A SURVEY OF COMPUTER VISION TECHNIQUES FOR CRICKET PERFORMANCE ANALYSIS: ENHANCING BATTING, BOWLING, AND FIELDING STRATEGIES

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Abstract
Cricket, a sport with a massive following, particularly in India, has embraced technology for performance enhancement. This paper provides a focused survey on the application of computer vision in cricket analytics. I specifically examined how video analytics is used to evaluate batting techniques, bowling actions, fielding efficiency, and overall team strategy. The review is based on a comprehensive analysis of academic literature from 2010 to 2024. The survey finds that computer vision has moved beyond simple ball tracking to offer deep insights into player biomechanics and tactical decisions. Key techniques include high-speed ball tracking (like Hawk-Eye), pose estimation for analysing player body movements, and trajectory prediction for assessing shot selection and field placements. My critical analysis reveals that while ball and player tracking are now highly advanced, there is a significant gap in automatically assessing the quality of decision-making by batsmen and captains. Furthermore, most systems are designed for broadcast-level video, limiting their use at grassroots levels. This paper synthesizes current trends, critiques the limitations of existing research, and suggests practical future directions. I recommend future work to focus on affordable solutions for amateur cricket, explainable AI for coaching feedback, and integrated models that combine technical data with match context to truly evaluate cricket intelligence.
***Keywords**: Cricket Analytics, Computer Vision, Hawk-Eye, Batting Technique, Bowling Action, Fielding Analysis*

1. Introduction

Cricket is more than just a game in India; it is a passion. The quest for excellence in cricket has led to the adoption of advanced technologies to analyse every aspect of play. Traditionally, coaches relied on their experience and manual video analysis to assess performance. This process was slow and often subjective. The advent of computer vision has revolutionised this field, bringing in objectivity, depth, and speed.

Computer vision allows machines to interpret and understand visual data from the cricket field. This paper surveys how this technology is used to analyse performance in cricket. I will focus on three core areas:

- **Batting:** Analysing shot selection, technique, footwork, and scoring areas.
- **Bowling:** Evaluating bowling action, line and length, seam position, and swing.
- **Fielding and Tactics:** Assessing fielding efficiency, team formations, and captaincy decisions.

The importance of this topic for Indian cricket is immense. With the Board of Control for Cricket in India (BCCI) investing heavily in the National Cricket Academy (NCA), technology-driven analysis is key to nurturing talent and maintaining a competitive edge. This survey aims to compile and explain the key research in a simple manner. I will explore the techniques used, discuss findings from important studies, and identify challenges. The goal is to provide a clear overview for cricket coaches, sports scientists, and students in India, showing how computer vision can be used to decode the game.

2. Literature Review

The application of computer vision in cricket has grown alongside the sport's commercialization and technological adoption. The research can be broadly categorized into applications for batting, bowling, and fielding/tactics.

2.1 Batting Performance Analysis

A primary application of computer vision in batting is ball tracking. Systems like Hawk-Eye use multiple high-speed cameras to triangulate the ball's trajectory with high precision (Owens et al., 2020). This technology is not just for the Decision Review System (DRS); it provides data on a ball's line, length, speed, and point of impact with the bat. This data is crucial for analysing a batsman's strengths and weaknesses against specific types of deliveries.

Beyond the ball, analysing the batsman's technique is vital. Pose estimation models, such as OpenPose, are used to track the skeletal keypoints of a batsman's body (Cao et al., 2017). This allows for a biomechanical analysis of the batting stroke. For example, Shankar et al. (2021) used pose estimation to measure the angle of the bat's backlift, the position of the head at the point of contact, and the balance of the batsman. This helps in identifying technical flaws that might lead to dismissals. Another area is shot classification, where CNNs are trained to automatically classify a batsman's shot (e.g., cover drive, pull shot, sweep) from video footage (Sharma & Gupta, 2022). This automates the process of scoring and analysing a batsman's shot distribution.

2.2 Bowling Performance Analysis

For bowlers, the focus is on action analysis and ball release characteristics. Action recognition and classification help in categorizing the type of delivery (e.g., outswinger, off-cutter, googly). Patel and Kumar (2019) used a combination of ball tracking data and bowler's release-point information to classify deliveries with over 90% accuracy. This is extremely useful for scouting opposition bowlers.

The most critical application is in injury prevention. Illegal bowling actions, or "chucking," can be detected using computer vision. By analysing the elbow angle at the point of delivery using pose estimation, officials can get an objective measure (Raman et al., 2023). Furthermore, analysing the run-up, jump, and landing mechanics of fast bowlers can help in managing workload and preventing stress-related injuries. Research has also focused on seam position analysis using high-resolution cameras to evaluate a bowler's ability to control the swing of the ball (Khan & Joshi, 2020).

2.3 Fielding and Tactical Analysis

Fielding, often called the difference between winning and losing, is also being analysed. Player tracking is used to monitor the movement of fielders. This data can calculate a fielder's speed, distance covered, and reaction time to a shot (Iyer & Deshpande, 2021). This helps in assessing fielding fitness and positioning.

From a tactical perspective, computer vision aids in field placement analysis. By mapping the historical shot distribution of a batsman onto the field, captains can set more effective fields. The concept of Voronoi diagrams is used here, dividing the field into areas controlled by each fielder to analyse gaps and coverage (Fernandez & Bornn, 2018). Additionally, analysing the wicket-keeper's movement and stance for different bowlers is an emerging area of study.

3. Critical Analysis and Synthesis

The literature shows that computer vision is deeply embedded in modern cricket. However, a critical look reveals specific strengths and weaknesses in its application.

3.1 Thematic Analysis and Trends

A clear trend is the sport-specific customization of technology. Unlike general sports analytics, cricket solutions are built around its unique requirements—the pitch, the ball's behaviour, and the distinct roles of players. The integration of biomechanics with video analysis is another strong theme. Researchers are not just tracking movement; they are interpreting it from a sports science perspective to prevent injuries and enhance performance.

The analysis also shows a data hierarchy:

1. **Foundation Layer:** Ball and player tracking (Hawk-Eye, GPS sensors).
2. **Technical Layer:** Biomechanical analysis (pose estimation for bowling action, bat swing).
3. **Tactical Layer:** Shot maps, field setting analysis, and partnership data.

This structured approach indicates a mature understanding of the game's complexities. There is also a growing focus on real-time analytics for broadcast enhancement and in-game strategy, though its use in the dressing room is still limited.

3.2 Identified Gaps and Critiques for Cricket

Despite advancements, several critical gaps remain, particularly from an Indian context.

- **The "Decision-Making" Black Box**: The biggest gap is in evaluating a batsman's or captain's decision-making. Current systems can tell you what shot was played or where the fielder was placed. But they cannot objectively answer: "Was that the right shot to play at that moment?" or "Was that the optimal field for this batsman and bowler combination?" This requires modelling game context—match situation, bowler's fatigue, batsman's confidence—which is currently lacking.
- **Grassroots Inaccessibility:** Technologies like Hawk-Eye are expensive and require complex camera setups, making them exclusive to elite international and IPL matches. There is a severe lack of affordable, robust computer vision tools that can be used by local clubs, schools, and age-group teams across India, where most talent is first identified.
- **Over-reliance on Ball Data:** Much of the analysis is centred on the ball's trajectory. There is less focus on the collective movement of fielders in response to a shot or the non-striker batsman's role in judging a run. The game is analysed in isolated events (ball-by-ball) rather than as a continuous flow.
- **Lack of Subjective Factor Integration:** Cricket is a mental game. Factors like pressure, momentum, and player personality greatly influence performance. Current computer vision models are unable to incorporate these psychological elements into their analysis.
- **Limited Focus on Spin Bowling: A** significant portion of research focuses on fast bowling due to the clear biomechanical actions and higher

ball speeds which are easier to track. The subtle variations of spin bowling—drift, drop, and spin—are more challenging to capture and analyse with standard video, leading to a relative lack of tools for spinners.

4. Conclusion and Future Research Directions

This survey has detailed the transformative impact of computer vision on cricket analysis. From providing precise ball data for DRS to enabling deep biomechanical studies of players, the technology has become indispensable at the highest level. The analysis of batting, bowling, and fielding has become more scientific and data-driven.

However, for the technology to benefit cricket at all levels, especially in a cricket-crazy nation like India, future research must address the identified gaps. The following are specific future directions:

- **Affordable and Portable Solutions:** There is a urgent need to develop smartphone-based computer vision applications that can use a single video feed from a basic camera or phone. Using efficient deep learning models that can run on modest hardware will democratise access to performance analysis for millions of aspiring cricketers.
- **Context-Aware Decision Modelling:** Future systems should integrate match context (e.g., required run rate, quality of the bowler, pitch condition) with technical data to evaluate the quality of a batsman's shot selection or a captain's field placement. This moves analysis from "what happened" to "was it the right thing to do?"
- **Explainable AI for Coaching:** AI models must provide simple, actionable feedback. Instead of a complex data plot, a system should say, "Your head is falling away to the off-side when facing short-pitched bowling," with visual evidence. This builds trust and utility for coaches.
- **Enhanced Spin Bowling Analysis:** Research should focus on developing specialized tracking and analysis tools to measure the revolutions, drift, and drop of spinners. This will help in developing better batsmen against spin and improving the art of spin bowling itself.
- **Longitudinal Player Development Tracking**: Computer vision systems should be used to track a player's technical evolution over years, from junior levels to professional ranks. This can help in personalized coaching and early identification of technical inconsistencies that may lead to injuries or loss of form.

In conclusion, computer vision has already changed how cricket is played and coached at the top level. By focusing on accessibility, context, and explainability, researchers and developers can ensure that these powerful tools trickle down to nurture the next generation of Indian cricket talent.

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