECHNOLOGIES

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Annotatsiya: Ushbu maqolada zamonaviy videoanaliz texnologiyalarining yadro itqitish texnikasini baholash va takomillashtirishda qo'llanilishi masalalari o'rganilgan. Kompyuter ko'rishi va sun'iy intellekt asosidagi tahlil tizimlari orqali sportchilarning texnik xatolarini aniqlash va tuzatish metodikasi taqdim etiladi.

Kalit so'zlar: yadro itqitish, videoanaliz, biomexanika, sport texnikasi, kompyuter ko'rishi, texnik diagnostika, trenerlik metodikasi, harakat tahlili.

Аннотация: В статье рассматривается применение современных технологий видеоанализа для оценки и совершенствования техники толкания ядра. Представлена методология выявления и исправления технических ошибок спортсменов с использованием систем анализа на основе компьютерного зрения и искусственного интеллекта.

Ключевые слова: толкание ядра, видеоанализ, биомеханика, спортивное оборудование, компьютерное зрение, техническая диагностика, методика тренерской работы, анализ движений.

Abstract: This article examines the application of modern video analysis technologies in the assessment and improvement of shot put techniques. A methodology for identifying and correcting athletes' technical errors using analysis systems based on computer vision and artificial intelligence is presented.

Keywords: shot put, video analysis, biomechanics, sports equipment, computer vision, technical diagnostics, coaching methodology, movement analysis.

Introduction

In technical disciplines of athletics, achieving high performance largely depends on the biomechanical precision of movement execution. Shot put is a complex coordinative action that requires an optimal combination of strength, speed, and technical mastery [1]. In traditional coaching practice, technique evaluation is mainly based on coaches' visual observation and experience, which may lead to subjective errors. In modern sports science, video analysis technologies have become widely used tools for objectively assessing and improving athletes' technical skills [2]. With the advancement of computer vision and artificial intelligence algorithms, it is now possible to measure biomechanical parameters with millimeter and millisecond precision [3]. Through video analysis systems, each phase of an athlete's movement can be examined separately, speed and angle indicators can be measured, and the performance can be compared to optimal technical models.

Methodology and Literature Review

The research methodology is based on a systematic analysis of scientific literature, a comparative study of existing video analysis software, and the development of diagnostic criteria grounded in biomechanical theory. Knudson and Morrison extensively describe the application of biomechanical analysis in shot put, outlining execution phases according to the kinetic chain theory [1]. Bartlett and Bussey highlight the advantages of video analysis methods in assessing sports technique, emphasizing the potential of high-speed recording and three-dimensional analysis [4]. Among Uzbek researchers, Azizov and Rahimov explore issues in technical preparation within the national athletics school, concluding that modern technologies should be integrated with traditional coaching experience [5]. Russian sports scientists Popov and Suslov comparatively analyze the implementation of video analysis programs in training, evaluating the features of "Dartfish," "Kinovea," and "Coach's Eye" software [6].

Video analysis technologies allow precise measurement of biomechanical parameters, including the displacement of the body's center of mass, angular velocity of limb segments, maximum arm velocity, and release angle of the shot [7]. Modern software can divide the athlete's movement into phases and identify errors in each phase: preparatory phase, glide/rotation, final acceleration, and balance maintenance [8]. The most important criteria for diagnosing technical errors include deviation of the center of mass trajectory, incorrect sequencing of bodily segments, deviation of the release angle from optimal values, and inefficient transmission of force impulse [2]. Mahmutaliyev and Ismoilov stress the need to develop specifically adapted technical criteria for Uzbek athletes [9].

The corrective methodology based on video analysis involves three stages: first, the athlete's current technique is recorded and analyzed; second, identified errors are presented visually and numerically; third, a targeted system of corrective exercises is introduced followed by repeated video analysis [10]. Digital technologies provide athletes with real-time feedback, which accelerates the development of motor memory [3].

Results and Discussion

Based on literature analysis, the effectiveness of video analysis technologies in improving shot put technique has been validated. Modern software allows objective detection and quantitative evaluation of technical errors, enhancing the scientific foundation of coaching processes. Analysis of biomechanical parameters indicates the most frequently occurring technical errors: suboptimal upward trajectory of the center of mass, simultaneous instead of sequential activation of body segments, deviation of the release angle from the optimal 38–42 degrees, and insufficient knee extension during the final acceleration phase. Video analysis increased the precision of error detection by 67% compared to traditional visual assessment [4].

The developed diagnostic criteria are grounded in fundamental principles of sports biomechanics: kinetic chain principle, impulse transfer law, and projectile motion physics. Quantitative thresholds were established for each error type; for example, if the release angle deviates by more than 5 degrees from optimal values, this is considered a major error and may reduce throwing distance by 1–1.5 meters. Corrective methodology is individualized based on video analysis data and the specific characteristics of each athlete.

Individual exercise programs are recommended to eliminate identified errors. For example, if a violation of segment sequencing is observed, exercises are selected that reinforce isolated segment activation. The advantages of video analysis technologies include objectivity, reproducibility, visual feedback, comparative capability, and quantitative assessment of progress.

Athletes can review movements in slow motion and compare them to elite performers, which accelerates learning. However, certain limitations exist, such as the cost of high-quality equipment, the need for coaches' technological literacy, and the requirement to select appropriate software. In the context of Uzbekistan, implementation of these technologies requires specialized training for coaches and providing sports institutions with modern equipment [9].

Conclusion

The findings demonstrate that modern video analysis technologies provide an effective and scientifically grounded approach to diagnosing and correcting shot put technique. Through computer vision and biomechanical analysis programs, it is possible to objectively identify technical errors, quantify them, and develop individualized corrective methodologies. The literature review confirms the wide application and proven effectiveness of video analysis tools in international sports practice. The developed diagnostic criteria enable the evaluation of key biomechanical parameters in the main phases of shot put. The corrective methodology is based on video analysis data and adapted to the individual characteristics of each athlete. Practical recommendations include: equipping sports institutions with modern video analysis systems, providing specialized training for coaches in the use of such technologies, establishing video analysis laboratories within national sports research institutes, and creating a database of video-based technical assessments.

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