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Deep Learning in Cricket: A Comprehensive Survey of Shot Detection and Performance Analysis

Milind Mahajan[1], Shreekar Kulkarni[2], Mitesh Kulkarni[3], Abhishek Sabale[4], Aakanksha Thakar[5]
[1,2,3,4,5]Department of Information Technology, PVGCOET & GKPIM, Pune, Maharashtra, India
Emails: *milind6787@gmail.com[1], shrikarkulkarni42@gmail.com[2], miteshhk05@gmail.com[3], abhisheksabale777@gmail.com[4], aakanksha191102@gmail.com[5]*

Abstract
Cricket shot detection and performance analysis have become increasingly significant in the realm of sports analytics. This paper presents a comprehensive survey of recent advancements in cricket shot detection and performance analysis using deep learning techniques. Through a systematic review of ten research papers, various methodologies, algorithms, and approaches employed in the field were examined. The surveyed papers showcase the application of deep convolutional neural networks (CNNs), transfer learning, and multimodal feature integration for accurate shot detection and outcome classification. Additionally, the survey highlights common processes such as data preprocessing, model training, and evaluation metrics, while also discussing the integration of features extracted from video, audio, and image modalities. Through a detailed literature review, this paper analyzes the similarities and differences in approaches, methodologies, and results across the surveyed papers. Furthermore, this survey identifies opportunities for future research and development to advance the field of cricket shot detection and performance analysis. Overall, this survey provides valuable insights into the state-of-the-art techniques and challenges in utilizing deep learning for cricket analytics, offering guidance for researchers and practitioners in the domain.

Keywords: *Cricket shot detection; Deep convolutional neural networks; Features extracted from video.*

1. Introduction
Cricket, a sport beloved by millions worldwide, has increasingly become a focal point for technological innovation, particularly in the realms of performance analysis and automated systems. In recent years, the integration of deep learning methodologies has revolutionized cricket analytics, enabling advanced shot detection and performance analysis that offer invaluable insights for players, coaches, and analysts alike.This survey paper aims to provide a comprehensive overview of recent advancements in cricket shot detection and performance analysis using deep learning techniques, drawing insights from ten seminal research papers in the field. Through a combination of the approaches, discoveries, and consequences of these investigations, this study aims to better understand the present cutting-edge methods and highlight future opportunities for investigation in this constantly evolving field. The first set of referenced papers delves into methodologies for cricket shot detection and classification using deep learning algorithms. Ahmed Foysal et al. [1] propose a methodology for classifying sports videos, including cricket, by leveraging deep learning algorithms applied to both audio and visual information. Dixit and Balakrishnan [2] focus on classifying ball-by-ball outcomes in cricket matches using Convolutional Neural Networks (CNNs), showcasing the potential of deep learning in understanding game dynamics. Nirgude et al. [3] introduce an interactive approach to identifying cricket shots through deep learning mechanisms, while Khan et al. [4] present a data-driven recognition system for cricket batting shots using deep CNNs. Fernandes et al. [5] further contribute to the field by presenting a deep CNN-based approach for classifying different cricket shots, demonstrating

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high accuracy and robustness in shot detection. In addition to shot detection, several papers explore the application of deep learning in cricket performance analysis. Siddiqui et al. [6] enhance cricket performance analysis by incorporating human pose estimation and machine learning techniques, offering insights into player movements and actions on the field. Mannan et al. [7] focus on detecting various cricketing activities using deep learning methods, providing a foundation for automated analysis of gameplay. Furthermore, Siddiqui et al. [8] propose a novel scheme for cricket shot detection from videos, leveraging saliency and optical flow techniques, while Fernandes et al. [9] explore cricket shot detection using 2D CNNs, highlighting the versatility and effectiveness of deep learning architectures in detecting cricket shots. Lastly, Kumar et al. [10] address outcome classification in cricket matches using deep learning methods, aiming to create automatic commentary generation based on ball-by-ball outcomes, showcasing the potential of deep learning in enhancing the viewer experience of cricket matches. By synthesizing the methodologies and findings from these seminal papers, this survey aims to provide a comprehensive understanding of the current landscape of cricket shot detection and performance analysis using deep learning techniques. Furthermore, it will identify challenges,
opportunities, and future directions for research in this exciting and rapidly evolving field.

2. Literature Review

2.1. Cricket Shot Detection

1. Deep CNN-based Data-driven Recognition of Cricket Batting Shots [4]
2. Shot-Net: A Convolutional Neural Network for Classifying Different Cricket Shots [6]
3. Cricket Shot Detection from Videos [7]
4. Cricket Shot Detection using 2D CNN [8]
5. Enhancement of Cricket Performance Analysis with Human Pose Estimation and Machine Learning [5]

2.2. Performance Analysis and Outcome Classification

1. Sports Video Classification from Multimodal Information Using Deep Neural Networks [1]
2. Deep Learning using CNNs for Ball-by-Ball Outcome Classification in Sports [2]
3. An Interactive Approach to Identify Cricket Shots through Deep Learning Mechanism [3]
4. Detection of Cricketing Activities Using Deep Learning [9]
5. Outcome Classification in Cricket Using Deep Learning [10]

2.3. Common Processes

2.3.1. Deep Learning Architectures

All the reviewed papers showcase the utilization of deep learning architectures, predominantly focusing on Convolutional Neural Networks (CNNs), to tackle various tasks related to cricket shot detection and performance analysis. These architectures serve as the backbone for robust classification and recognition tasks across the board.

2.3.2. Data Preprocessing

Preprocessing techniques play a crucial role in enhancing model performance across the surveyed literature. Strategies such as image normalization and feature extraction are commonly employed to preprocess the data, ensuring that the models receive clean and relevant input for accurate analysis [3], [5], [9].

2.3.3. Model Training

The process of model training is fundamental across all the reviewed papers. Models are trained using diverse datasets, either locally developed or publicly available, to ensure their robustness and effectiveness in real-world scenarios. This step involves fine-tuning the parameters of the deep learning architectures to achieve optimal performance [4], [9], [10].

2.3.4. Evaluation Metrics

Evaluation metrics serve as the yardstick to gauge the effectiveness of the proposed models. Various metrics such as accuracy, precision, recall, and F1-score are commonly used to assess the performance of the models across different tasks. These metrics provide insights into the model's ability to correctly classify cricket shots, predict match outcomes, and analyze player actions [2], [4], [7].

2.4. Similar Approaches

2.4.1. Shot Detection

Several papers [4], [6], [7], and [8] focus extensively on cricket shot detection using deep learning architectures. These approaches predominantly rely on CNN-based models to accurately classify different

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types of cricket shots, such as cut shots, cover drives, and pull shots. The emphasis is on leveraging visual cues from cricket videos to identify and classify these shots with high accuracy.

2.4.2. Performance Analysis

Other papers [5], [9], and [10] delve into broader performance analysis tasks, including outcome classification and activity detection. These approaches leverage deep learning techniques to predict match outcomes, detect cricketing activities, and analyze player behavior on the field. The focus is on providing comprehensive insights into player performance and match dynamics using advanced machine learning algorithms.

2.5. Differences in Approaches and Methodologies

2.5.1. Input Modalities

One notable difference lies in the input modalities utilized across the reviewed papers. While some papers [1], [2], and [3] leverage multimodal information (audio and visual) for sports video classification and shot detection, others focus solely on visual information [4], [5]. This difference in input modalities reflects the diverse strategies employed to tackle the challenges of cricket shot detection and performance analysis.

2.5.2. Specificity of Tasks

Moreover, there is a distinction in the specificity of tasks addressed by the reviewed papers. Papers focusing on shot detection [4], [6], [7], and [8] specifically target the classification of cricket shots, whereas those focusing on performance analysis [5], [9], and [10] encompass broader tasks such as outcome classification and activity detection. This difference underscores the varied applications of deep learning in cricket analytics.

2.6. Accuracy and Results

2.6.1. Shot Detection Accuracy

Papers [4] and [8] report high accuracy rates of 90% and 91.5%, respectively, in detecting cricket batting shots using deep CNN architectures. These results highlight the effectiveness of the proposed methodologies in accurately classifying different types of cricket shots from video footage. Accuracy Report are shown in Table 1.

Table 1 Accuracy Report

Paper	Methodology	Accuracy(%)
[1]	CDBN, RBM	86.34
[2]	LSTM, CNN	70
[3]	CNN	1.264 (RMSE)
[4]	2D CNN, LSTM	90
[5]	RF, ML	99.7
[6]	CNN, DL	80
[7]	DCNN, SVM	83.098
[8]	CNN, OpenCV	91.5
[9]	CNN, ResNet	99.47
[10]	LRCN, CNN	85

2.7. Outcome and Classification Accuracy

Similarly, papers [2] and [10] achieve impressive accuracies of almost 80% and 70%, respectively, in classifying ball-by-ball outcomes in cricket matches using deep learning techniques. These results demonstrate the capability of deep learning models to predict match outcomes and provide valuable insights into player performance. In summary, the surveyed literature showcases the efficacy of deep learning approaches in cricket shot detection and performance analysis. While some papers focus on specific tasks such as shot detection, others address broader performance analysis tasks. Despite differences in approaches and methodologies, the overarching goal remains the same: to leverage advanced machine learning techniques to enhance our understanding of cricket dynamics and player behavior on the field.

3. Approaches from The Previous Work

3.1. Deep CNN-based Data-driven Recognition of Cricket Batting Shots [4]

- **Data Collection:** The authors collected a dataset comprising approximately 800 batting shot clips for training and evaluation purposes.

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- **Model Architecture:** They proposed a deep Convolutional Neural Network (CNN) architecture with multiple layers, including convolution, pooling, flattening, and full connection, for shot detection.
- **Training and Evaluation:** The model was trained and evaluated using the collected dataset, achieving an overall accuracy of 91.5% in detecting different types of cricket shots (Figure 1).

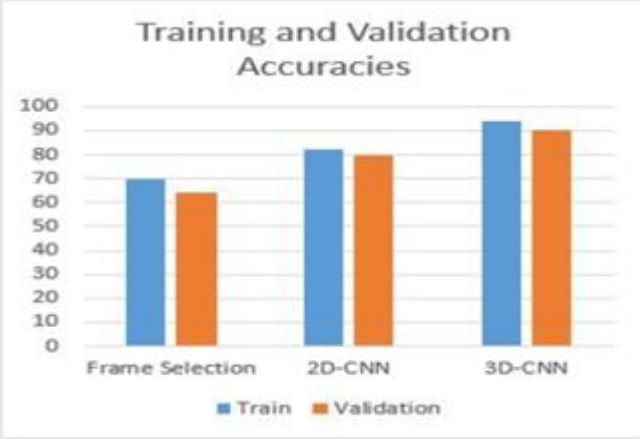

Figure 1 Accuracy Comparison [4]

3.2. Shot-Net: A Convolutional Neural Network for Classifying Different Cricket Shots [6]

- **Dataset Preparation:** The authors prepared a dataset consisting of various cricket shots, including cut shots, cover drives, and pull shots, for training and testing the model.
- **Model Development:** They proposed a 13-layered Convolutional Neural Network referred to as "Shot-Net" for classifying six categories of cricket shots.
- **Training and Testing:** The model was trained on the prepared dataset and evaluated for accuracy and cross-entropy rate to assess its performance in shot classification tasks.

3.3. Cricket Shot Detection from Videos [7]

- **Feature Extraction:** The authors utilized state-of-the-art techniques such as saliency and optical flow to extract static and dynamic cues from cricket videos.
- **Model Architecture:** They employed Deep Convolutional Neural Networks (DCNNs) for feature extraction and representation learning from video frames.
- **Dataset Creation:** A new dataset comprising 429 videos was introduced to evaluate the performance of the proposed framework for cricket shot detection.
- **Performance Evaluation:** The model achieved accuracies of 83.098% and 65.186% for detecting right-handed and left-handed shots, respectively, demonstrating its effectiveness in shot classification tasks.

3.4. Cricket Shot Detection using 2D CNN [8]

- **Data Preparation:** The authors prepared a dataset of cricket videos containing various batting shots for model training and evaluation.
- **Model Design:** They proposed a 2D Convolutional Neural Network (CNN) architecture for shot detection, leveraging the spatial features of video frames.
- **Training and Testing:** The model was trained on the prepared dataset and tested on unseen shots to evaluate its accuracy and performance in cricket shot detection tasks.

3.5. Enhancement of Cricket Performance Analysis with Human Pose Estimation and Machine Learning [5]

- **Data Acquisition:** The authors collected cricket match footage to extract player movements and actions for performance analysis.
- **Pose Estimation:** Human pose estimation techniques were employed to extract key points representing player poses from the video frames.
- Various machine learning algorithms were utilized to analyze player movements and actions, enhancing performance analysis in cricket matches.

3.6. Sports Video Classification from Multimodal Information Using Deep Neural Networks [1]

- **Feature Fusion:** The authors combined audio and visual information from sports videos for classification using deep neural networks.

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- **Model Training:** Deep learning architectures were trained on the multimodal dataset to classify different sports activities, including cricket shots.

3.7. Deep Learning using CNNs for Ball-by-Ball Outcome Classification in Sports [2]

- **Outcome Definition:** The authors defined ball-by-ball outcomes in cricket matches, such as runs, dots, boundaries, and wickets, for classification tasks.
- **CNN Architecture:** Convolutional Neural Networks (CNNs) were employed to classify ball-by-ball outcomes based on video frames representing cricket shots (Figure 2).

Figure 2 Class Probabilities Per Frame from The Single-Frame Averaging Model [2]

3.8. An Interactive Approach to Identify Cricket Shots through Deep Learning Mechanism [3]:

- **Dataset Creation:** A dataset of cricket shots was created for model training, comprising various shot types and player actions.
- **Deep Learning Model:** The authors developed an interactive approach using deep learning mechanisms, specifically Convolutional Neural Networks (CNNs), for identifying and classifying cricket shots from video footage (Figure 3).

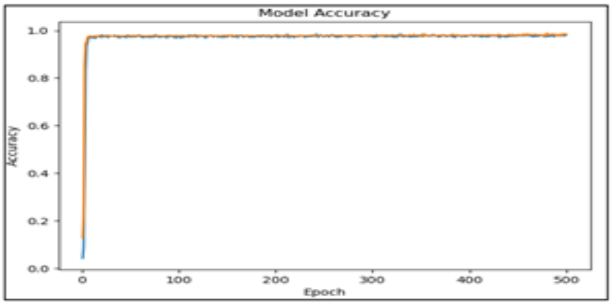

Figure 3 Model Accuracy [3]

3.9. Detection of Cricketing Activities Using Deep Learning [9]

- **Activity Definition:** The authors defined various cricketing activities and events to be detected using deep learning techniques.
- **Model Architecture:** Deep learning models, including Convolutional Neural Networks (CNNs), were trained to recognize and classify cricketing activities based on video data.

3.10. Outcome Classification in Cricket Using Deep Learning [10]

- **Outcome Labeling:** Ball-by-ball outcomes, such as runs, dots, boundaries, and wickets, were labeled for classification tasks in cricket matches.
- **Deep Learning Techniques:** The authors employed Convolutional Neural Networks (CNNs) and Long Short-Term Memory Networks (LSTMs) to classify ball-by-ball outcomes based on video analysis.

4. Examining The Systems Breakdown

1. **Data Collection**

a. Gather cricket match videos or image datasets for training and evaluation.

2. **Preprocessing**

a. Analyze videos/images to extract relevant frames or clips.

b. Normalize images/videos for consistency in lighting, resolution, and format.

c. Perform feature extraction to capture essential characteristics of cricket shots or player actions.

3. **Model Selection:**

a. Choose appropriate deep learning architectures such as Convolutional Neural Networks (CNNs), Recurrent Neural Networks (RNNs), or hybrid models based on the nature of the task.

4. **Model Training:**

a. Split the dataset into training, validation, and test sets.

b. Train the selected model using the training dataset and adjust hyperparameters as needed.

c. Validate the model performance using the validation set to prevent overfitting.

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d. Fine-tune the model based on validation results.

5. Evaluation:

a. Test the trained model using the unseen test dataset to assess its accuracy and performance.
b. Evaluate the model based on predefined metrics such as accuracy, precision, recall, and F1-score.
c. Analyze the results to identify strengths, weaknesses, and areas for improvement.

6. Integration:

a. Integrate the trained model with other modules or systems for real-world applications.
b. Implement necessary integration steps to ensure seamless operation and compatibility with existing infrastructure.

7. Deployment:

a. Deploy the trained model in production environments for practical use.
b. Monitor model performance and make necessary adjustments to ensure continued accuracy and reliability.
c. Provide user documentation and support for stakeholders using the deployed system.

8. Feedback Loop:

a. Gather feedback from users and stakeholders to identify potential enhancements or issues.
b. Iteratively improve the model based on user feedback and emerging requirements.

9. Future Research:

a. Identify areas for future research and development to further advance the field of cricket shot detection and performance analysis using deep learning.

Conclusion

In conclusion, the papers reviewed in this survey exemplify the significant advancements in the field of cricket shot detection and performance analysis using deep learning techniques. Through the exploration of various methodologies, including deep convolutional neural networks (CNNs), transfer learning, and multimodal feature integration, researchers have made substantial progress in accurately identifying cricket shots, classifying ball-by-ball outcomes, and analyzing player performance. The literature review revealed common processes such as data preprocessing, model training, and evaluation metrics, which are essential for developing robust and accurate deep learning models. Additionally, the integration of features extracted from video, audio, and image modalities has played a crucial role in enhancing the accuracy and robustness of classification tasks. Despite the differences in approaches and methodologies across the reviewed papers, a common theme emerges the efficacy of deep learning in automating complex tasks in cricket analysis. From shot detection to outcome classification, deep learning models have demonstrated impressive accuracy rates, paving the way for innovative applications such as automatic commentary generation and player performance evaluation. Looking ahead, future research in this field could focus on addressing challenges such as dataset scarcity, model generalization, and real-time implementation. By overcoming these hurdles, researchers can further advance the capabilities of deep learning models in cricket analysis, ultimately contributing to a deeper understanding of the game and enhancing the overall quality of cricketing experiences for players and fans alike. In summary, the studies reviewed in this survey underscore the transformative potential of deep learning in revolutionizing cricket shot detection and performance analysis, offering valuable insights and paving the way for future advancements in this exciting domain.

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