

COMMITTEE FOR THE ASSESSMENT OF DOCTORAL DISSERTATION PROPOSAL

TO THE TEACHING AND SCIENTIFIC COUNCIL OF THE UNIVERSITY OF BELGRADE - FACULTY OF SPORT AND PHYSICAL EDUCATION

Subject: Review and evaluation report of doctoral dissertation proposal of Jelena Aleksić, a doctoral program student.

Based on the decision that was made on the 11th teaching and scientific meeting which took place on May 8th, 2025, at the University of Belgrade - Faculty of Sport and Physical Education, in accordance with the 32nd article of the Doctoral academic studies Rulebook - revised version number 02-br. 532/22-4 from November 9th, 2022, and articles 41-43 of the University of Belgrade- Faculty of Sport and Physical Education Statute - revised version (02-br. 151/24-8 from December 19th, 2024), on the proposal of the Doctoral Academic Studies Council (02- br. 607/25-2 from April 29th, 2025) it was decided to form the committee for scientific background evaluation of the doctoral dissertation proposal written by Jelena Aleksić titled:

“FEASIBILITY OF AI-BASED MARKERLESS MOTION CAPTURE FOR ASSESSING MOVEMENT QUALITY (ПРИМЕНЉИВОСТ АУТОМАТСКЕ ДЕТЕКЦИЈЕ КРЕТАЊА ЗАСНОВАНЕ НА ВЕШТАЧКОЈ ИНТЕЛИГЕНЦИЈИ У ПРОЦЕНИ КВАЛИТЕТА ПОКРЕТА)“.

Committee was formed from the following members:

1. Dr. Olivera Knežević, assistant professor, University of Belgrade, Faculty of Sport and Physical Education, chair;
2. Dr. Aleksandar Nedeljković, full professor, University of Belgrade, Faculty of Sport and Physical Education, member;
3. Dr. Filip Bečanović, research associate, University of Belgrade, School of Electrical Engineering, member.

After evaluating the doctoral dissertation proposal of the candidate, Committee is handing in to the Teaching and Scientific board following

REPORT

BIOGRAPHY OF THE CANDIDATE

Jelena Aleksić was born on March 17, 1993, in Kraljevo, Serbia. She received Bachelor's and Master's degrees in Sports and Physical Education from the University of Belgrade, Faculty of Sport and Physical Education, and is pursuing a PhD degree at the same faculty. During her undergraduate studies, she also spent a semester studying pre-medicine at Midway University in Kentucky, USA.

Since 2023, Jelena is employed as Junior Researcher in the Methodological Research Laboratory (MIL) at Faculty of Sport and Physical Education, University of Belgrade. Her research focuses on biomechanics, rehabilitation, and the application of artificial intelligence in human motion analysis.

She has contributed to various interdisciplinary projects and institutional collaborations, including the Erasmus+ funded “RESUPERES: Intervention Proposal for Resilience Development in Higher Education” (2023-2025) and the “Strategies for the Prevention of Cognitive Disorders Progression” (2023-2027), in collaboration with the Center for Memory Disorders and Dementia, Faculty of Medicine, University of Belgrade.

Beyond her scientific work, Jelena holds ACROVINYASA™ yoga instructor certificate, TOEFL certificate in English and DELF B1 certificate in French. She also possesses advanced technical skills in various software tools, including Adobe Creative Suite, Procreate, FinalCut Pro, and web development platforms.

SCIENTIFIC PRODUCTION AND COMPETENCE OF THE CANDIDATE

Jelena Aleksić’s scientific and research activity to date includes the publication of 16 scientific papers in international journals and 9 papers presented at scientific conferences. A list of the most relevant publications is provided below:

- **Aleksić, J.**, Mesaroš, D., Kanevsky, D., Knežević, O. M., Cabarkapa, D., Faj, L., & Mirkov, D. M. (2024). Advancing Field-Based Vertical Jump Analysis: Markerless Pose Estimation vs. Force Plates. *Life*, 14(12), 1641.
- **Aleksić, J.**, Kanevsky, D., Mesaroš, D., Knezevic, O.M., Cabarkapa, D., Bozovic, B., Mirkov, D.M. (2024). Validation of Automated Countermovement Vertical Jump Analysis: Markerless Pose Estimation vs. 3D Marker-Based Motion Capture System. *Sensors*, 24(20), 6624.
- **Aleksić, J.**, Gkatzaveli, S., Tasić, L., Obrenović, M., Stojanović, N., & Ćuk, I. (2023). The concurrent validity of motion X-ray technology utilizing Polar Verity Sense to measure velocity, force, and power – Pilot study. *TEME*, 47(3), 717-733.
- Cabarkapa, D., Johnson, Q. R., **Aleksić, J.**, Cabarkapa, D. V., Philipp, N. M., Sekulic, M., Krsman, D., Trunic, N., & Fry, A. C. (2024). Comparison of vertical jump and sprint performances between 3 × 3 and 5 × 5 elite professional male basketball players. *Frontiers in Sports and Active Living*, 6.
- Cabarkapa, D. V., Cabarkapa, D., **Aleksić, J.**, & Fry, A. C. (2024). Does the short-term learning effect impact vertical jump performance assessment on a portable force plate system? *Frontiers in Sports and Active Living*, 6.

Proposal of Doctoral Dissertation Topic

Jelena Aleksić proposed the topic for her doctoral dissertation: “FEASIBILITY OF AI-BASED MARKERLESS MOTION CAPTURE FOR ASSESSING MOVEMENT QUALITY (ПРИМЕНЉИВОСТ АУТОМАТСКЕ ДЕТЕКЦИЈЕ КРЕТАЊА ЗАСНОВАНЕ НА ВЕШТАЧКОЈ ИНТЕЛИГЕНЦИЈИ У ПРОЦЕНИ КВАЛИТЕТА ПОКРЕТА)“.

In accordance with Article 31, Paragraph 2 of the Rulebook on Doctoral Academic Studies, a public presentation of the doctoral dissertation project proposal was held on May 23rd, 2024, in front of the members of the Council of Doctoral Academic Studies. Based on the presentation, the topic proposal and the research project for the doctoral dissertation were positively evaluated.

SCOPE AND AIM OF THE DISSERTATION

Movement quality is one of the fundamental indicators of motor efficiency, athletic performance, and injury risk, and as such, it plays a key role in sports diagnostics and rehabilitation (Bishop et al., 2018; Kotsifaki et al., 2022). Given that human movement is the result of a complex interaction between biomechanical, neurological, and physiological mechanisms, its adequate assessment cannot rely solely on outcome metrics such as jump height or running time (Xu et al., 2023). Instead, it is necessary to conduct a detailed biomechanical analysis of movement patterns and the variables that describe them in order to obtain a more comprehensive insight into movement quality (Walsh et al., 2012).

Traditionally, such analysis is conducted in laboratory settings using advanced systems such as three-dimensional (3D) optical systems and force plates, which are considered the "gold standard" in kinematic and kinetic movement analysis (Yang et al., 2024). However, the application of such equipment in field settings is greatly limited due to their high cost, limited portability, and the need for specialized personnel to operate the equipment and process the collected data (Das et al., 2023). Additionally, 3D optical systems require placing reflective markers on the participant's body, which can interfere with natural movement and affect the obtained results (Yang et al., 2024).

In recent years, thanks to rapid advancements in computer vision and artificial intelligence (AI), new opportunities have emerged for markerless motion analysis (Uhlrich et al., 2023). Although sophisticated systems such as Dari Motion and Theia 3D have already demonstrated their accuracy and applicability in laboratory settings (Wren et al., 2023), their use still requires significant financial and technical resources. At the same time, advances in mobile phone technology have enabled high-frequency video capture (120 and 240 frames per second), opening the door to more accessible applications of these tools in field settings (Pueo et al., 2020).

Among the available video analysis tools, Kinovea has become widely adopted due to its user-friendly interface and ability to perform semi-automated kinematic analysis (Nor Adnan et al., 2018; Puig-Diví et al., 2019). A limitation of this method lies in the need for manual marking of reference points and key movement phases in the video, which requires a certain amount of time and user effort (Caseiro-Filho et al., 2023). Nevertheless, this tool remains an accessible option for users who do not have access to more advanced markerless pose-estimation solutions. In contrast, AI-based solutions such as OpenPose, MMPose, and OpenCap enable fully automated identification of body segments and calculation of a significant number of relevant biomechanical variables (Yang et al., 2024; Svetek et al., 2025).

These tools represent a potentially revolutionary alternative to traditional laboratory systems, as they enable detailed analysis of movement quality in real-world, field conditions, at significantly lower cost and without complex technical infrastructure. However, an open question remains regarding the extent to which these tools are sufficiently reliable and valid across different sports and clinical contexts. To date, the majority of validation studies involving markerless solutions have been limited to basic metrics, such as jump height (Aderinola et al., 2023; Balsalobre-Fernández et al., 2014; Caseiro-Filho et al., 2023; Nor Adnan et al., 2018; Pueo et al., 2020), while kinematic variables that could provide a more comprehensive insight on movement quality remain largely unexplored. Moreover, the majority of studies have focused on simple, linear tasks such as walking or running (Ceriola et

al., 2023; D'Antonio et al., 2023; Hii et al., 2023; Mundt et al., 2023; Needham et al., 2021), whereas complex and explosive movements have been significantly less explored (Balsalobre-Fernández et al., 2014; Caseiro-Filho et al., 2023; Nor Adnan et al., 2018; Pueo et al., 2020).

Additionally, many studies have analyzed the movement of the center of mass, while often neglecting the motion of individual body segments, despite its potential to reveal specific movement inefficiencies (Nor Adnan et al., 2018; Pueo et al., 2020). Another notable limitation in the current literature is the absence of clearly defined and standardized protocols for conducting video-based movement assessments, leading to considerable variability in results. This issue is particularly pronounced with tools such as Kinovea, where the accuracy of measurements can be significantly influenced by user subjectivity and experience, the use of visual markers, and the quality of the recorded footage (Caseiro-Filho et al., 2023; Puig-Diví et al., 2019). These limitations underscore the need for systematic research into the reliability, validity, and practical applicability of such tools in real-world sports and clinical settings (Yang et al., 2024).

PROBLEM, SCOPE, AND AIM OF THE RESEARCH

The problem this research addresses is the challenge of making reliable, accurate kinematic assessments accessible in field-based sports and rehabilitation settings. Traditional laboratory-based methods are not always feasible for frequent use due to their high cost and operational complexity.

The objective of this research is placed on applicability of markerless pose estimation solutions using smartphone video recordings to assess movement quality. More specifically, this research will focus on testing the feasibility of two video analysis methods, specifically Kinovea and MMPose-based markerless solution, exploring whether they can serve as viable, practical alternatives to traditional motion analysis systems.

The primary **aims** of the research are:

1. To examine the consistency and agreement between video analysis methods (Kinovea and MMPose-based markerless solution) and gold-standard laboratory-based systems.
2. To investigate factors that might affect the accuracy of video-based assessments, such as the experience of the rater, the use of visual markers, the frame rate of the recordings, and the biomechanical models used in the analysis.

Based on the general research aims, three experimental phases are planned for a comprehensive evaluation of the reliability and validity of video analysis methods (Kinovea and MMPose-based markerless solution):

Phase 1. Testing the stability and accuracy of the biomechanical model during simple, controlled movement tasks – *Experiment 1*

Phase 2. Testing the stability and accuracy of the biomechanical model in detecting poses and tracking dynamic movements under controlled laboratory conditions – *Experiment 2*

Phase 3. Testing the stability and accuracy of the biomechanical model in detecting poses and tracking dynamic movements in field-based settings – *Experiment 3*

THE HYPOTHESES OF THE RESEARCH

Within each phase of the experiment, the following hypotheses will be examined:

H1: Video analysis methods (Kinovea and MMPose-based markerless solution) demonstrate strong consistency within and between repeated measurements of key kinematic variables.

H2: Video analysis measurements (Kinovea and MMPose-based markerless solution) are highly aligned with those obtained from gold-standard systems in laboratory and field settings, demonstrating their practical value for assessing movement quality.

H3: The accuracy of video analysis depends on specific factors such as the biomechanical model, rater's experience, use of markers for reference points, and recording conditions (frame rate, measurement setup, etc.).

METHODS

The research will include 30 male and female participants (Nage= 20-30 years) per each experimental phase, whose participation will be strictly voluntary. The inclusion criteria will require participants to: (1) have good overall health, with a fully preserved locomotor and nervous system, (2) be physically active (i.e., recreational athletes), and (3) be familiar with motoric tests that will be included in this research. Laboratory assessments for the first and second experimental phases will be conducted in the Methodological Research Laboratory (MIL) at the Faculty of Sport and Physical Education, University of Belgrade. The third experimental phase, involving field-based assessments, will take place in the faculty's sports hall.

The first experimental phase will comprise simple motor tasks, including: standing still, lateral arm raises, overhead arm raises, straight leg raises from a supine position, a dorsiflexion test in a lunge position (Wall Dorsiflexion test), and dorsiflexion/plantarflexion in a seated position. The second experimental phase will focus on a variety of vertical and horizontal jump tests, including: countermovement jump, squat jump, unilateral countermovement jump, and standing long jump. The third experimental phase will involve more complex, dynamic tasks such as a 10-meter sprint and the 5-0-5 change-of-direction test.

Each experimental phase will consist of two measurement sessions performed on separate days to evaluate the intra- and inter-session reliability of the video-based motion analysis tools (Kinovea and MMPose). To ensure consistency in environmental conditions, particularly video lighting, repeated measurements will be conducted at the same time of day for each participant, either during morning or early afternoon hours.

Additionally, a separate validation session will be conducted to compare the Kinovea and MMPose outputs against a laboratory-based "gold-standard" system. Each movement trial will be recorded simultaneously using both a smartphone camera and a laboratory system. Synchronization will be achieved via a wireless remote trigger to ensure that the recordings are taken at the same time.

All experimental procedures will be performed by an experienced researcher.

Detailed descriptions of the measurement procedures and variables that will be analyzed for each experimental phase are provided in the project proposal submitted by the doctoral candidate, Jelena Aleksić, ensuring methodological transparency and replicability.

To evaluate the research hypotheses, the following statistical analyses will be performed:

For H1 (intra- and inter-session reliability), both relative and absolute measures of reliability will be used, including intraclass correlation coefficients (ICC) with 95% confidence intervals (95% CI), standard error of measurement (SEM), and coefficient of variation (CV%).

For H2 (validity of measurements), Pearson's correlation coefficient (r), root mean square error (RMSE), and Bland–Altman analysis will be employed.

For H3 (influence of specific factors), a two-way repeated measures analysis of variance (RM ANOVA) and Cohen's d effect size will be used. Additionally, linear regression analysis will be conducted to correct any observed discrepancies using regression-based adjustments.

Statistical significance will be set at $p < 0.05$ for all analyses.

Expected Outcomes and Scientific Contribution

This research is expected to make a significant theoretical and practical contribution to the field of sports biomechanics and diagnostics, particularly through the development and validation of accessible and user-friendly tools for assessing movement quality outside of laboratory settings. From a theoretical standpoint, the research will enrich the existing scientific literature by examining the reliability and validity of markerless pose-estimation methods. By establishing a clear and replicable methodological framework and applying regression models to correct results obtained through video analysis, the study will enhance the accuracy and practical applicability of video-based methods for evaluating movement quality.

Beyond its scientific contribution, the results of this research will have substantial practical value, enabling professionals in sports and rehabilitation to conduct biomechanical analyses in field-based settings without the need for expensive and less accessible laboratory equipment. Through the validation of a simpler tool such as Kinovea and a more technologically advanced solution like MMPose, the study will support broader implementation of these tools in alignment with the varying needs of practitioners. Additionally, their use will significantly improve timely and informed decision-making within training and rehabilitation processes. A particular strength lies in the potential for early detection of asymmetries and compensatory movement patterns, which may signal an increased risk of injury.

Furthermore, the findings of this study will facilitate the wider application of biomechanical diagnostics across diverse populations, ranging from young athletes and recreational individuals to patients in clinical settings. In doing so, this research will promote better integration of scientific knowledge into everyday practice and support the development of tailored interventions grounded in relevant, evidence-based information.

PROPOSED LITERATURE

The candidate has listed a total of 66 bibliographic entries. The proposed literature is up-to-date, with the majority of the sources representing primary scientific references. A selection of the bibliography is presented below:

1. Aderinola, T. B., Younesian, H., Whelan, D., Caulfield, B., & Ifrim, G. (2023). Quantifying jump height using markerless motion capture with a single smartphone. *arXiv*. <https://arxiv.org/abs/2302.10749>
2. Balsalobre-Fernández, C., Tejero-González, C. M., del Campo-Vecino, J., & Bavaresco, N. (2014). The concurrent validity and reliability of a low-cost, high-speed camera-based method for measuring the flight time of vertical jumps. *Journal of Strength and Conditioning Research*, 28(2), 528–533. <https://doi.org/10.1519/JSC.0b013e318299a52d>
3. Bishop, C., Read, P., McCubbine, J., & Turner, A. (2018). Vertical and horizontal asymmetries are related to slower sprinting and jump performance in elite youth female soccer players. *Journal of Strength and Conditioning Research*.
4. Caseiro-Filho, L. C., Girasol, C. E., Rinaldi, M. L., Lemos, T. W., & Guirro, R. J. (2023). Analysis of the accuracy and reliability of vertical jump evaluation using a low-cost acquisition system. *BMC Sports Science, Medicine and Rehabilitation*, 15(1), 43. <https://doi.org/10.1186/s13102-023-00734-w>
5. Ceriola, L., Miletì, I., Donati, M., & Patanè, F. (2023). Comparison of video-based algorithms for 2D human kinematics estimation: A preliminary study. *Journal of Physics: Conference Series*, 2590, 012002.
6. D'Antonio, E., Taborri, J., Miletì, I., Rossi, S., & Patane, F. (2021). Validation of a 3D markerless system for gait analysis based on OpenPose and two RGB webcams. *IEEE Sensors Journal*, 21(15), 17064-17075.
7. Das, K., de Paula Oliveira, T., & Newell, J. (2023). Comparison of markerless and marker-based motion capture systems using 95% functional limits of agreement in a linear mixed-effects modelling framework. *Scientific Reports*, 13(1), 22880. <https://doi.org/10.1038/s41598-023-49360-2>
8. Hii, C. S. T., Gan, K. B., Zainal, N., Mohamed Ibrahim, N., Azmin, S., Mat Desa, S. H., van de Warrenburg, B., & You, H. W. (2023). *Automated gait analysis based on a marker-free pose estimation model*. *Sensors*, 23(14), 6489.
9. Kotsifaki, A., Van Rossom, S., Whiteley, R., Korakakis, V., Bahr, R., Sideris, V., & Jonkers, I. (2022). Single leg vertical jump performance identifies knee function deficits at return to sport after ACL reconstruction in male athletes. *British Journal of Sports Medicine*, 56(9), 490–498. <https://doi.org/10.1136/bjsports-2020-103596>
10. Mundt, M., Born, Z., Goldacre, M., & Alderson, J. (2023). Estimating ground reaction forces from two-dimensional pose data: A biomechanics-based comparison of AlphaPose, BlazePose, and OpenPose. *Sensors*, 23(1), 78.
11. Needham, L., Evans, M., Cosker, D. P., Wade, L., McGuigan, P. M., Bilzon, J. L., & Colyer, S. L. (2021). The accuracy of several pose estimation methods for 3D joint centre localisation. *Scientific Reports*, 11, 20673.
12. Nor Adnan, N. M., Ab Patar, M. N. A., Lee, H., Yamamoto, S. I., Jong-Young, L., & Mahmud, J. (2018). Biomechanical analysis using Kinovea for sports application. *IOP Conference Series: Materials Science and Engineering*, 342(1), 012097. <https://doi.org/10.1088/1757-899X/342/1/012097>
13. Pueo, B., Penichet-Tomas, A., & Jimenez-Olmedo, J. M. (2020). Validity, reliability and usefulness of smartphone and kinovea motion analysis software for direct measurement of vertical jump height. *Physiology & behavior*, 227, 113144. <https://doi.org/10.1016/j.physbeh.2020.113144>

14. Puig-Diví, A., Escalona-Marfil, C., Padullés, J., Busquets Faciabén, A., Padullés, X., & Marcos-Ruiz, D. (2019). Validity and reliability of the Kinovea program in obtaining angles and distances using coordinates in 4 perspectives. *PLOS ONE*, 14(5), e0216448. <https://doi.org/10.1371/journal.pone.0216448>
15. Svetek, A., Morgan, K., Burland, J., & Glaviano, N. R. (2025). Validation of OpenCap on lower extremity kinematics during functional tasks. *Journal of Biomechanics*, 183, 112602. <https://doi.org/10.1016/j.jbiomech.2025.112602>
16. Uhlich, S. D., Falisse, A., Kidziński, Ł., Muccini, J., Ko, M., Chaudhari, A. S., ... & Delp, S. L. (2023). OpenCap: Human movement dynamics from smartphone videos. *PLOS Computational Biology*, 19(10), e1011462. <https://doi.org/10.1371/journal.pcbi.1011462>
17. Walsh, M., Boling, M. C., McGrath, M., Blackburn, J. T., & Padua, D. A. (2012). Lower extremity muscle activation and knee flexion during a jump-landing task. *Journal of Athletic Training*, 47(4), 406–413.
18. Wren, T. A. L., Isakov, P., & Rethlefsen, S. A. (2023). Comparison of kinematics between Theia markerless and conventional marker-based gait analysis in clinical patients. *Gait & Posture*, 104, 9–14. <https://doi.org/10.1016/j.gaitpost.2023.05.029>
19. Xu, J., Turner, A., Comyns, T. M., Harry, J. R., Chavda, S., & Bishop, C. (2023). Countermovement rebound jump: A comparison of joint work and joint contribution to the countermovement and drop jump tests. *Applied Sciences*, 13(19), 10680. <https://doi.org/10.3390/app131910680>
20. Yang, H. S. (2024). Advances in markerless motion capture systems: A review of OpenCap and its applications. *Asian Journal of Kinesiology*, 26(4), 42–47. <https://doi.org/10.15758/ajk.2024.26.4.42>

Conclusion

The project proposal submitted by the candidate Jelena Aleksić has been prepared based on current and relevant scientific literature, which has enabled a clear definition of the research problem. The proposed dissertation topic represents an innovative and scientifically grounded approach within the domain of sports biomechanics and diagnostics, with substantial potential for practical application. The aims and hypotheses are clearly and thoroughly formulated, in accordance with the subject matter of the research, while the proposed methodology is carefully designed and appropriately elaborated.

The planned study encompasses three experimental phases to be conducted in both laboratory and field conditions, allowing for a comprehensive assessment of the reliability and validity of two video-based markerless motion analysis methods: a simpler, semi-automated solution (Kinovea), and a more advanced, fully automated artificial intelligence-based solution (MMPose). A particular strength of this research lies in its focus on evaluating the practical applicability of these tools in real-world settings, offering wide accessibility and low implementation costs in comparison to standard laboratory systems.

The proposed research demonstrates a high degree of scientific rigor and practical relevance, as it offers possibilities for improving tools used to assess movement quality in both sports and clinical settings. Furthermore, the study contributes significantly to the integration of modern technological solutions into sports science and paves the way for the development of future multidisciplinary approaches in this field.

We suggest that the Teaching and Scientific Council of the Faculty accept the Committee's Report and approve the proposed decision to accept the topic of the doctoral dissertation with the title "FEASIBILITY OF AI-BASED MARKERLESS MOTION CAPTURE FOR ASSESSING MOVEMENT QUALITY (ПРИМЕНЉИВОСТ АУТОМАТСКЕ ДЕТЕКЦИЈЕ КРЕТАЊА ЗАСНОВАНЕ НА ВЕШТАЧКОЈ ИНТЕЛИГЕНЦИЈИ У ПРОЦЕНИ КВАЛИТЕТА ПОКРЕТА)" and in accordance with positive legal regulations, refer to the Council of Social and Human Sciences for consideration.

Proposal of the mentors, the mentors's consents and a list of their publications

Given the nature of the research problem addressed in the doctoral dissertation proposal and the ongoing collaboration during the preparatory phase of the project, we propose that dr Dragan Mirkov, full professor at the University of Belgrade, Faculty of Sport and Physical Education, be appointed as the supervisor for the doctoral dissertation.

Dr Dragan Mirkov, full professor, meets the requirements stipulated by the Standards for Accreditation of Doctoral Study Programs and has expressed his consent to serve as the dissertation supervisor for Jelena Aleksić on the proposed topic.

Attached is a list of selected publications authored by dr Dragan Mirkov, full professor, in international scientific journals over the past five years. These works fall within the scientific field of Physical Education and Sport and are directly relevant to the proposed dissertation topic. Specifically, his research addresses the validation and application of modern technologies for assessing sports performance, biomechanical analysis of movement, and the evaluation of metric properties of both laboratory and field-based testing protocols:

1. Aleksić, J., Mesaroš, D., Kanevsky, D., Knežević, O. M., Cabarkapa, D., Faj, L., & **Mirkov, D. M.** (2024). Advancing Field-Based Vertical Jump Analysis: Markerless Pose Estimation vs. Force Plates. *Life*, 14(12), 1641. <https://doi.org/10.3390/life14121641>
2. Aleksić, J., Kanevsky, D., Mesaroš, D., Knezevic, O.M., Cabarkapa, D., Bozovic, B., **Mirkov, D.M.** (2024). Validation of Automated Countermovement Vertical Jump Analysis: Markerless

Pose Estimation vs. 3D Marker-Based Motion Capture System. *Sensors*. 24(20), 6624. <https://doi.org/10.3390/s24206624>

3. Anicic, Z., Janicijevic, D., Knezevic, O. M., Garcia-Ramos, A., Petrovic, M. R., Cabarkapa, D., & **Mirkov, D. M.** (2023). Assessment of Countermovement Jump: What Should We Report?. *Life (Basel, Switzerland)*, 13(1), 190. Milic, M.,
4. Mirković, S. V., Đurić, S., Sember, V., Knezevic, O. M., Pajek, M., Mirković, M. M., & **Mirkov, D. M.** (2022). Evaluation of the Limb Symmetry Index: The Side Hop Test. *Frontiers in Physiology*, 13, 874632.
5. Živković, A., Marković, S., Cuk, I., Knežević, O. M., & **Mirkov, D. M.** (2025). Reliability and Validity of Key Performance Metrics of Modified 505 Test. *Life*, 15(2), 198. <https://doi.org/10.3390/life15020198>

In Belgrade, 06.06.2025.

Commitee members:

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Dr. Aleksandar Nedeljković, full professor
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University of Belgrade, School of Electrical Engineering, member