PANIMALAR ENGINEERING COLLEGE

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DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

A Deep Learning-Based Sports Shot Classification System

SDG 9: Industry, Innovation and Infrastructure

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PROJECT GUIDE

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PROJECT COORDINATOR

ABSTRACT

- This research introduces **"Shot Sense"** a deep learning framework designed to classify sports shots using CNNs built with TensorFlow.
- Accurate classification of sports shots is essential for sports analytics, coaching, and broadcasting, as it provides valuable insights into gameplay and player performance.
- **Shot Sense** can be described as a **deep learning-based framework** rather than a single network.
- It leverages **Convolutional Neural Networks (CNNs)**, which are a class of deep learning networks, to perform sports shot classification.
- The proposed framework holds promise for advancing sports analysis, broadcasting, and coaching, paving the way for automated and nuanced shot classification in various sports domains.

INTRODUCTION

- Advances in data technologies have revolutionized sports analytics, with shot classification significantly improving analytics, coaching, and broadcasting.
- Traditional shot classification methods are inefficient, being manual, time-consuming, and inflexible.
- CNNs address these limitations by automatically extracting features and achieving high accuracy in complex classifications.
- A TensorFlow-based CNN framework is proposed, using optimized architectures, data augmentation, and advanced techniques like dropout and transfer learning.
- This framework automates shot classification, offering deeper insights into athlete performance and gameplay strategies, enhancing sports analysis and coaching.

OBJECTIVE OF THE PROJECT

- **Accurate shot classification**: Develop a framework for precise classification of various sports shots using advanced deep learning methods.
- **Address complexities in sports dynamics**: Ensure the model handles variations in angles, movements, and conditions across diverse sports scenarios.
- **Enhance model performance**: Utilize techniques like data augmentation, dropout, transfer learning, and hyperparameter tuning for optimal results.
- **Automate analytics**: Replace manual efforts with automated solutions for efficient sports shot analysis and decision-making.
- **Enable scalability and insights**: Use TensorFlow for scalable deployment, providing deeper data-driven insights into gameplay strategies and athlete performance.

LITERATURE SURVEY

S.NO	YEAR	AUTHOR DETAILS	JOURNAL DETAILS	APPROACH	OUTCOME
1.	2023	**Author**: Yihong Wu. **Title:** Visual Analytics of Off-ball Movements in Basketball.	Analyzes movement patterns with Voronoi-based visualization.	Develops a model and OBTracker for off-ball analysis	Provides valuable insights, but its complexity may hinder wider use.
2.	2023	**Author** : Jiang Wu **Title:** Interactive Pattern Mining of Multivariate Event Sequences in Racket Sports	Interactive system integrating expert knowledge into pattern mining for racket sports.	Constraint based algorithm and visual interface for tactic discovery and comparison.	Combines expert input with data mining, enhancing tactical analysis in racket sports.

LITERATURE SURVEY

3.	2024	**Author**: A. Dey **Title**: Cricket Batting Shots Classification with Vision Transformer Network	Introduces Attention Networks, Vision Transformers.	(ViTs) were employed to leverage both spatial and temporal information for improved shot categorization.	The experiments achieved highest accuracy by using (ViTs) on the PES dataset.
4.	2024	**Author**: Venkatesh B R **Title** : Classification of Cricket Shot from cricket Videos using Deep Learning Models.	Vision Transformers show superior performance in sports action recognition compared to traditional CNN.	Research is image-based; extending to video would enhance shot recognition accuracy.	Shot-ViT outperforms existing models, demonstrating the effectiveness of fine-tuned Vision Transformers for sports tasks.

LITERATURE SURVEY

5.	2023	**Author**: Zheng Wang **Title:** Similar Sports Play Retrieval with Deep Reinforcement Learning.	Introduces play2vec, reinforcement algorithms, and ScoreSearch.	Uses deep learning and reinforcement learning for play retrieval	Efficiently retrieves similar plays from game databases.
6.	2023	**Author** : Zhutian Chen **Title:** Augmenting Sports Videos Using Natural Language.	Uses natural language to create augmented sports videos	Detects visualizable entities, maps them to visualizations, schedules them.	High accuracy and is highly rated by experts.

LITERATURE SURVEY

7.	2023	**Author**: Gupta & Muthiah **Title:** Learning Cricket Strokes via Spatial and Motion Visual Word Sequences	Multimedia Tools and Applications.	Spatial and motion visual word sequences	Enhanced action classification in cricket strokes.
8.	2023	**Author** : Azhar et al. **Title:** Transformer-Based Cricket Shot Classification	International Symposium on Image and Signal Processing and Analysis	Transformer based model	Demonstrated the effectiveness of transformers for cricket action recognition.

LITERATURE SURVEY

9.	2021	**Author**:Devanandan et al. **Title:**Random Forest-Based Cricket Shot Image Classification	3rd International Conference on Advancements in Computing	Random Forest model	Provided a machine learning alternative for cricket shot image classification.
10.	2017	**Author** :Thomas et al. **Title:** Computer Vision for Sports: Current Applications and Research Topics	Computer Vision and Image Understanding	Computer vision approaches	Reviewed computer vision applications in sports analytics.

EXISTING METHODOLOGY

- Data visualization has the potential to greatly impact sports.
- **Shot map** is a visual representation used to analyze a player's batting performance by displaying where the batsman hits the ball on the field during an inning.
- It helps in understanding the batsman’s shot selection, timing, and areas of strength or weakness.
- While shot maps have improved the game in many ways, there is still room for improvement, especially for more advanced and detailed analysis.
- Current shot maps have two major limitations: They don’t offer enough interactivity for answering different types of analytical questions. They don’t allow easy visual comparison of differences across various situations.
- **ViTs** are a type of neural network model designed for image data, where traditional **Convolutional Neural Networks (CNNs)** were typically used.

PROPOSED METHODOLOGY

- The proposed system aims to revolutionize the field of sports analytics and broadcasting by employing advanced deep learning techniques for the classification of sports shots.
- The core of the system lies in the innovative architecture, a hybrid combination of **Convolutional Neural Networks (CNNs) for spatial feature extraction and Artificial Neural Networks (ANNs)** for temporal modelling.
- Performance evaluation is rigorous, with metrics like **accuracy**, precision, recall, F1-score, and **confusion matrices** providing insights into the model's proficiency.
- It features user-friendly interfaces and visual tools for broadcasters, coaches, and analysts. This ensures real-time access to shot classification results and data insights for better engagement.
- The system commits to continuous improvement through feedback mechanisms, adapting to evolving sports scenarios and shot types.

ENVIRONMENT REQUIREMENTS

1. Software Requirements:

- Operating System : Windows / Linux
- Simulation Tool : Anaconda with Jupyter Notebook

2. Hardware requirements:

- Processor : Pentium IV/III
- Hard disk : minimum 80 GB
- RAM : minimum 2 GB

ARCHITECTURE DIAGRAM

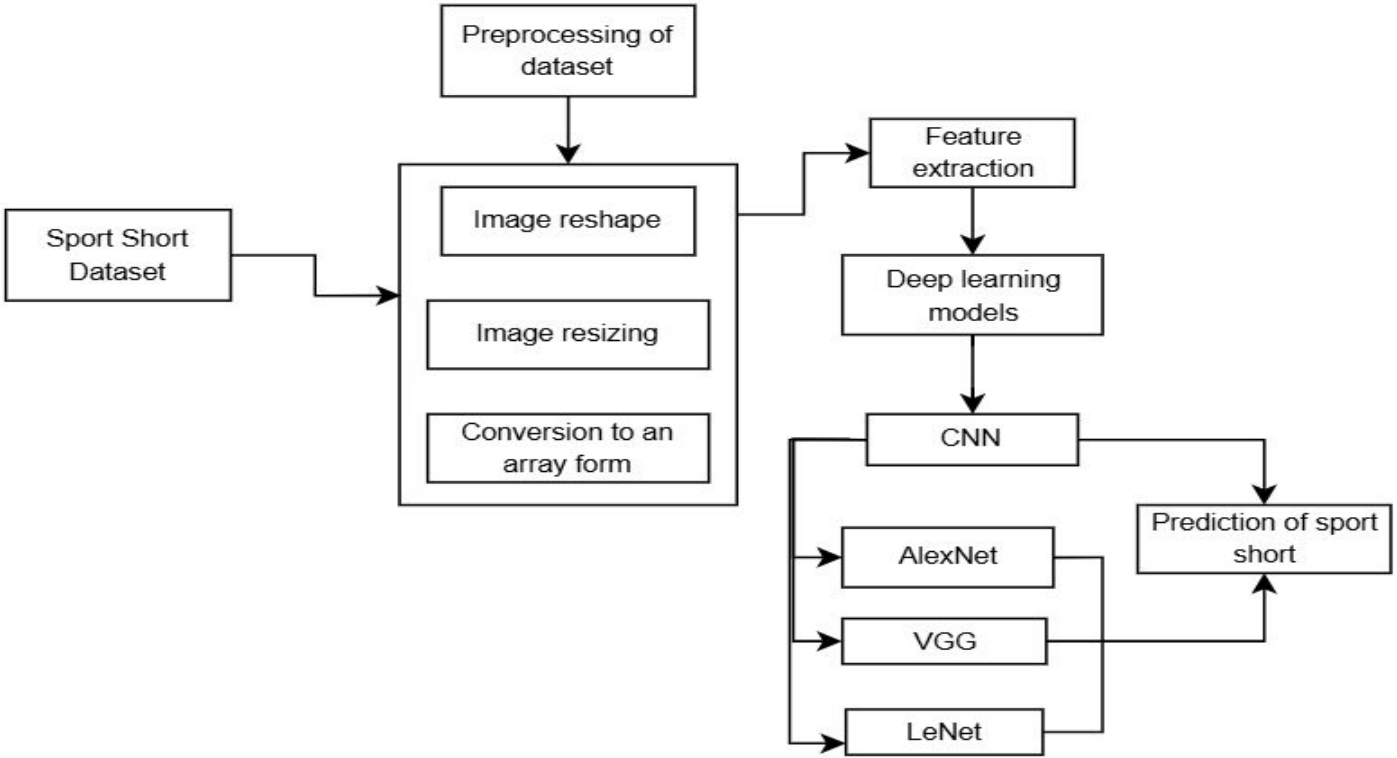


Fig 1. It depicts the AI-driven workflow for cricket shot classification using AlexNet,VGG and LeNet

WORKFLOW DIAGRAM

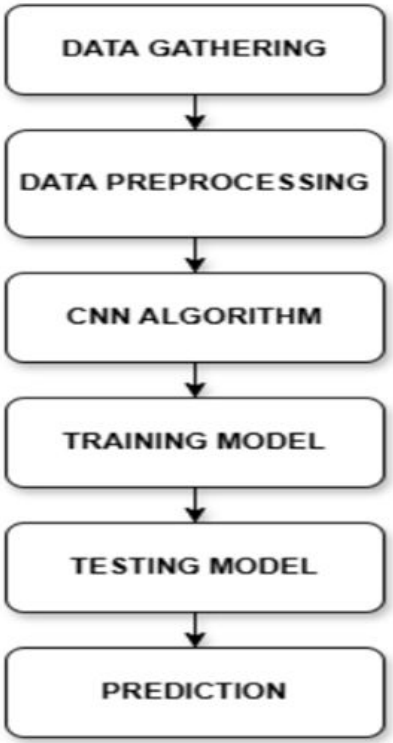


Fig 2. The workflow diagram depicts the process from data preprocessing to shot type prediction in cricket analysis.

PROJECT WORKFLOW

1. Data Collection – 4,000 cricket shot images categorized into 12 shot types for training and testing.

2. Preprocessing – Images resized, noise reduced, and data augmented to improve model performance.

3. Model Training – AlexNet, VGG16, and LeNet trained to classify shots using CNN-based feature extraction.

4. Evaluation – Models compared using accuracy, F1-score, and recall, with AlexNet chosen for final implementation.

5. Prediction – The trained model classifies new cricket shot images based on spatial and motion features.

6. Application – Used for player performance analysis, coaching enhancements, and automated sports analytics.

METHODOLOGY

- The dataset consists of 4,000 sports shot images categorized into 12 shot types, ensuring a diverse set of training data for deep learning models.
- Images are preprocessed through resizing, noise reduction, and augmentation to enhance model generalization.
- Deep learning models, including AlexNet, VGG16, and LeNet, are trained to classify shots based on spatial and motion features.
- The training phase involves feature extraction, model optimization, and validation with a separate test dataset.
- Performance is evaluated using accuracy, F1-score, and recall, ensuring the best model selection.
- AlexNet, demonstrating the highest accuracy, is implemented for precise shot classification.
- The system aids in player performance analysis, coaching insights, and automated sports analytics.

NOVELTY

- Uses computer vision and deep learning to analyze athlete posture in real-time, providing instant feedback and corrective suggestions.
- Implements cricket shot classification using AlexNet, making the system specialized for cricket players.
- Predicts and warns athletes about potential injury risks by identifying improper postures and repetitive stress patterns.
- Adapts to individual athletes using machine learning, offering personalized recommendations based on performance history.
- Enables accessibility through a web or mobile-based AI platform, allowing real-time analysis from anywhere.
- Compares an athlete’s posture with professional players' datasets, providing insights into performance alignment with elite standards.

USE CASE DIAGRAM

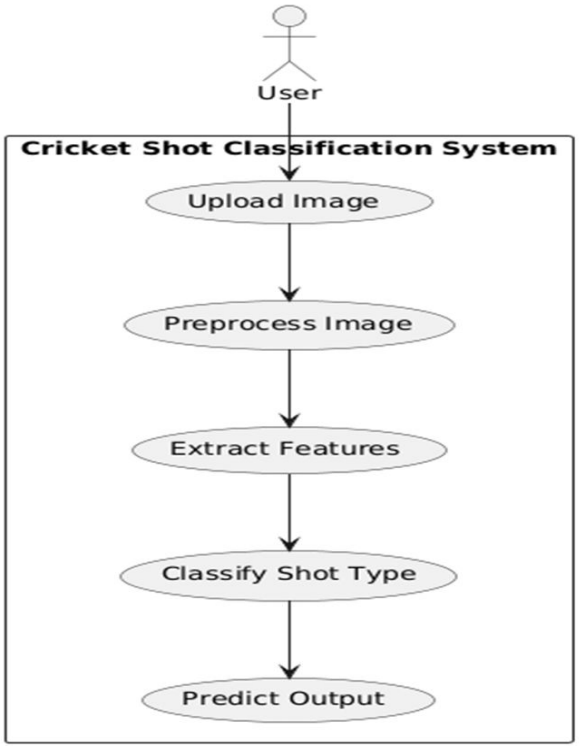


Fig 3. The use case diagram illustrates the interactions between users and the system for cricket shot classification, covering data input, processing, and prediction.

DATA FLOW DIAGRAM

DFD LEVEL 0

DFD LEVEL 1

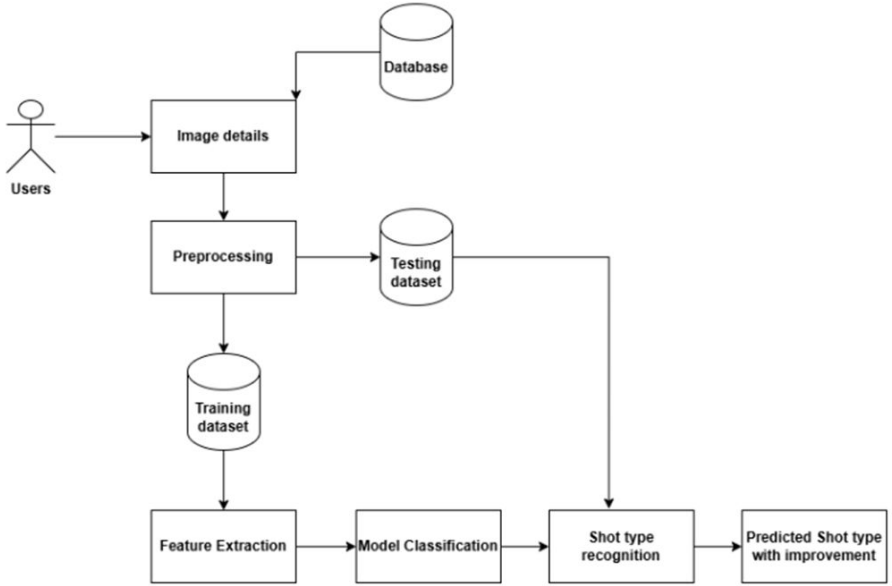
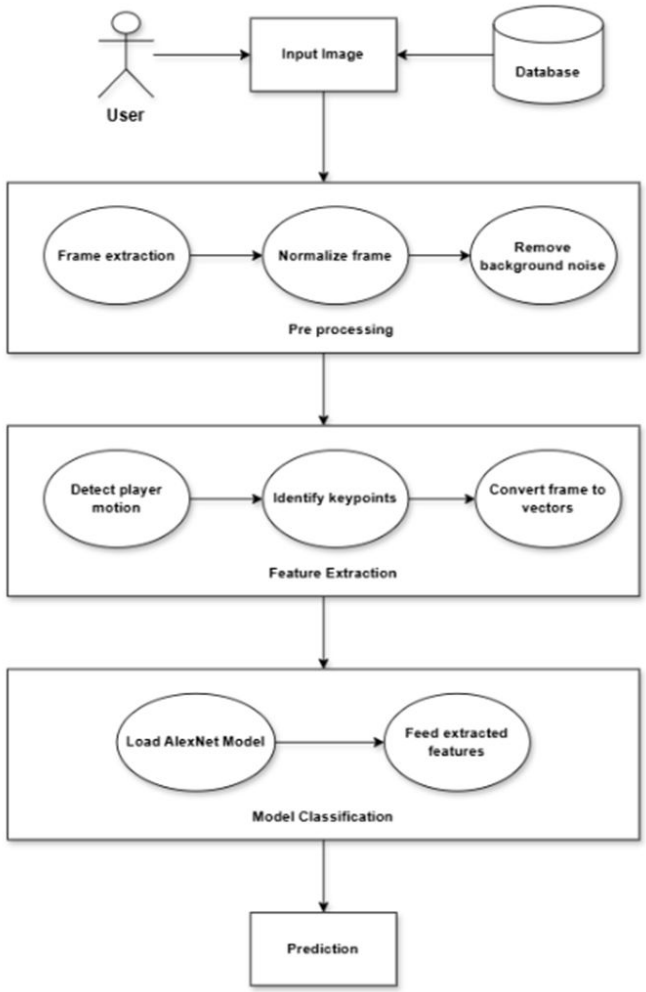


Fig 4.The DFD illustrates data flow across preprocessing, feature extraction, model classification, and prediction in the cricket shot classification system.

DFD LEVEL 2


User
Input Image
Database
Frame extraction
Normalize frame
Remove background noise
Pre processing
Detect player motion
Identify keypoints
Convert frame to vectors
Feature Extraction
Load AlexNet Model
Feed extracted features
Model Classification
Prediction

MODULES SPLIT-UP

SPORTS SHOT CLASSIFICATION:

1. Manual Net
2. VGG
3. ALEXNET
4. LENET
5. Deploy

MODULE DESCRIPTION

Sports shot classification System:

- A sports shot classification system is a powerful tool that utilizes advanced deep learning techniques, specifically Convolutional Neural Networks (CNNs), to automatically identify and categorize various sports shots, such as goals, assists, blocks, and rebounds.
- This system processes and analyzes sports video footage by extracting spatial and temporal features from the data, enabling it to distinguish between different types of shots with remarkable accuracy.
- By integrating these models into real-time applications, such as live sports broadcasting and analytics platforms, the system provides instant classification results, offering valuable insights into gameplay dynamics and player performance.
- This technology revolutionizes sports analytics by eliminating the need for manual annotation, improving efficiency, and enabling nuanced performance analysis and strategic decision-making in a wide range of sports.

1. Manual Net

- This module involves a **custom-designed convolutional neural network (CNN)** architecture, built manually to explore how different configurations affect sports shot classification performance.
- It allows for experimenting with various **layer structures, activation functions, and hyperparameters** to tailor the architecture for specific shot categories like goals, assists, or rebounds.
- By manually tweaking and training, this module provides valuable insights into **how network architecture impacts classification**, helping refine models for better accuracy in identifying diverse sports shots.

2. VGG (Visual Geometry Group Network)

- VGG, specifically the VGG16 model, is a sophisticated CNN architecture that uses **small 3×3 convolutional filters** in a deep, uniform network design.
- It excels at extracting intricate spatial features by stacking multiple convolutional layers, making it highly effective for distinguishing between visually similar sports shots like drives and flicks.
- The deeper architecture of VGG16 enables it to capture **fine-grained motion details**, enhancing its ability to analyze complex shot mechanics. Although computationally intensive,
- VGG16's structured and detailed approach to feature extraction makes it a powerful tool for **detailed classification tasks** in sports analytics.

3. ALEXNET

- AlexNet is a deep convolutional neural network known for its pioneering architecture in image classification tasks.
- It comprises **five convolutional layers**, each followed by max pooling and ReLU activation functions, enabling efficient extraction of both spatial and motion features.
- For sports shot classification, AlexNet excels at identifying key elements such as **body posture, ball trajectory, and shot execution**, ensuring high accuracy even in complex scenarios.
- Its use of **dropout layers** reduces overfitting, making it a robust choice for tasks with large and diverse datasets. Overall, AlexNet's design is optimized for extracting fine-grained details, which are essential in sports analytics.

4. LENET

- LeNet, one of the earliest convolutional neural networks introduced by Yann LeCun, serves as a lightweight and efficient baseline model.
- It consists of **two convolutional layers**, followed by subsampling (pooling) layers and fully connected layers, enabling efficient feature extraction with fewer computational resources.
- Initially designed for digit recognition, LeNet adapts well to **sports shot classification tasks with smaller datasets** or limited resolution images.
- While simpler than other architectures, LeNet remains valuable for its ability to capture **essential spatial hierarchies**, offering a cost-effective solution for sports shot classification, particularly in resource-constrained environments.

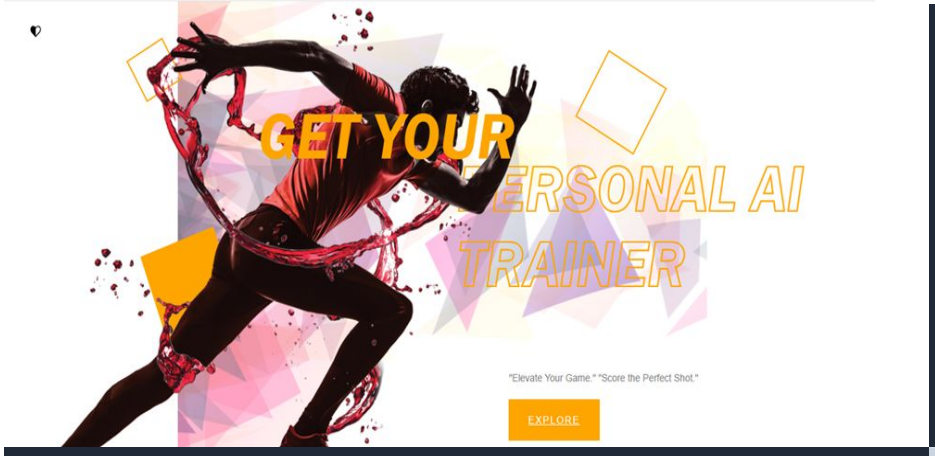
5. Deploy

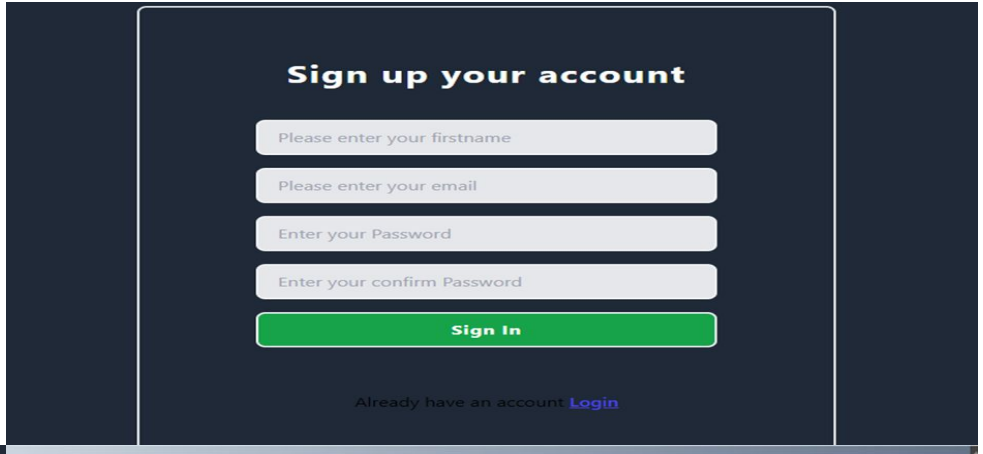
- The Deploy module ensures the seamless integration of the trained models into practical applications for **real-time sports shot classification**.
- It focuses on optimizing the system to work with **live sports broadcasting, analytics platforms, and coaching tools**, providing instant shot classification results during events.
- This module incorporates a **user-friendly interface**, allowing broadcasters, analysts, and coaches to interact effortlessly with the system, view classification results, and gain actionable insights into gameplay strategies.
- Deployment also considers aspects like **system scalability and security** to handle high volumes of live data without compromising performance or privacy.

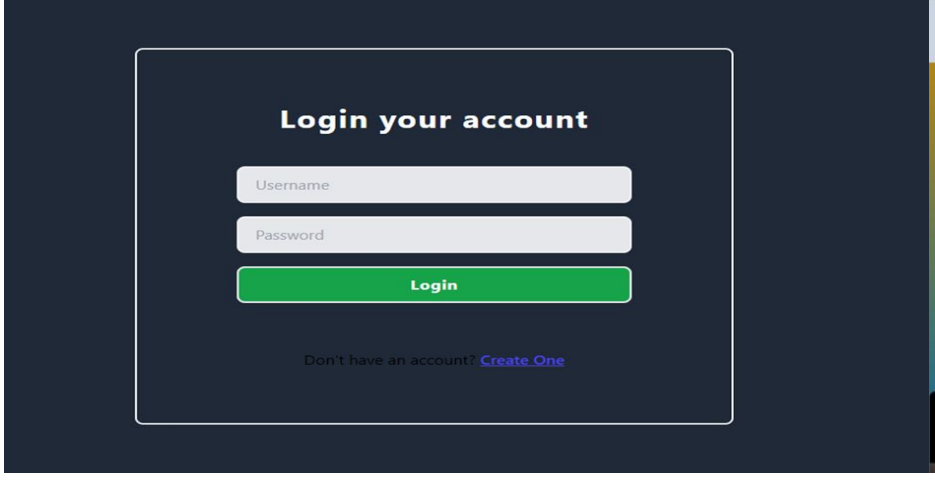
PERFORMANCE METRICS OF EACH MODEL

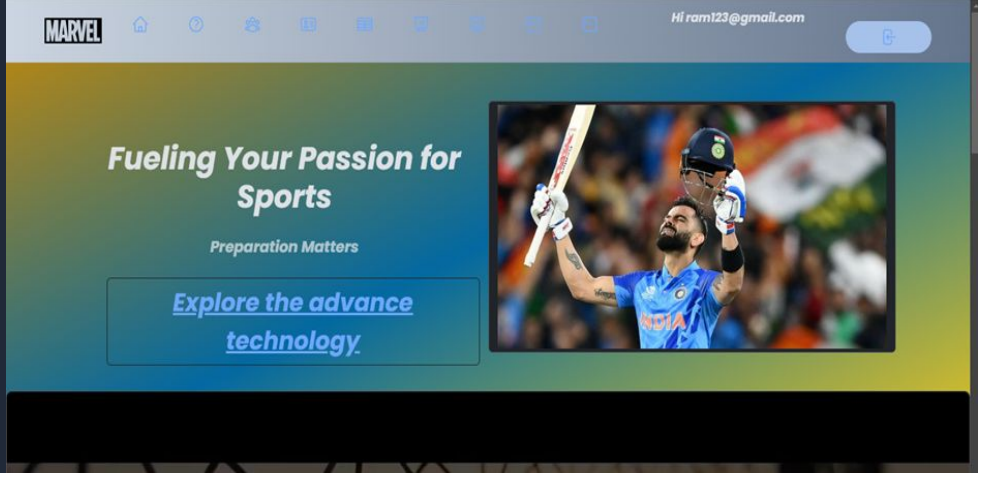
Model	Precision	Recall	F1 Score	Accuracy
AlexNet	96 %	95 %	95.5 %	99.70%
LeNet	90 %	89 %	89.5 %	96.15%
VGG16	52 %	51 %	51.5 %	50%

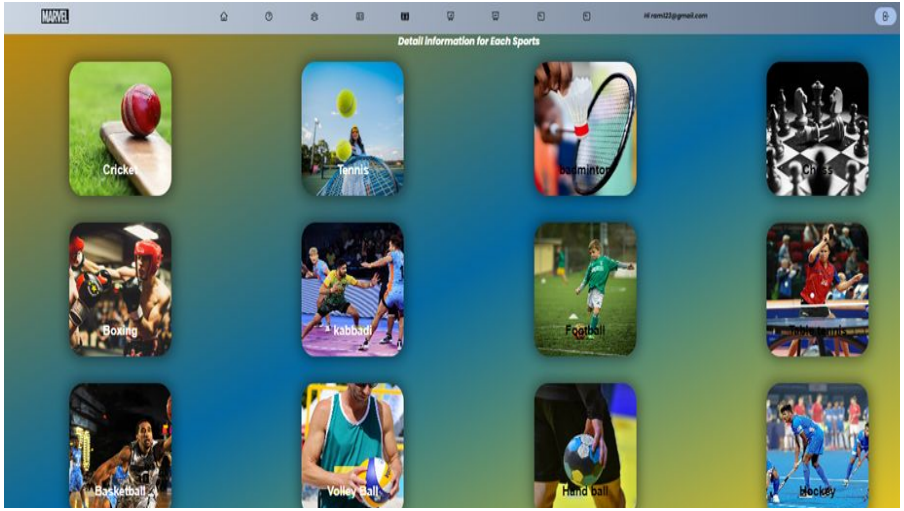
OUTPUT SNAPSHOTS







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Detail Information for Each Sports
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Tennis
Badminton
Chess
Boxing
Kabbadi
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Volley Ball
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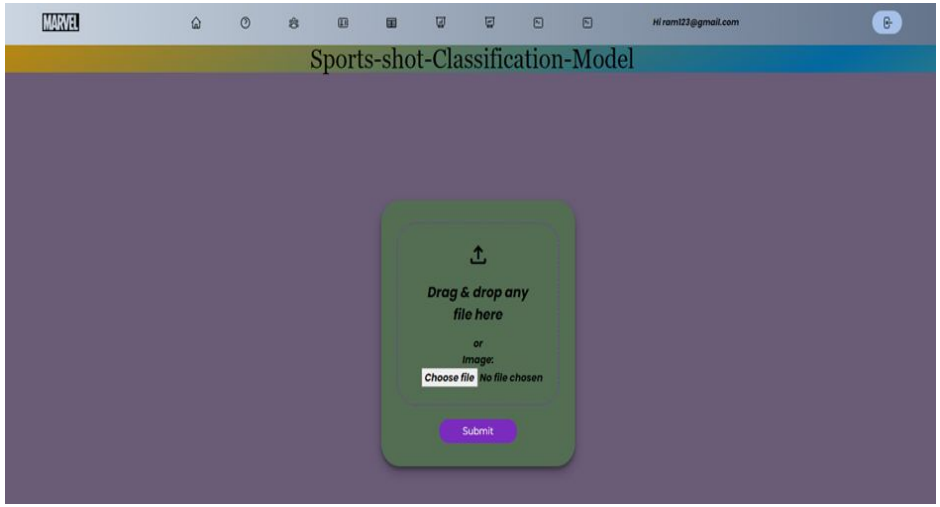
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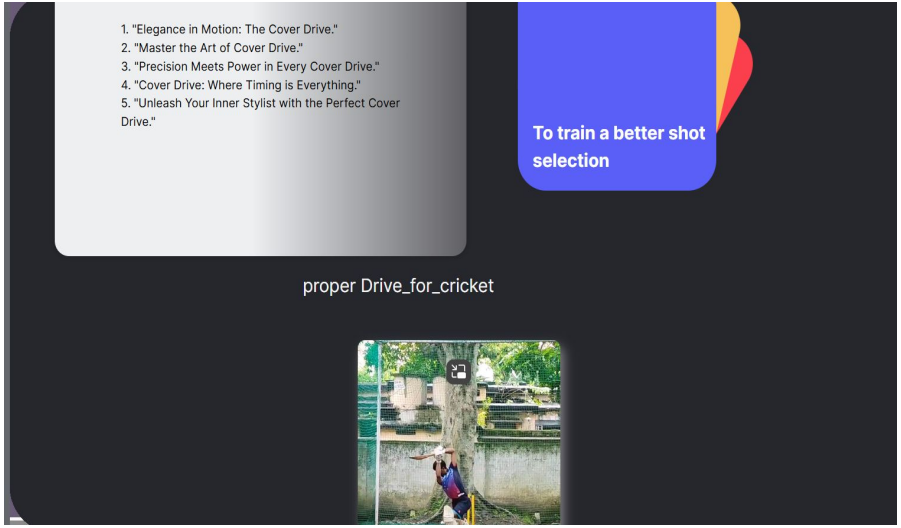
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2. "Master the Art of Cover Drive."
3. "Precision Meets Power in Every Cover Drive."
4. "Cover Drive: Where Timing is Everything."
5. "Unleash Your Inner Stylist with the Perfect Cover Drive."
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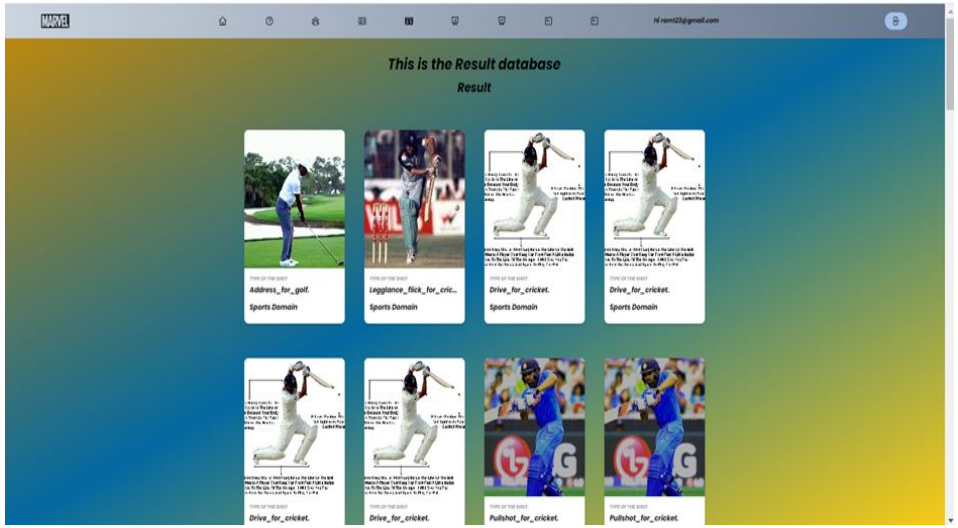
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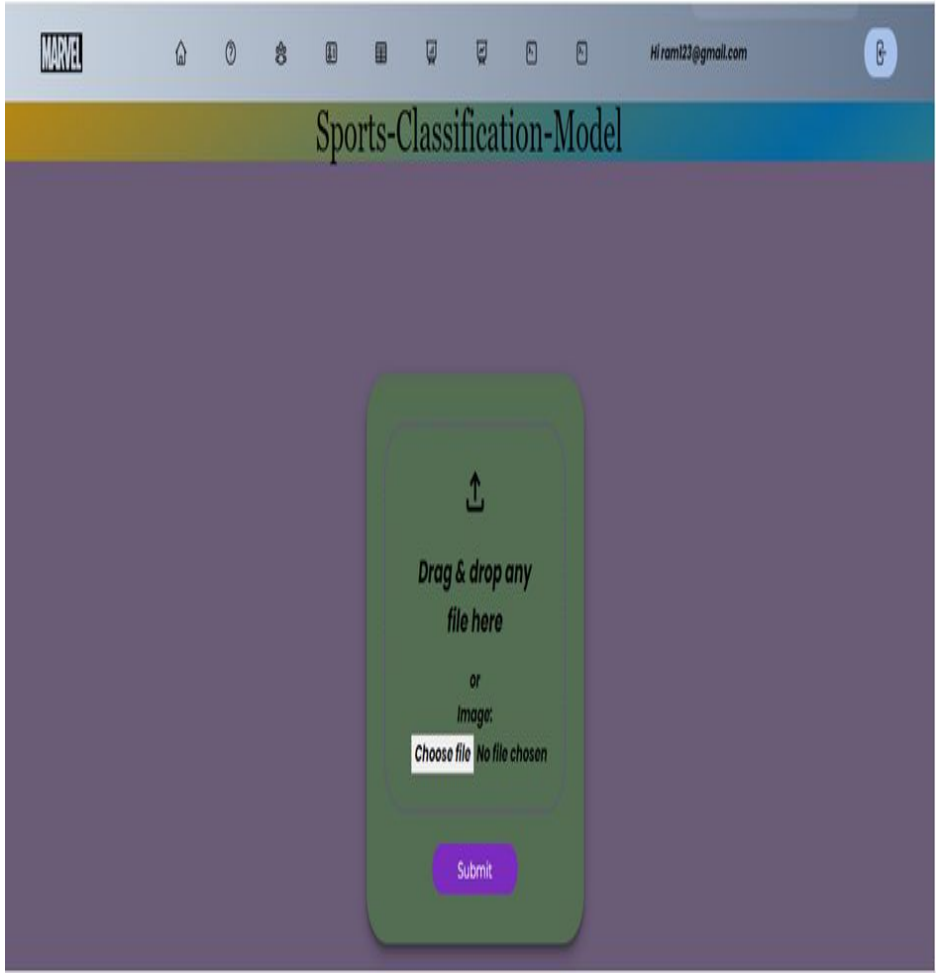

Results for Sports classification

Sport Domain is boxing

Origin:Boxing has ancient origins, with roots in Greece and Rome.

Importance:It's crucial for self-defense, discipline, and physical fitness.

Best Country The United States has a strong boxing tradition.

BestPlayer Muhammad Ali is celebrated as one of the greatest boxers.

Significant Event:The "Fight of the Century" between Ali and Joe Frazier is iconic.

Notable Female Player:Claressa Shields is a dominant female boxer in modern times.

CONCLUSION

- Advanced deep learning models like CNNs, VGG16, AlexNet, and LeNet excel in extracting distinctive features to improve classification accuracy using image datasets.
- CNNs serve as a foundation for differentiating various types of sports shots through hierarchical feature extraction.
- VGG16 extracts intricate shot-specific features with deep architecture, AlexNet improves shot-type detection with ReLU activations, and LeNet captures spatial hierarchies with its simple design.
- These models automate shot classification, offering efficiency and accuracy in sports analytics.
- They contribute to advancements in player performance assessment, broadcasting technologies, and overall sports analytics.

FUTURE ENHANCEMENT

- Fine-grained classification can provide deeper insights into player techniques and styles, while multimodal fusion (audio and biometrics) may enhance contextual analysis.
- Transfer learning, real-time feedback, edge computing, and continuous learning can improve system adaptability and responsiveness.
- Ethical considerations, such as privacy protection through federated learning, should be prioritized.
- Collaborating with sports analytics platforms can boost the system's relevance and practical applications.
- Expanding datasets to include emerging sports will ensure broader applicability across diverse sports scenarios.

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[11]. Azhar et al. (2023) introduced a Transformer-based Cricket Shot Classification model, demonstrating the applicability of transformer architectures for cricket action recognition. [DOI: 10.1109/ISPA58351.2023.10279281].

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