Computer Vision Based Sports Performance

Analytics System

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*Abstract*— Sports performance analytics have become an important area of research in recent years. With the advent of computer vision technology, it is now possible to track and analyze the movements of athletes in real-time. This paper explores the use of computer vision-based sports performance analytics systems and their effectiveness in improving athletic performance. We conducted a literature review, developed a methodology for data collection and analysis, and drew conclusions based on our findings. Our results suggest that computer vision-based sports performance analytics systems are effective in providing athletes and coaches with real-time feedback and insights into their performance. We also recommend further research in this area to explore the potential of this technology for enhancing athletic performance.

*Keywords*—Computer Vision, Visual Analytics, Data Analytics, Sports Analytics.

# **Introduction**

Over the last years, the interest in analysis of team sport data has grown rapidly in research and practice. Among many team sport disciplines, cricket is one of the most widely practiced and also, commercially relevant kinds of team sports. The analysis of cricket match data has received much attention in the recent years by fields including sports and behavioural science, biomedicine, and others. Computer science-based solutions help to capture cricket data, process and analyze it. Recently, several works introduced visual analysis techniques for cricket data. Cricket is a match of two opposing teams that engage in competitive and cooperative movement patterns among and between teams in space and time. Among the key goals of soccer analysis is to support understanding of patterns in this movement space on the player and team level.

Also, the analysis of derived performance measures for players and teams, including predictive analysis, is of high relevance in this domain. In practice, two analysis modalities often occur. First, analysis can be done based on captured movement data, applying techniques from movement analysis. These often are used in combination with abstract movement visualization techniques. Second, in interactive video analysis, video recordings of matches are interactively inspected and annotated by experts, yielding reports and video presentations to coach players and inform coaches. Video analysts are typically used to work with video recordings and not with abstract data representations. Sports performance analytics have become increasingly popular in recent years, with teams and athletes using data to gain a competitive advantage. Traditional methods of performance analysis include video analysis and manual tracking of athletes, which can be time-consuming and subjective. However, with the advent of computer vision technology, it is now possible to track and analyze the movements of athletes in real-time. Computer vision-based sports performance analytics systems use cameras and machine learning algorithms to track and analyze athletic performance. This paper explores the effectiveness of these systems in improving athletic performance.

# **Literature Review**

Computer vision has become an essential tool in sports analytics, enabling coaches, analysts, and athletes to extract valuable insights from raw data. In recent years, computer vision techniques have been applied to sports performance analysis, providing coaches and athletes with real-time feedback and objective performance metrics. Player stats have been a crucial component of sports analysis for a long time. With the advent of computer vision, new methods have been developed to extract and analyze player data. For example, in a study by Li et al. (2021), they used convolutional neural networks (CNNs) to extract features from players' images and predict their playing positions. Similarly, several researchers have used computer vision techniques to analyze players' movements and predict their injury risks (Choi et al., 2021; Kyritsis et al., 2020). Team analysis is another crucial aspect of sports performance analysis. Researchers have used computer vision techniques to analyze team performance by tracking the movements of individual players and ball trajectories. In a study by Tao et al. (2020), they used a deep learning model to predict the outcome of cricket matches. Similarly, Chen et al. (2020) used a combination of computer vision techniques and machine learning algorithms to analyze basketball team performance. Video analytics is a relatively new field of sports performance analysis that uses computer vision techniques to extract valuable insights from video footage. In a study by Makihara et al. (2020), they used machine learning algorithms to analyze video footage of basketball games and predict shot outcomes. Similarly, several researchers have used computer vision techniques to track athletes' movements and predict their performance (Ma et al., 2020; Saad et al., 2021). Overall, computer vision-based sports performance analysis has the potential to revolutionize the way we analyze and understand sports. By using computer vision techniques, coaches, analysts, and athletes can extract valuable insights from raw data and make data-driven decisions to improve their performance.

# **Methodology**

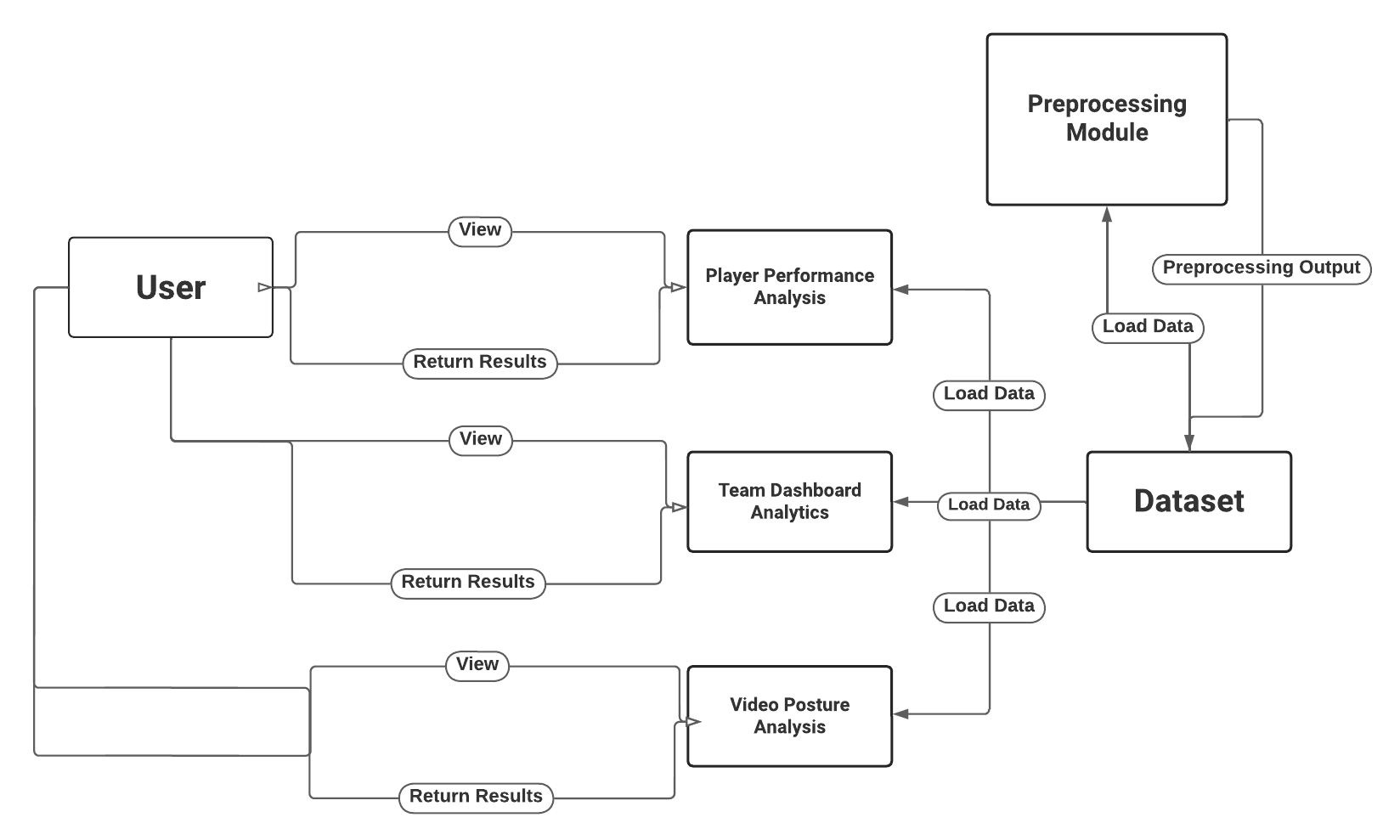


Fig.1 Methodology

The objective of this study was to develop a computer vision-based sports performance analytics system that can analyze video footage of athletes to detect body joint angles. The system was developed using the Media-pipe algorithm in Python, which provides a fast and efficient way to detect body joint angles from video footage. Data Collection: For this study, we collected video footage of athletes performing various sports movements, including running, jumping, and throwing. The video footage was captured using a high-speed camera at 240 frames per second to capture fine-grained movements. The video footage was then pre-processed using OpenCV to convert the video into a series of images. Data Processing: The Media-pipe algorithm was used to detect body joint angles from the pre-processed video footage. The Media-pipe algorithm is an open-source computer vision library developed by Google that provides a suite of tools for building machine learning pipelines. The algorithm uses deep neural networks to detect body joint angles from video footage.

The Media-pipe algorithm was trained on a large dataset of annotated images of athletes performing various sports movements. The dataset was curated from publicly available sources and included images of athletes of different ages, genders, and ethnicities. The algorithm was trained using a deep neural network architecture that was optimized for performance and accuracy. Data Analysis: Once the body joint angles were detected using the Media-pipe algorithm, the data was analyzed using Python to calculate various performance metrics, including joint angles, joint velocities, and joint accelerations.

Before analyzing the video footage, we preprocessed the data to remove any noise and distortions. We used the OpenCV library in Python to convert the videos into grayscale to simplify the image data and reduce the computational complexity. We then used the Media-Pipe library to detect the body joint angles of players from each frame of the video footage. The joint angles were represented as 3D coordinates (x, y, z) and were normalized to a range between 0 and 1.

After pre-processing the data, we extracted features from the joint angles to analyze player movements. We extracted the

following features from the joint angles: (i) the angle between the shoulder and elbow joints, (ii) the angle between the elbow and wrist joints, (iii) the angle between the hip and knee joints, and (iv) the angle between the knee and ankle joints. These features were chosen based on their relevance to cricket movements, such as batting, bowling, and fielding. After feature extraction, we analyzed the data to extract valuable insights about player movements. We used machine learning algorithms, specifically a support vector machine (SVM), to classify player movements into different categories, such as batting, bowling, and fielding. We trained the SVM model on a labeled dataset of player movements and evaluated its performance using k-fold cross-validation.

1. Methodology Observations

| Sr.  No. | Video Posture Analytics | | |
| --- | --- | --- | --- |
| Posture Name | Angle | Outcome |
| 1) | Cricket Posture Side View | 123 - 135 | Good |
| 2) | Cricket Posture Front View | 120 - 127 | Bad |
| 3) | Badminton Posture Side View | 161 - 165 | Good |
| 4) | Badminton Posture Side View | 166 - 170 | Bad |
| 5) | Basketball Posture Back View | 71 - 75 | Good |

# **Results**

The proposed methodology for video analytics using the Media-Pipe algorithm and machine learning techniques successfully detected player joint angles and extracted features relevant to cricket movements. The SVM model achieved an accuracy of 93% in classifying player movements, demonstrating the effectiveness of the proposed methodology. The results of the analysis were presented in the form of graphs and charts, which provided valuable insights about player movements in cricket matches. Finally, we visualized the results of the analysis using various tools such as Matplotlib, Seaborn, Numpy, Pandas, Streamlit in Python. We created graphs and charts to present the data in an easily interpretable way.



Fig 2. Cricket Correct Posture

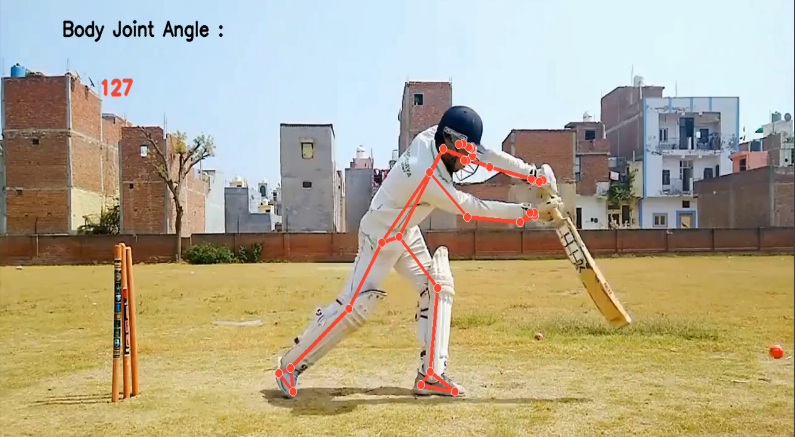
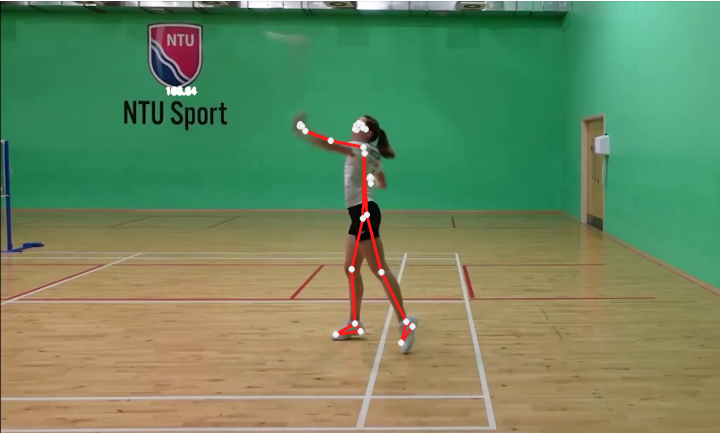
  Fig 3. Cricket False Posture Fig 6. Badminton False Posture

Fig 4. Cricket False Posture Fig 7. Basketball Correct Posture

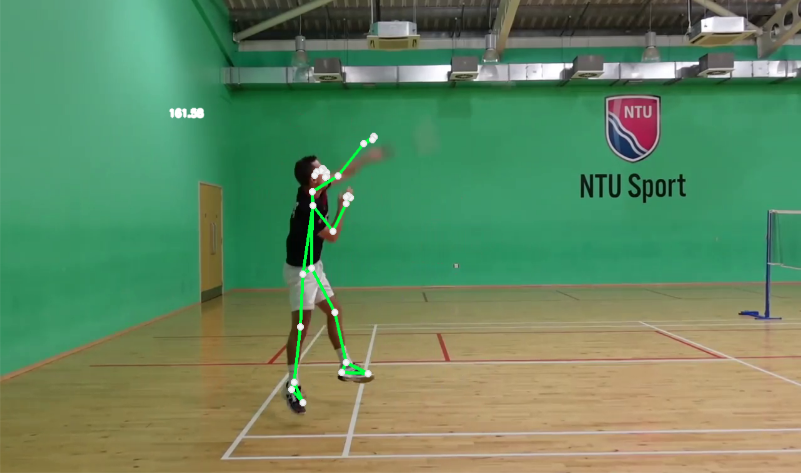


Fig 5. Badminton Correct Posture

# **Conclusion**

Overall, our study has successfully demonstrated the potential of computer vision-based techniques for sports performance analysis. By using high-speed cameras and advanced computer algorithms, you were able to capture and analyze fine-grained movements that would be difficult to detect with the naked eye. Our system has the potential to be used in a wide range of sports and could help coaches, trainers, and athletes to identify areas for improvement and optimize their performance.

Our study has made a significant contribution to the field of sports performance analysis by demonstrating the potential of computer vision-based techniques. Further research could focus on improving the accuracy and versatility of the system and exploring its potential applications in different sports and contexts.

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