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IT4010 – Research Project - 2024

Topic Assessment Form

Project ID: 24-25J-275

1. Topic (12 words max)

Biomechanical Analysis for Weight Lifting Performance Enhancement

2. Research group the project belongs to

Machine Learning and Soft Computing (MLSC)

3. Research area the project belongs to

Machine Learning (ML)

4. If a continuation of a previous project:

Project ID	
Year	

5. Brief description of the research problem including references (200 – 500 words max) – references not included in word count.

Weightlifting requires precise and efficient movement patterns to maximize performance and minimize the risk of injury. Traditional biomechanical analysis in weightlifting typically involves sophisticated and costly equipment, such as motion capture systems and force plates, which are not accessible to all athletes and coaches. This limits the ability of many athletes to receive detailed and accurate feedback on their lifting techniques, potentially hindering their performance and increasing their risk of injury.

The emergence of computer vision and machine learning technologies offers a promising alternative. These technologies enable detailed biomechanical analysis through video footage, making it more accessible and affordable. However, current solutions in the market lack the specificity needed for weightlifting techniques, such as the snatch and clean and jerk. Most existing tools are generalized and do not cater to the unique demands and biomechanics of these complex lifts.

Furthermore, there is a significant gap in tools that provide real-time feedback and recommendations directly via mobile devices. Real-time feedback is crucial for athletes and coaches to make immediate adjustments and improvements during training sessions. The lack of such tools means that athletes often have to rely on delayed feedback, which can be less effective.

This project aims to address these gaps by developing an AI-powered mobile application specifically for weightlifters. The app will utilize advanced computer vision and machine learning techniques to deliver accurate biomechanical assessments of weightlifting movements. By detecting and tracking key body points, calculating joint angles, and evaluating lifting techniques, the AI model will provide insights into movement efficiency, symmetry, and potential areas of improvement.

In addition to biomechanical analysis, the app will offer real-time feedback and personalized training advice. This will enable athletes to make immediate adjustments to their techniques, improving performance and reducing the risk of injury. The app will also include personalized meal planning and nutrition tracking based on performance data, ensuring that athletes receive tailored nutritional advice to support their training and recovery.

Moreover, the app will feature an injury prediction and prevention module. By analyzing biomechanical data and contextual factors such as training intensity and history, the AI model will predict injury risks and suggest preventative measures. This holistic approach will not only enhance performance but also support overall health and injury prevention for weightlifters.

In summary, this project aims to create a comprehensive tool that leverages AI to provide detailed biomechanical analysis, real-time feedback, personalized training and nutrition advice, and injury prevention strategies specifically for weightlifters. This innovative approach addresses the existing research gaps and offers significant potential for enhancing weightlifting performance and safety.

References:

- This project introduces a novel method to measure the quality of the actions performed in Olympic weightlifting using human action recognition in videos (University of Peradeniya, Sri Lanka, n.d.)
- In strength training, the performance of the athletes varies according to different objectives of the training. (Zahari Taha, 2016)
- This dataset is the aggregation of time-varying performance records of powerlifting competition contestants and their characteristics, enabling the analysis of performance in powerlifting by different groups and times. With "robustness" added in the analysis by dropping records from years with small numbers of observations, the resulting time horizon is from 1988 to 2019. (NYC Data Science Academy, n.d.)
- Bodybuilding is an appearance-oriented sport that involves performing a series of poses on stage where judges rank each competitor on muscular mass, symmetry and definition. (BOND University, n.d.)

6. Brief description of the nature of the solution including a conceptual diagram (250 words max)

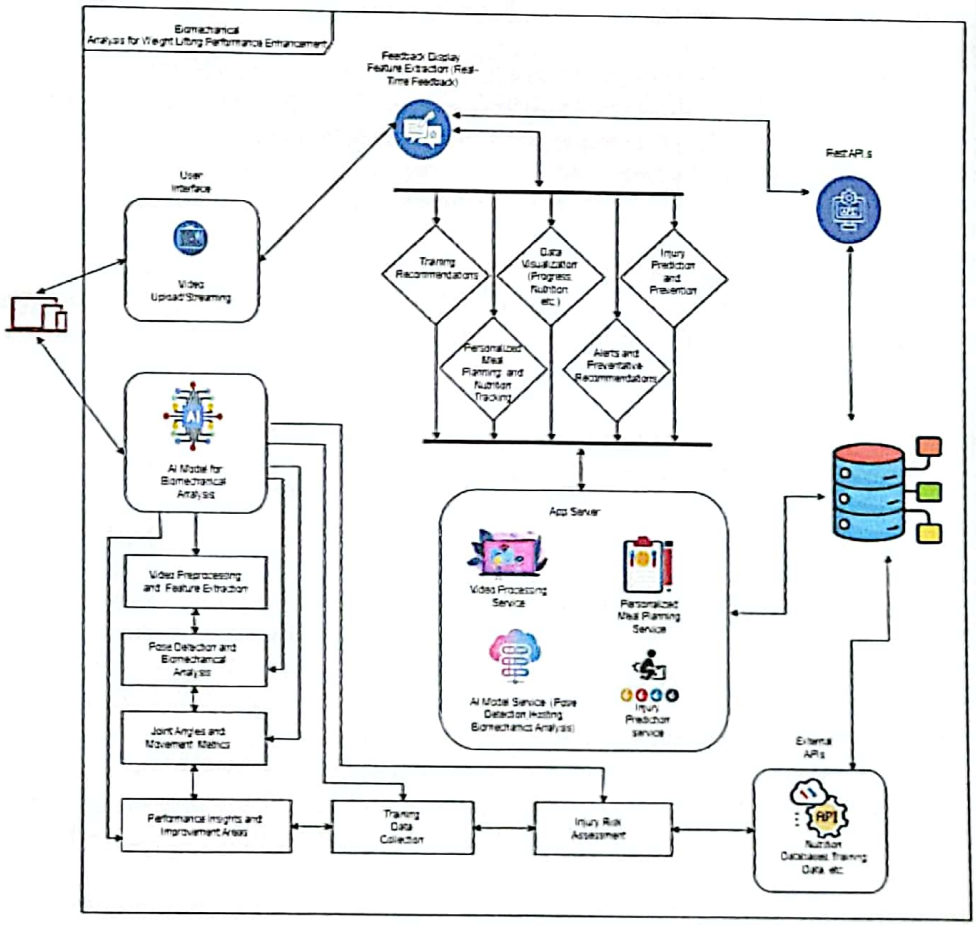
The solution involves developing a mobile application that leverages advanced computer vision and machine learning techniques to analyze video footage of weightlifting exercises. The app will feature several integrated modules:

Biomechanical Assessment Module: Utilizes AI to detect and track key body points, calculate joint angles, and evaluate lifting techniques, movement efficiency, and symmetry specific to weightlifting exercises like the snatch and clean and jerk.

Real-Time Feedback and Training Recommendations: Provides instant feedback on lifting techniques and suggests corrective measures to improve performance.

Personalized Meal Planning and Nutrition Tracking: Creates customized nutrition plans based on performance data, activity levels, and specific nutritional needs and goals.

Injury Prediction and Prevention: Employs a machine learning model to predict injury risks using biomechanical data and contextual factors such as training intensity and history.



7. Brief description of specialized domain expertise, knowledge, and data requirements (300 words max)

The project requires expertise in several specialized domains to develop a comprehensive AI-powered mobile application for biomechanical analysis and performance enhancement in weightlifting.

First, expertise in computer vision and machine learning is essential. Developing AI models that accurately detect and analyze body movements requires proficiency with frameworks. These tools enable the creation of models capable of tracking key body points, calculating joint angles, and providing detailed biomechanical assessments tailored to weightlifting techniques like the snatch and clean and jerk.

Second, knowledge in the biomechanics of weightlifting is crucial. Understanding specific movement patterns, joint mechanics, and forces involved in weightlifting exercises allows for accurate analysis and meaningful feedback. This ensures that the AI model not only identifies movements but also interprets them in the context of weightlifting performance, focusing on efficiency, symmetry, and technique improvement.

Third, mobile application development skills are necessary to create a user-friendly platform accessible to athletes and coaches. Utilizing frameworks like React Native or Flutter, the project aims to develop an intuitive and responsive mobile app that seamlessly integrates the AI models, providing real-time feedback, training recommendations, and other features directly to users.

Fourth, expertise in sports nutrition is vital for the personalized meal planning and nutrition tracking module. The ability to develop and manage customized meal plans based on athletes' performance data and dietary needs ensures that the nutritional advice supports their training and recovery goals.

Finally, data science and analytics skills are required to handle large datasets, perform statistical analysis, and validate the AI models to ensure their accuracy and reliability.

The project also necessitates specific data:

- High-quality video footage of weightlifters performing various lifts to train and validate the AI models.
- Detailed biomechanical data, including annotations of body movements and joint angles specific to weightlifting techniques.
- Nutritional data providing insights into weightlifters' dietary habits, performance data, and nutritional needs to develop personalized meal plans.
- Historical injury data, including contextual factors like training intensity and frequency, to train the injury prediction model

8. Objectives and Novelty

Main Objective Develop an AI-powered mobile application for biomechanical analysis, real-time feedback, personalized meal planning, and injury prevention tailored for weightlifters.			
Member Name	**Sub Objective**	**Tasks**	**Novelty**
Wimalarathna S.D.A.N.	Biomechanical Assessment	Develop AI model for pose detection and biomechanical analysis specific to weightlifting.	High accuracy weightlifting-specific analysis on mobile devices
Gunawardena K.S.S	Real-Time Feedback and Training Recommendations	Integrate AI model into a mobile app, provide real-time feedback and training tips for weightlifting.	Instant feedback and tailored advice via mobile app
Ranaweera I.U.	Advanced personalized Meal Planning and Nutrition Tracking	Develop ML model for meal planning, considering performance data, weight goals, injuries, age and budget, with continuous monitoring and adjustments for optimal results.	Considered data adjusts dietary recommendations dynamically. Allow athletes to set and update their goals, which will adjust the recommendations accordingly.
Ranatunga B.M.	Injury Prediction and Prevention	Develop ML model for injury prediction using biomechanical and contextual data specific to weightlifting.	Video-derived data for injury prediction in mobile app

9. Supervisor checklist

a) Does the chosen research topic possess a comprehensive scope suitable for a final-year project?

Yes	✓	No	

b) Does the proposed topic exhibit novelty?

Yes	✓	No	

c) Do you believe they have the capability to successfully execute the proposed project?

Yes	✓	No	

d) Do the proposed sub-objectives reflect the students' areas of specialization?

Yes	✓	No	

e) Supervisor's Evaluation and Recommendation for the Research topic:

10. Supervisor details

	Title	First Name	Last Name	Signature
Supervisor	Ms.	Gaya	Dassanayake	
Co-Supervisor	Ms.	Poojani	Gunathilake	M. P. Gunathilake
External Supervisor				
Summary of external supervisor's (if any) experience and expertise				

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Topic Assessment Form

This part is to be filled by the Topic Screening Panel members.

Acceptable: Mark/Select as necessary

Topic Assessment Accepted	
Topic Assessment Accepted with minor changes (should be followed up by the supervisor) *	
Topic Assessment to be Resubmitted with major changes*	
Topic Assessment Rejected. Topic must be changed	

* Detailed comments given below

Comments

The Review Panel Details

Member's Name	Signature

*Important:

1. According to the comments given by the panel, make the necessary modifications and get the approval by the **Supervisor** or the **Same Panel.**
2. If the project topic is rejected, identify a new topic, and follow the same procedure until the topic is approved by the assessment panel.