Parshvanath Charitable Trust's
A. P. SHAH INSTITUTE OF TECHNOLOGY
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SMART BADMINTON PLAYER ANALYSIS AND PERFORMANCE OPTIMIZATION SYSTEM

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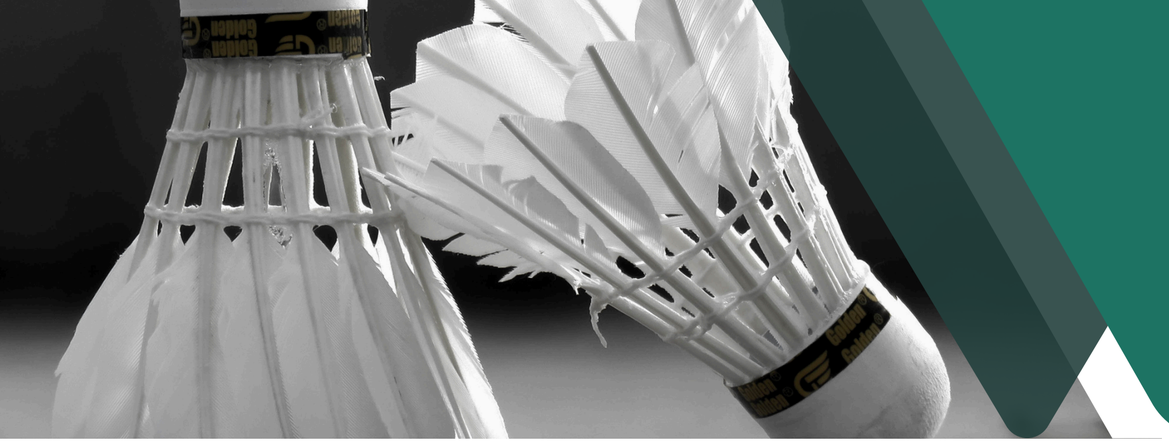


INTRODUCTION

Badminton is a fast-paced sport requiring agility, precision, and real-time decision-making. However, analyzing player performance and optimizing gameplay remains challenging due to:

01 **The rapid movement of the shuttlecock.**

02 **Difficulty in tracking player positioning and shot patterns.**

03 **Limited data-driven insights available for coaching.**

Currently, professional analysis is done manually by coaches or using expensive motion capture systems. However, these methods are:

01 **Time-consuming and subjective.**

02 **Costly and inaccessible for amateur players.**

03 **Lacking real-time insights for performance improvement.**

LITERATURE SURVEY

of the existing systems

Paper	Objective	Methodology	Key Findings	Limitations
Leong, Kah Loon, and Oleksandr Krasilshchikov. **"Match and Game Performance Structure Variables in Elite and Youth International Badminton Players."** Journal of Physical Education and Sports.	Analyzed match and game performance variables in elite and youth badminton players.	Statistical analysis of match data from international tournaments.	Identified key performance indicators (e.g., rally length, shot accuracy, physical demands).	Limited to high-level players; lacks real-time tracking.
Chien, Yu-Hang, and Fang Yu. **"Automated Hit-Frame Detection for Badminton Match Analysis."**	To automate hit-frame detection in badminton match analysis.	Developed a deep learning model to identify hit frames from video footage, using convolutional neural networks (CNNs) and temporal features.	Improved accuracy in detecting hit events, aiding in match analytics and player performance evaluation.	Performance may vary across different camera angles and lighting conditions.

Paper	Objective	Methodology	Key Findings	Limitations
Gómez, M.Á., F. Rivas, A.S. Leicht, and J.M. Buldú. **"Using Network Science to Unveil Badminton Performance Patterns."** Chaos, Solitons & Fractals 135 (2020).	Used network science to analyze badminton performance patterns.	Applied graph theory and network modeling to study shot sequences and player interactions.	Found that centrality measures can predict match success.	Requires extensive match data for meaningful insights.
Wang, Wei-Yao, et al. **"Exploring the Long Short-Term Dependencies to Infer Shot Influence in Badminton Matches."**	To analyze shot influence using deep learning models.	Implemented a long short-term memory (LSTM) network to model shot sequences and their impact on match outcomes.	Demonstrated that LSTM models can effectively capture shot dependencies, improving strategic decision-making in coaching.	Dataset used is limited to professional matches, potentially affecting generalizability to amateur games.
Rahmad, N.A., N.A.J. Sufri, N.H. Muzamil, and M.A. As'ari. **"Badminton Player Detection Using Faster Region Convolutional Neural Network."** Indonesian Journal of Electrical Engineering and Computer Science.	Developed a Faster R-CNN model for badminton player detection.	Deep learning model trained on match videos to detect and track players.	Achieved high detection accuracy, demonstrating AI's potential in badminton analysis.	Focuses only on player detection, not full performance analysis.

LIMITATIONS

of the existing systems

01 High Cost of Implementation

02 Immense Data Requirement

03 Lack of an All-in-One System

04 Limited Availability of Open-Source Solutions

05 Lack of Standardization in Metrics and Evaluation

06 Real-Time Processing Limitations

- **By leveraging deep learning techniques, pre-trained models, and cost-effective computer vision solutions, some of these challenges can be mitigated.**
- **Developing an open-source dataset and analytics framework for badminton can help standardize research in this field.**

PROBLEM STATEMENT

Problem Statement

- Analyzing badminton matches manually is time-consuming and lacks accuracy due to human subjectivity.
- Current systems focus on single aspects but no single solution provides a fully automated, lightweight system integrating all aspects.

Our Solution

- To develop an AI-powered system that processes badminton match footage, filters unnecessary frames, detects court boundaries, tracks players and the shuttlecock, identifies played shots, and generates real-time performance statistics.
- The processed data is overlaid on the match footage to produce a comprehensive, visually enriched output video.

TECHNOLOGY STACK

of our system

Python

A versatile programming language widely used for AI, data science, and automation.

TensorFlow

An open-source deep learning framework developed by Google, ideal for training neural networks.

Roboflow

A platform for managing and preprocessing computer vision datasets, making AI model training easier.

PyTorch

A deep learning framework developed by Meta, known for its dynamic computation graph and ease of use.

OpenCV

A powerful open-source library for real-time computer vision and image processing tasks.

YOLO

("You Only Look Once") A real-time object detection model designed for fast and accurate image analysis.

EXPERIMENTAL SETUP

Input

- Match footage from badminton tournaments
- Format: MP4 video files
- Frame Rate: 30 FPS
- Resolution: 720p / 1080p

Performance Evaluation Parameters

- Frame Processing Speed: FPS of the final output video
- Shuttlecock Detection Accuracy: Measured using IoU and Precision-Recall
- Player Tracking Accuracy: Bounding box IoU comparison with ground truth

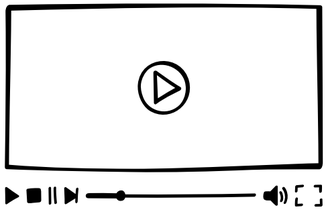
Software and Hardware Setup

- Programming Language: Python
- YOLOv8 for object detection, TrackNet for shuttle detection
- CPU: Intel i7/i9 (or AMD Ryzen equivalent)
- GPU: NVIDIA RTX 3060 or higher for real-time processing
- RAM: 16GB+ for smooth execution

Customization & Modifications

- Pretrained YOLOv8 model fine-tuned on badminton datasets to improve shuttlecock detection accuracy
- Pose estimation fine-tuned with custom heuristics to improve player shot detection
- Replay detection model trained from scratch to ensure optimal frame filtering.

PROJECT FLOW DIAGRAM

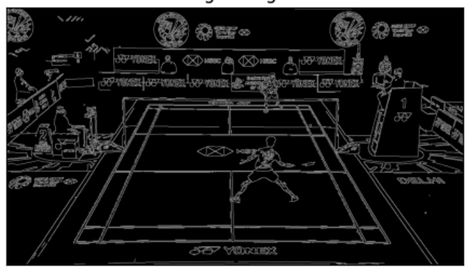


Load the video

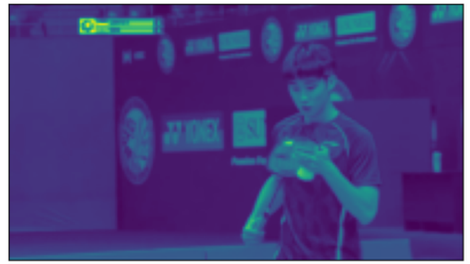
Original Image

Frame Conversion

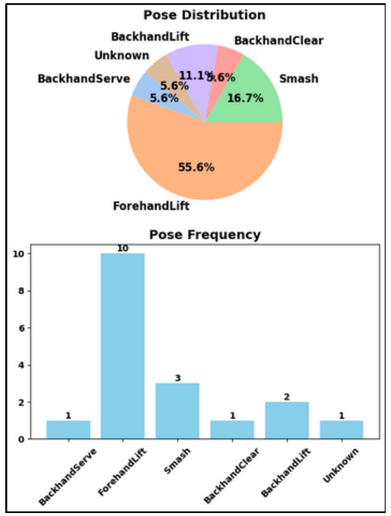
Edge Image



Court Line Detection

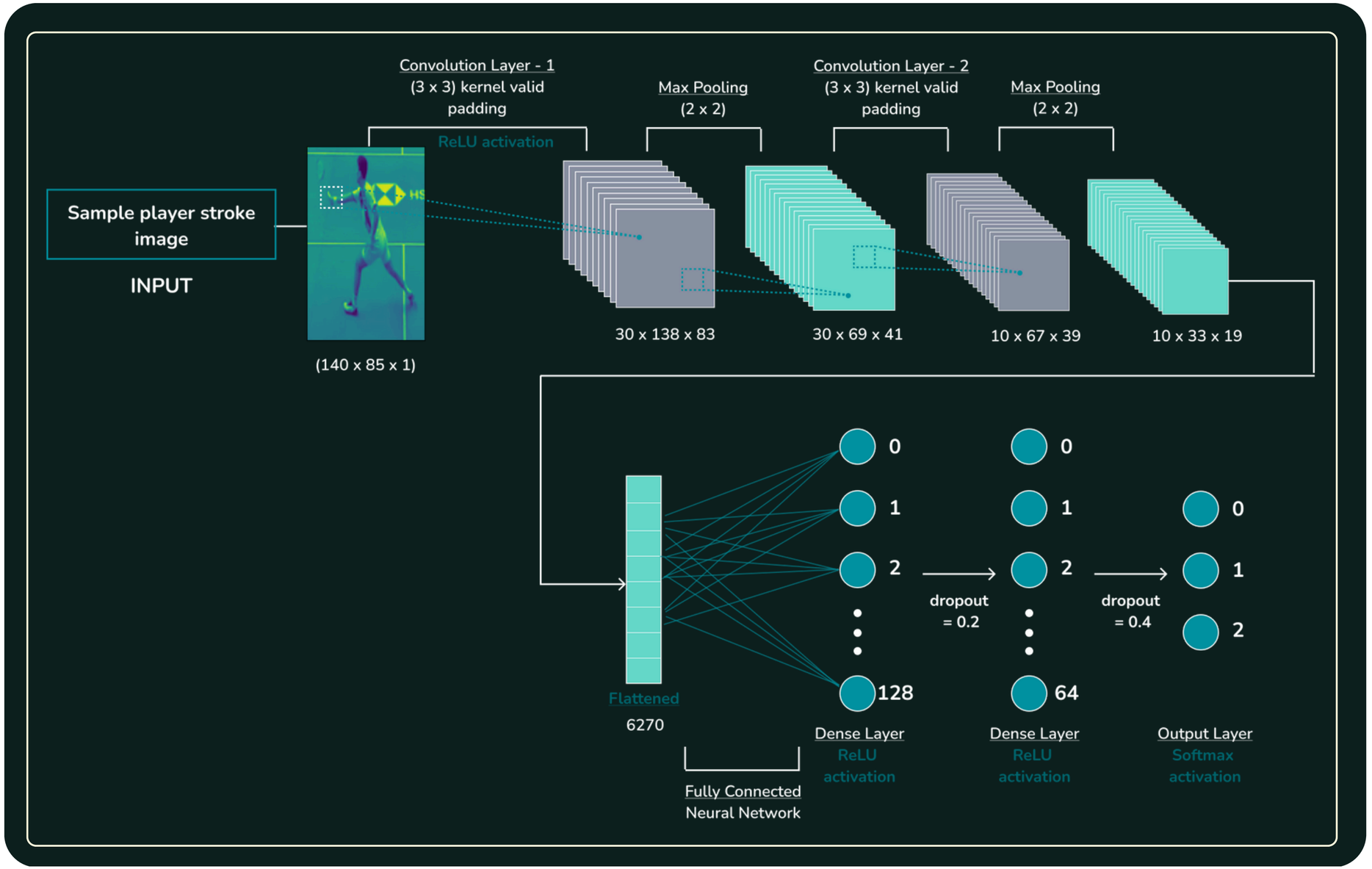


Player and Shuttlecock Detection



Pose Detection and Statistical Analysis

CNN ARCHITECTURE

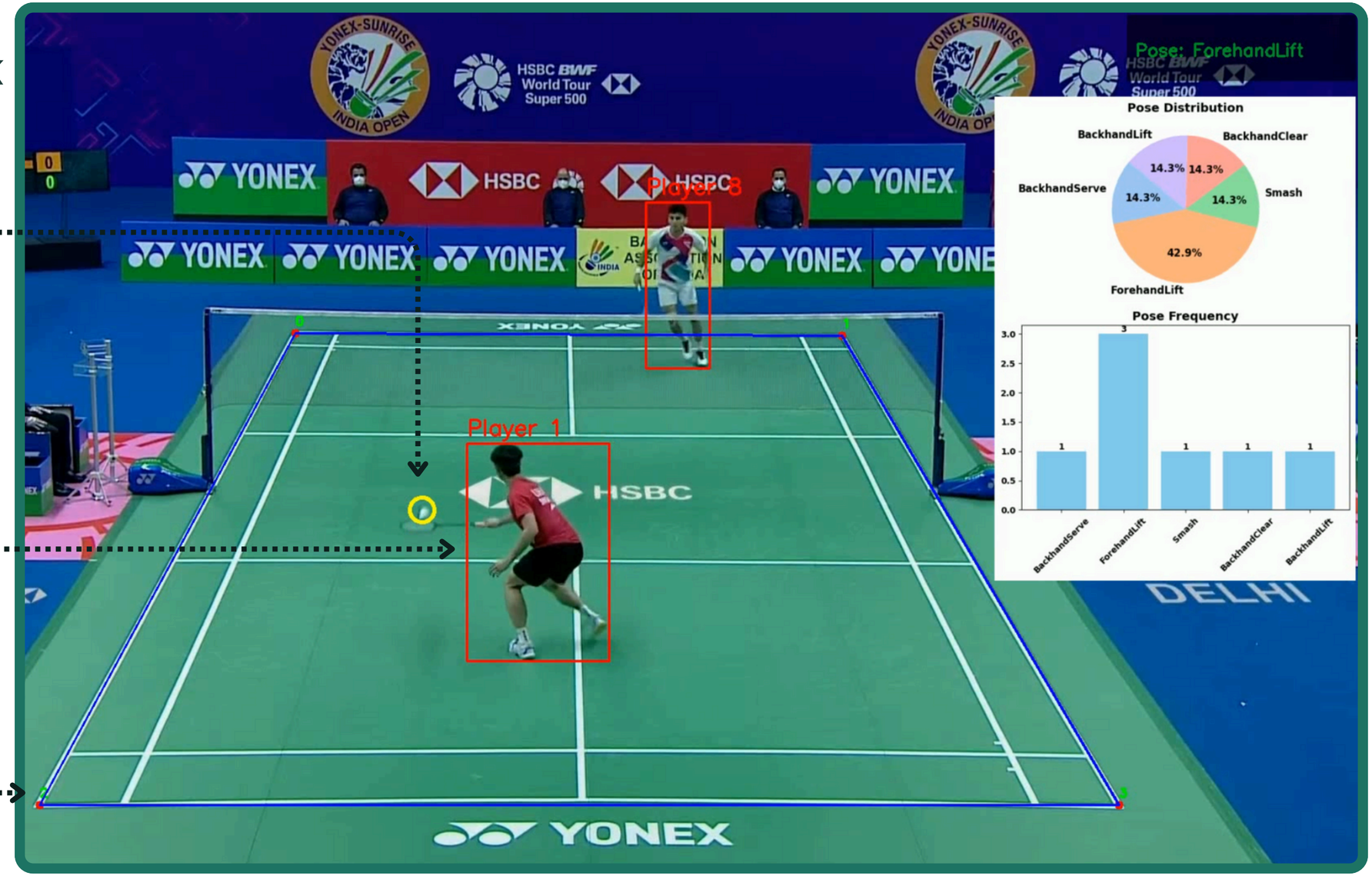


OUTPUT

Shuttlecock Detection

Player Detections

Court Line Detection



Pose Predictor

Graphical Analysis of played shots

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THANK YOU !!!