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AI Umpire Using Deep Learning Strategies

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Abstract - The system enables real-time detection and accurate classification of key cricket events such as sixes, no balls, wide, and outs. It uses advanced technologies like sensors, cameras, and AI algorithms to ensure high precision in identifying and analyzing these moments. By significantly reducing human error, it enhances the accuracy of on-field decisions and supports consistent and fair gameplay. This not only promotes unbiased outcomes but also strengthens the integrity of the sport. Additionally, it boosts player confidence by ensuring that decisions are trustworthy and based on data. Spectators also benefit, as the system creates a more exciting and reliable viewing experience. Overall, it contributes to a fairer, more transparent, and enjoyable game for everyone involved.

***Key Words*:** Real-time detection, accurate classification, fair gameplay, and advanced technology drive this cricket decision system.

1. INTRODUCTION

The integration of advanced technology into cricket is transforming the way the game is both played and officiated. This innovative system enables real-time detection and accurate classification of key match events such as sixes, no balls, wides, and outs. Using cutting-edge tools like sensors, high-definition cameras, and AI algorithms ensures precise and reliable decision-making, providing a level of accuracy previously difficult to achieve. By reducing the chances of human error, it enhances the overall fairness of the game, ensuring that every call made on the field is as accurate as possible. This system plays a crucial role in maintaining consistency, eliminating the inconsistency that sometimes arises from human judgment during fast-paced moments. Additionally, technology supports unbiased outcomes, promoting integrity and transparency within sport. It also contributes to the overall experience of the game, helping to boost player confidence by ensuring that all decisions are based on data and are transparent. Players can focus more on their performance, knowing that any decision affecting them are trustworthy and well-supported. Spectators, too, benefit greatly from this technology, as it provides a more engaging and reliable viewing experience. By offering clarity and precision, the system deepens fan engagement and trust in the sport. This real-time, data-driven approach to officiating enhances not only the quality of the game but also the entertainment value for viewers.

2.LITERATURE REVIEW

[1] A Triboelectric Impact Sensor for Contact Detection in Sports. IEEE Sensors Journal, 25(2), 15 January 2025.
This paper presents a novel, cost-effective, and scalable method for developing a flexible impact sensor using triboelectric nanogenerator technology. The sensor is designed to detect contact in various sports with high accuracy, offering a new tool for performance analysis. By utilizing triboelectric nanogenerators, the sensor can efficiently harvest energy from impacts, making it both sustainable and practical. The technology enables real-time monitoring of physical contact, which could enhance safety by detecting dangerous impacts. Additionally, it provides valuable data for athletes and coaches, helping improve training and performance strategies. The sensor's flexibility and scalability make it adaptable to a wide range of sports equipment. Its affordable production cost also makes it accessible for widespread use. Ultimately, this innovation has the potential to significantly improve both performance analysis and safety monitoring in sports.

[2] Chien-Hung Wu (2022). Artificial-intelligence robot umpires in sailing race. Frontiers in Psychology, 2022.
This research explores the use of AI-driven robot umpires in sailing competitions, aiming to enhance the sport's officiating. It examines how these robotic systems can accurately manage race rules in real time, ensuring consistent decision-making. By utilizing advanced AI technology, robot umpires can eliminate human error, improving fairness during races. The research also highlights the efficiency these systems bring to the event, reducing delays and enhancing race management. With AI-driven umpires, sailing events can achieve greater transparency in rule enforcement. This innovation could lead to a more precise and objective approach to officiating. Ultimately, the integration of robot umpires has the potential to significantly transform sailing competitions.

[3] Evin Tissera, Kathleen A Shorter, Minh Huynh & Amanda C Benson .Reliability and validity of the fulltrack AI application to determine cricket bowling line and length compared to 3D motion capture. Published online: 30 July 2024.
This study evaluates the Fulltrack AI application in comparison to 3D motion capture technology to assess its reliability and validity in measuring cricket bowling techniques. The primary focus is on analyzing the accuracy of line and length in bowling,

which are crucial aspects of a bowler's performance. By comparing these two technologies, the study aims to determine how effectively Fulltrack AI can replicate the precision of 3D motion capture in real-world conditions. It examines the consistency of both systems in capturing data, ensuring their usefulness for coaching and performance analysis. The research also considers the ease of use and accessibility of Fulltrack AI compared to traditional motion capture methods. This comparison will highlight the potential advantages of adopting AI-driven solutions in sports performance analysis. Ultimately, the study seeks to provide insights into the practicality and effectiveness of Fulltrack AI for evaluating cricket bowling techniques. The findings could have significant implications for the future of coaching and player development in cricket.

[4] Kathleen A Shorter, Kevin Tissera, Amanda C Benson & Minh Huynh (2024). A comparison of Fulltrack AI application as an alternative to radar gun measured cricket ball delivery speed. First published online: October 1, 2024.
This research compares the Fulltrack AI application with traditional radar gun methods for measuring cricket ball delivery speeds. The primary goal is to evaluate the accuracy and reliability of Fulltrack AI as a modern alternative in sports analytics. By analyzing data collected from both technologies, the study assesses how well the AI system matches the performance of radar guns. It also explores the consistency of speed measurements across different delivery styles and conditions. The research highlights the potential benefits of using AI, such as ease of use, cost-effectiveness, and enhanced data integration. Additionally, it examines how Fulltrack AI can contribute to player development and coaching strategies. The study aims to validate AI-based tools for real-time performance tracking in cricket. Ultimately, it supports the advancement of technology-driven solutions in sports measurement and analytics.

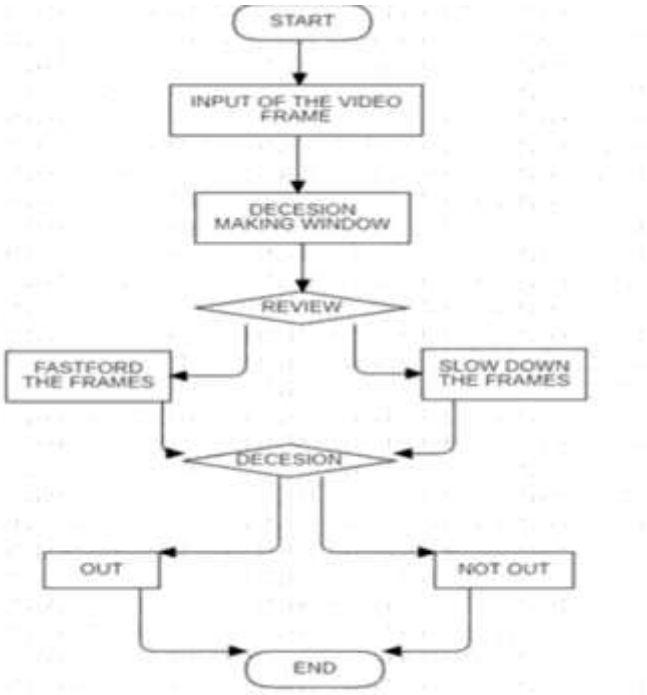
3.EXISTING SYSTEM

The **Cricket Game Intelligent Bot Umpire**, described in patent WO2021124351A1, is an advanced automated system designed to monitor, score, and make decisions during cricket matches. It features intelligent telescopic functions to track the ball accurately and avoid collisions, enhancing decision-making accuracy. The bot also offers real-time analytics and coaching insights, helping players improve their performance. In addition to this, the **Cricket Umpire Assistance** is an open-source project available on GitHub. It utilizes video input from a single smartphone camera to provide ball tracking and decision support. This project aims to make umpiring assistance more accessible and affordable. Both systems highlight the growing role of AI and computer vision in sports. Together, they represent a shift toward smarter, tech-driven officiating in cricket.

4.PROPOSED SYSTEM

This project focuses on developing an AI umpire system using deep learning to automate decision-making in sports such as cricket, tennis, and baseball. It will apply object detection techniques like YOLO and Faster R-CNN, along with trajectory prediction models such as RNN and LSTM, to accurately track the ball and make real-time decisions. The system aims to support or potentially replace human umpires by delivering consistent and precise judgments, especially during critical game moments. It will address challenges such as acquiring diverse datasets, maintaining real-time processing speeds, and managing complex edge cases. The ultimate goal is to create a functional prototype that offers fast, objective decisions. By leveraging AI, the system enhances the reliability and fairness of officiating. This innovation has the potential to transform the way sports are judged and analyzed. Overall, it represents a major step forward in the integration of AI into sports technology.

5.SYSTEM OVERVIEW



6. SYSTEM IMPLEMENTATION

6.1.Video processing

The **Video Processing** module is responsible for handling the reading and displaying of video frames in the system. It begins by initializing the video capture object using OpenCV, allowing access to video input from a file or camera. This module continuously reads frames from the video source and displays them in real time, serving as the foundation for further analysis

and processing. In addition to frame display, it calculates the frames per second (FPS), providing a useful measure of processing speed and system performance. Monitoring FPS helps in identifying any lag or delays during video analysis. The module ensures smooth playback while maintaining

synchronization with other components. It acts as a crucial interface between raw video data and higher-level AI or detection models. Efficient handling of frame capture and display ensures accuracy in time-sensitive tasks. This module also supports frame resizing or preprocessing if required by subsequent modules. Overall, it plays a key role in the performance and responsiveness of the system.

6.2.Ball Detection

The Ball Detection module utilizes the YOLO (You Only Look Once) deep learning model to identify and locate the ball in each video frame. YOLO is known for its speed and accuracy in real-time object detection, making it ideal for sports applications. The module processes each frame and detects the ball as an object, drawing bounding boxes around it for visual confirmation. These bounding boxes help in tracking the ball's position throughout the video. By detecting the ball in real time, the module supports further analysis such as trajectory prediction or event classification. The use of YOLO ensures efficient processing without significant delays. This module forms the foundation for accurate decision-making in AI-assisted sports systems. Overall, it enables fast and reliable ball detection critical for real-time applications.

6.3.Ball Tracking

The Ball Tracking module is designed to continuously monitor the ball's movement throughout the video. It achieves this by maintaining a history of the ball's centroids, which represent the center points of the ball in each detected frame. As new positions are recorded, the module connects these centroids with lines, visually mapping the trajectory of the ball. This visual trail helps in understanding the ball's motion, direction, and speed over time. To ensure the tracking remains accurate and responsive, the module periodically removes older centroids from the history. This prevents clutter and maintains a clear, up-to-date path visualization. The module plays a key role in analyzing dynamic ball behavior, which is essential for real-time decision-making. It complements detection by providing continuity across frames. Efficient tracking supports higher-level functions like trajectory prediction or event recognition. Overall, this module enhances the system's ability to interpret ball movements in fast-paced sports scenarios.

6.4.Direction Detection

The Direction Detection module is responsible for analyzing the ball's movement direction by calculating the angle of its trajectory. It does this by examining the history of centroids recorded during ball tracking and focusing on the last two positions. Using these points, it computes the slope of the line connecting them to determine the angle of motion. This angle provides insight into changes in the ball's path, such as whether it is rising, falling, or moving horizontally. If the calculated angle exceeds a predefined threshold, the module infers that the ball has bounced. This logic helps in detecting key events during gameplay, such as pitch bounces in cricket. The module plays a crucial role in event detection by identifying changes in trajectory patterns. It enhances the accuracy of bounce detection without relying on manual observation. By automating this process, the system ensures consistency in decision-making. Overall, the module adds significant value to sports analytics and AI-assisted umpiring.

6.5.Decision Making

The Decision-Making module is designed to predict the future positions of the ball by analyzing its current trajectory. It calculates these positions by extrapolating the movement vector formed from recent ball locations. Using this vector, the module forecasts where the ball is likely to travel next, providing critical insight into its path. To aid in visualization, it marks the predicted positions with lines and circles on the video frame. This graphical representation helps in understanding the ball's future motion in real time. The module is particularly useful in scenarios like predicting whether the ball will hit the stumps or cross a boundary. By anticipating the ball's path, it supports automated decisions in various sports contexts. The use of trajectory prediction enhances both accuracy and response time. This module bridges detection and event recognition, making it vital for real-time AI umpiring. Overall, it significantly improves decision-making by providing data-driven predictions.

7.SCREENSHOTS

Fig 1 : Video Processing

Fig 2: Ball Detection

Fig 3 : Ball Tracking

Fig 4 : Direction Detection

Fig 5: Decision Making

Fig 6: Boundary checking

Fig 7: Out or Notout decision

8.CONCLUSION

The AI Umpire System utilizes advanced deep learning techniques to automate the decision-making process traditionally handled by human umpires. By analyzing real-time data, the system ensures decisions are accurate, timely, and free from human bias. It is designed to be adaptable across multiple sports, including cricket, tennis, and baseball. Through continuous training with real-world datasets, the system improves over time, enhancing its reliability and precision. This adaptability allows it to stay updated with changing game dynamics and rules. The core objective is to support or replace human umpires in making critical calls, especially during high-pressure moments. Its implementation can lead to more consistent officiating and fewer disputes during matches. Additionally, the system contributes to the integrity of the sport by promoting fairness through objective decisions. It also offers valuable insights for coaching and performance analysis. Overall, the AI Umpire System represents a major advancement in sports technology and officiating.

9.FUTURE ENCHANCEMENT

This project is primarily aimed at training centers, gully cricket tournaments, and small-scale cricket competitions, offering an affordable and effective solution for performance tracking and analysis. It helps players and coaches gain valuable insights to improve skills and strategies. Though designed for grassroots and amateur-level use, the system is scalable and can be upgraded for professional settings. By integrating multiple cameras and microphones, it can provide high-quality data for precise analysis. At advanced levels, it supports real-time feedback and decision-making. The setup is adaptable for different venues and match types. It enhances training efficiency and game performance. Coaches can monitor player movement, techniques, and game patterns. With customization, it can match the analytical standards of national and international matches. Overall, it bridges the gap between casual and professional cricket with smart technology.

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