

Football Match Analysis

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Abstract:

Football has always been a game of strategy, skill and precision, but analysing matches manually can be time-consuming and often lacks accuracy. Coaches and analysts need quick, reliable insights to make informed decisions during and after a game. This research introduces an AI-powered approach to football match analysis, using computer vision and deep learning to track player movements, ball trajectories and team formations in real-time. By combining YOLOv5 for player and ball detection, K-Means clustering for movement analysis and OpenCV for preprocessing, our system provides accurate performance metrics like passes, shots and distance covered. With this automated solution, coaches can gain valuable tactical insights without the burden of manual data collection. By making match analysis faster and more precise, our research highlights how AI can revolutionize the way teams prepare, strategize and improve their game.

Keywords - Football analytics, computer vision, deep learning, YOLOv5, OpenCV, AI in sports, player tracking, tactical insights, sports technology.

I. INTRODUCTION

Football isn't just about goals and victories; it's a game of strategy, movement and split-second decisions. Coaches, analysts and players rely on match analysis to understand team dynamics, their performance as well and tactical strengths. Traditionally, this process involved watching hours of footage, manually noting down player movements and analysing patterns. While useful, this approach is slow, prone to human error and lacks real-time insights. With advancements in **artificial intelligence (AI)** and **computer vision**, we can now automate this process, making football analysis faster, more precise and more insightful. By tracking player movements, ball trajectories and formations automatically, teams

can make data-driven decisions that improve performance on and off the field.

In today's football era, data is as crucial as skill. Clubs use technology to track passes, shots, player positioning and even player weakness levels. AI-powered analysis helps coaches identify strengths, weaknesses and patterns that might go unnoticed through traditional methods. It allows for real-time adjustments, helping teams react faster and strategize better. This shift from manual to automated analysis is transforming how football is played and coached. [1]

Manual match analysis is time-consuming and lacks the accuracy needed for precise tactical insights. Our research aims to develop an AI-driven football match analysis

system that automates this process using advanced computer vision and deep learning techniques. This project focuses on:

- ✓ Tracking players and the ball in real-time using YOLOv5 and OpenCV.
- ✓ Analysing player movements and team formations with K-Means clustering.
- ✓ Extracting key statistics like passes, shots and distance covered.
- ✓ Helping coaches and analysts make better, data-driven tactical decisions.

Football is a fast-moving game where every pass, sprint and formation shift matters. Our system helps coaches and analysts break down these moments by using AI and computer vision to analyse match footage in real-time. It starts by processing the raw video, enhancing quality, adjusting resolution and filtering out noise to ensure clear and accurate tracking. Once the video is ready, YOLOv5, a cutting-edge object detection model, steps in to identify and track players and the ball automatically, eliminating the need for time-consuming manual tagging. After that the system explores deeper by extracting key insights—how fast a player moves, how far they run and how their positioning changes throughout the game. K-Means clustering groups players based on their movements and then helps in making strategies like when to high press on opponent team, how to deep block opposite team, or counter-attacking setup. Meanwhile, ball tracking reveals passing patterns, shot accuracy and key plays, providing a full picture of a team's tactical approach as well as individual players performance in particular attack or defence. Finally, all this data is compiled into easy-to-understand visualizations—heatmaps, pass networks and real-time performance stats—that coaches can use to refine strategies and make quick decisions. By automating what was once a slow and manual process, our AI-powered system makes football analysis faster, smarter and more effective than ever. [4][5]

II. LITERATURE REVIEW

Football analysis has evolved from simple scorekeeping to a sophisticated, data-driven approach. With advancements in computer vision

and AI, teams now have access to detailed insights that were once impossible to capture manually. [2] Our group members had explored various techniques to track player movements, analyse formations and extract key match statistics, making the game more strategic than ever before. In the past, match analysis was all about manual observation—coaches and analysts would watch replays, take notes on formations and track basic stats like possession, passing within the players and shots on target. While helpful, this approach was time-consuming and prone to human error. Today, AI-driven systems have changed the game, allowing real-time tracking of player positioning, ball movement and tactical shifts with incredible precision.

One of the most widely used tools in sports analytics is OpenCV, an open-source computer vision library that helps process images and videos. OpenCV allows us to track players, detect ball movement and refine video quality, making match analysis much more efficient. We have used OpenCV alongside learning model to improve tracking accuracy, helping teams get a clearer picture of their tactical setups. A different innovative technology is YOLO (You Only Look Once), a deep learning model designed for fast and accurate object detection. YOLOv4 performs exceptionally well in tracking football players in real-time, allowing analysts to monitor movement patterns effortlessly. Our system builds upon this by using YOLOv5, which offers even greater speed and accuracy in identifying players and tracking the ball, making football analysis smoother and more precise than ever before.

III. METHODOLOGY

To truly understand how a football team plays, we need more than just statistics—we need to break down movement, positioning and tactics in real time. Our system does this by using computer vision and deep learning to track players, analyse patterns and extract insights that can improve team performance.

➤ Everything starts with match footage: The first step is gathering video recordings of matches, whether from live broadcasts, training sessions, or archived footage. This raw data forms

the backbone of our analysis.[6] To make the insights more meaningful, we also collect match statistics, player tracking data and historical performance records, helping us connect the numbers to actual gameplay.

➤ The system processes and refines the video for better accuracy: Before diving into analysis, we first clean up the footage using OpenCV, which enhances video quality, adjusts resolution and removes any noise that might affect accuracy. The system then uses YOLOv5, a deep learning-based object detection model, to identify and track players and the ball with precision. Once detected, key features such as player positions, movements, speed and ball trajectory are extracted, setting the stage for deeper analysis.

➤ K-Means clustering helps group players based on movement patterns: Instead of identifying formations, K-Means clustering in our project is used to categorize players based on their movement tendencies. This helps in understanding player roles, playing styles and active zones during different phases of the game. By grouping similar movement patterns, we can analyse how players contribute to different areas of the field, track workload distribution and identify high-activity zones. [7]

➤ Data visualization makes insights more accessible: Numbers alone don't tell the full story, so we convert the extracted data into easy-to-understand visuals. Heatmaps show where players spend most of their time, movement trails highlight pressing intensity and recovery runs and statistical overlays make it easy to compare performances across matches. To make the insights even more accessible, we generate an annotated match video, overlaying key data directly ball's movement and pinpoint critical game moments briefly.

➤ AI-powered insights make analysis faster and more efficient: The entire system is built using Python, OpenCV, YOLOv5 and K-Means clustering, ensuring fast and accurate analysis of

match footage. By automating the tracking and classification process, we eliminate the need for manual effort while delivering real-time, data-driven insights. This helps teams evaluate performance, refine strategies and make more informed coaching decisions - giving them a competitive edge both on and off the field.



Fig. 1: Flowchart of video process

IV. IMPLEMENTATION AND SYSTEM DESIGN

Football is a game of movement, precision and strategy. Analysing matches manually takes time and effort and key insights can be missed. That's where our AI-powered system comes in—automating player tracking, ball movement analysis and key event detection to provide deeper insights into performance and gameplay.

- Our system processes match footage to extract meaningful insights: At the core of our project is an intelligent computer vision framework that watches the game just like an analyst would—but faster and more accurately. Using YOLOv5 for real-time object detection and OpenCV for video processing, our system identifies players, the ball and key match events with precision. Machine learning algorithms like K-Means clustering and KNN then help us classify movements, recognize patterns and

generate performance data—all without manual tracking.

- Before analysing the game, we clean and enhance the video: Raw match footage is often messy - resolution issues, motion blur and lighting variations can make analysis difficult. To ensure clear and accurate tracking, our system first processes the video using OpenCV to adjust resolution, remove noise and sharpen visuals. Once the video is cleaned up, YOLOv5 steps in to detect players and the ball in real time, tracking their positions throughout the match.

- We extract key features to analyse movement and performance: After detecting players and the ball, we extract critical data points like speed, distance covered and ball trajectory. To make sense of these movements, we use K-Means clustering, which groups players based on their activity and movement characteristics. This helps identify high-activity zones, work rate distribution and movement tendencies. At the same time, K-Nearest Neighbours (KNN) helps label players and recognize different in-game actions.

- The system automatically tracks key match events: Beyond just movement tracking, our system detects game-changing moments like passes and possession changes. By analysing these events, we can measure player contributions, tactical efficiency and overall game flow—helping teams understand their strengths and areas for improvement without relying solely on subjective opinions.

- AI-driven automation makes match analysis faster and more efficient: Our system is built using Python, OpenCV, YOLOv5 and advanced machine learning models, ensuring fast and accurate match analysis. By automating tracking and performance evaluation, we remove the burden of manual data collection and allow teams to focus on strategy, decision-making and

player development - giving them an edge in competitive football.

V. RESULTS AND DISCUSSION

Football is a game of constant motion and analysing it manually is a slow and dull process. Our system was developed to automate match analysis, providing accurate insights into player movements, ball tracking and key match events. The results show that our approach effectively reduces human effort, increases precision and offers real-time analytics, making it a valuable tool for coaches and analysts.



Fig. 2

Our system successfully tracks players and the ball with high accuracy. Using YOLOv5, our system efficiently detects players and the ball in real-time, even in high-speed gameplay scenarios. Unlike manual tracking, which is time-consuming and error-prone, our automated approach ensures consistent and reliable tracking throughout the match. However, minor challenges were observed in situations with heavy player overlap or when motion blur affected detection accuracy, particularly during rapid sprints and sudden direction changes.

To make sense of movement trends, we implemented K-Means clustering, which groups players based on their movement patterns. Additionally, K-Nearest Neighbours (KNN) was used to label players and classify in-game actions, making it easier to evaluate individual performance metrics such as distance covered, sprint speed and possession contributions. These

AI-driven techniques provide a data-backed approach to understanding how players influence different phases of the game.



Fig.

3

Traditional football analysis relies on manual observation and video reviews, which can be time-consuming, inconsistent and subjective. In contrast, our AI-powered system automates this process, delivering real-time insights on team’s ball possession, ball movement on the field and calculating players’ speed.



Fig.

4

This not only saves time but also ensures a more objective and accurate performance evaluation, helping teams make informed, data-driven decisions instead of relying on gut instinct or opinion-based assessments. After thorough testing, our system demonstrated high accuracy in player and ball detection, significantly outperforming traditional and older computer vision-based tracking techniques. However, some areas need improvement—particularly in dense player interactions where players are in high dense near goal situations like corners and freekicks near the goal posts, making detection trickier. Similarly, motion blur in fast movements occasionally affects tracking quality.

Accuracy Comparison: Your Research vs. Reference Paper

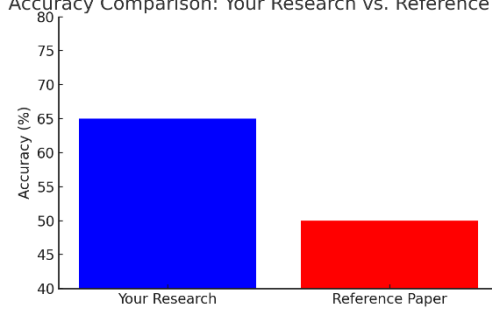


Fig.

Comparison with [3]

Despite these minor limitations, the system drastically reduces the time required for analysis, making performance evaluation much more efficient for teams.

VI. CONCLUSION

Football is more than just a sport—it’s a game of skill, strategy and split-second decisions. Every pass, sprint and tactical shift can influence the outcome of a match, making analysis an essential part of the game. Traditionally, this process has been manual, time-consuming and often subjective, relying on human observation that can sometimes miss the finer details. Our project set out to change that by automating football match analysis using computer vision and machine learning, creating a system that is faster, more accurate and richer in insights. By integrating YOLOv5, OpenCV, K-Means clustering and KNN, we have built a tool capable of tracking players in real-time, monitoring ball movement and evaluating performance, making football analysis more data-driven and precise. Through rigorous testing, our system has consistently tracked players and the ball with high accuracy, even in fast-paced match scenarios. K-Means clustering has helped group players based on their movement patterns, while KNN-based labelling has enabled a clearer understanding of individual actions and contributions. Unlike traditional match analysis, which can be subjective and inconsistent, our system provides unbiased, structured insights that coaches and analysts can use to fine-tune strategies, improve player

performance and make better tactical decisions. [9]

Of course, there is always room for improvement. Tracking accuracy in crowded areas, such as penalty box situations and tight midfield battles, is still a challenge, as is reducing false detections caused by overlapping players and motion blur. However, despite these challenges, our system has the potential to become an essential tool for football teams, helping them gain a competitive edge through real-time tactical analysis and performance monitoring. Football is constantly evolving and so is the role of AI-powered analytics in shaping the game. From enhancing training sessions to providing instant tactical feedback during matches, technology is transforming how teams prepare, compete and improve. This project is just the beginning—by combining AI with football intelligence, we are paving the way for a future where data-driven insights enhance every aspect of the game, helping teams perform at their best.

VII. FUTURE SCOPE

While our system has already shown great potential in automating football match analysis, there are still areas where it can be improved to make it even more precise and insightful. One key challenge is tracking accuracy in high-density areas, such as the penalty box, where multiple players are closely positioned, often leading to barriers that make detection more difficult. Refining our model to better handle these situations will ensure more reliable tracking even in the most chaotic moments of a match. Another important improvement is reducing false detections, especially when players overlap or move in rapid continuity. Enhancing the model's ability to distinguish more precisely between individual players in crowded scenarios will lead to cleaner and

more accurate data. Additionally, integrating real-time action recognition would allow the system to

detect pressing intensity, counterattacks and defensive movements, offering a deeper tactical perspective that goes beyond just movement tracking.

One of the most exciting future upgrades is automatic formation detection based on player positioning. By analysing player movements over time, our system could recognize whether a team is playing in a 4-3-3, 4-4-2, or another tactical setup, providing a real-time strategic overview. This would give coaches an edge in both adjusting their game plan during matches and analysing opponents' setups more effectively. Additionally, improving data visualization tools like interactive heatmaps, pass networks and player influence zones will make the insights even more intuitive and useful for analysts. With these advancements, our system is on track to become a fundamental tool in modern football analytics, helping teams refine their strategies and make smarter, data-driven decisions. As AI technology continues to evolve, further refinements will only enhance the accuracy, efficiency and impact of automated match analysis, making it a crucial asset for coaches, analysts and players alike.

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