(REVIEW ARTICLE)

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Survey on enhancing athletic training with activity recognition and deep learning

Shashank Tiwari, Hiranmayi Ch, Paul John M * and John Ricky P

Department of CSE (Artificial intelligence and Machine Learning), ACE Engineering College, Hyderabad, India.

Abstract

The proposed methodology focuses on the advanced analysis and enhancement of athletic techniques, particularly targeting the precision, angle, and positioning of movements such as shooting. By integrating technologies like Human Action Recognition (HAR), Artificial Intelligence (AI), and Deep Learning, the system analyzes player data from images or videos, identifying errors and offering insights for improvement. It suggests optimal shooting angles, positions for maximum scoring, and corrective measures to refine technique, thus aiding coaches in player assessment, strategy formulation, and tactical decision-making. The methodology employs OpenCV and Machine Learning algorithms for accurate performance analysis, while Deep Learning models, such as Artificial Neural Networks (ANN) and You Only Look Once (YOLOv8), optimize feature extraction and analysis. YOLOv8, an advanced computer vision framework, ensures precise detection of key attributes. These combined technologies enable the identification of performance flaws and guide athletes toward achieving their goals. The solution is developed using Python, OpenCV, HAR, and YOLOv8, with IDEs like VSCode and Jupyter Notebook facilitating its implementation.

Keywords: Deep Learning; Athletic Performance Enhancement; Human Action Recognition (HAR); Artificial Neural Networks (ANN); Computer Vision; YOLOv8

1. Introduction

Technology has really impacted sports by allowing the integration of hi-tech gadgets and tools into training as well as into the improvement of specific skills and overall performance levels. However, over the past couple of years, the shift has been monumental with machine learning techniques and artificial intelligence changing the face of traditional coaching. Such advances in technology have enabled one to capture massive information in order to understand the physical capacity and body motions of an athlete, in addition to the manner in which he or she applies tools or implements. Through the use of these tools, the athletes are in a position to get performance feedback and easily understand areas of strength, and weakness among other features hence enabling the athlete to tune his/her actions with high accuracy and precision. That is why the advantages belonging to such innovations are more significant in sports disciplines that require high skills and recognition of small details of work, for example, basketball and football.

The center of this change is Human Action Recognition (HAR), an innovative technique based on AI and deep learning, applied to human motion detection and analysis. In action, HAR systems can work with images or videos of athletes, from extracting the captured data to recognizing a specific motion, angle, or position. They also mentioned that in any of the sports depending on the type of sport such as football the system can determine the correct shooting posture, the angles made by the arms, feet positions, and even the path the ball takes in its flight. It also enables viewing the data in order to establish if a shot was done effectively or if there are some aspects of the technique that may reduce the chances of a player as far as shooting is concerned. These analyses allow for a level of detail that is normally not possible for a human coach to simply look at and observe, thus obtaining the benefit and value of coaching.

* Corresponding author: Paul John M

Besides specifying possible mistakes in technique, the system should provide options for correction. By means of the artificial neural network, the system can offer the proper shooting angles as well as the proper body position and movements so that the player would improve his results. For instance, when a player plays football, the system may advise the optimal shooting position for different distances to the goal post or if the angle of release is correct for increased shoot precision. Such an on-ice/off-ice support system is effective in helping the athletes fine-tune his/her strategy not only for eradicating technical faults when it comes to training but also for improving on performance efficacy as seen in the course of games. The accessibility of feedback and thus ability to make changes in training and athletes' performance on a constant basis guarantees that the athletes stay on the right track to positive development and are equipped with aspects necessary for their enhancement.

Coaches and teams of athletes are not exceptions to the influence of such technologies but also benefit from them. Because there is now a clear picture of how players move toward the ball and how they execute different skills, coaches will be able to make better-informed decisions when designing specific training sessions, organizing match strategies, and analyzing player performances. As is regarded in this case, more detailed knowledge about every player lets a coach develop the most effective strategies for training and pay more attention to the weak aspects of the game. This makes the assessment process less tender based on the abilities of the players.

Players, free from bias that may come with putting the judgement of one trainer against that of another trainer, thus presenting a clearer view of the strengths of the specific athlete in their abilities. With such kind of information, coaches are better placed to make proper strategies that are more likely to meet the team's general objectives especially when playing in other competitive teams.

In addition, this technology also allows for the constant assessment and monitoring of performance in regard to previous and new methods. If the athletes are in the process of training, then the system can always monitor the technique with which the athlete is practicing and regularly give feedback as to how the athlete's performance is improving. This way over time, an organization develops a rich performance profile that keeps track of all changes, areas of strength and weakness, and any trends that are observable. It also affords the athletes an understanding of ownership of their development hence allowing the coaches to practice informed Chile based on real-time data. Lastly, applying HAR, artificial intelligence, and deep learning to sports training, contributes to more accurate, quick, and individual training which helps athletes and coaches improve performance significantly. These technological enhancements indicate that readiness for the use of improved innovational sports training presents a brighter future for athletes.

2. Why Monitoring Athlete training with Artificial Intelligence (AI)

AI and deep learning bring about a whole new approach to athlete training for performance improvement-no longer can it be equal to other forms of training methods in terms of accuracy, efficiency, and bespoke personalization. Traditional coaching often relied on subjective assessment and can lead to differing evaluation for an athlete and thus missed some elements in that sportsperson techniques. While on the other hand, AI and deep learning application will provide objective, data-driven analyses based on motion where it can even evaluate the smallest of errors in an athlete's posture, angle, and positioning. This allows for pooling huge amounts of data and when collected from images or even videos provides real-time feedback, correcting mistakes just after they happen, thus rendering training much more effective and efficient. At the same time, these advanced techniques make progress in such systems as Human Action Recognition (HAR) and computer vision progress through which biomechanics of the athlete are tracked with a lot of accuracy in reading joint angles, alignment of the body, and patterns of motion. Such analysis would definitely be significant in refining techniques where a sport requires a high degree of precision such as football shooting, tennis serves, and sprinting. Furthermore, AI models will allow making personal training programs designed especially for each athlete's unique strengths and weaknesses; hence, each athlete's development can be focused on specific retouching areas for greater improvements. This approach not only ensures faster improvement but also makes skill refinement more targeted. AI will eliminate human bias as far as judgments are concerned so that evaluations are purely evidence-based, a parameter that is crucial for accurate performance assessment. With this technological advancement, a coach gains valuable data that can assist him in developing strategy.

2.1. Analyzing Player's Performance

2.1.1. You Only Look Once (YOLOv8)

YOLOv8, a high-quality object detection model, is essential, for example, real-time tracking of objects such as players, the ball, and specific key elements within the football pitch. YOLOv8 is a mode of operation that divides a picture into grids and forecasts the places of the objects within these grids, thus providing accurate bounding boxes for every identified item. In football terms, it means that YOLOv8 can spot each player's position but also know the precise time the pass is being made, the angle of the shot, or the direction of the ball toward the goal. For example, when YOLOv8 is activated, it can track the ball and recognize when players move even if they are blocked by the high visibility of other players or games. This power makes it particularly suitable for breaking down certain actions like goal-scoring or passing by, providing data about player positions, the body alignment at the time of the shot along with the trajectory of the ball. The strength of YOLOv8 in handling real-time objects is the fact that it can track, distinguish, and show the divisions of players, the ball, and even the environment. Thus, better hints of the game dynamic, strategies in defense, and attack can be determined.

2.1.2. OpenCV (Open Source Computer Vision Library)

For handling video feeds and doing the image manipulation tasks we use OpenCV. OpenCV is useful in football to extract frames from video footage for player analysis, ball tracing, positional play analysis. OpenCV enables us to look at these frames, and determine very subtle attributes of player posture like the angle of the foot when it proceeds with a shot or the position of the body while dribbling. It's a very detailed analysis so that coaches can really look at technique with extreme precision. Through YOLOv8, both OpenCV and YOLOv8 also work together to enhance detection accuracy by providing extra functionality such as motion tracking and background subtraction and further making it easier to analyze player movements.

2.1.3. Human Action Recognition (HAR)

Human Action Recognition (HAR) includes the action of identifying and classifying particular actions that football players take, for example shooting, dribbling, passing, and defending. HAR models will analyze video data to separate each movement into sequences, and to calculate the efficiency of execution. HAR can, for example, evaluate when and how a pass is struck by identifying the movements of the body related, the foot's approach to a strike provided by the ball, the force used and any follow through. HAR further allows the detection of defensive actions such as tackles, interceptions, and the positional adjustments, done in real time [1] for different football positions/values. HAR gives coaches the ability to give players a lot of pointed feedback on their technique and timing for each action.

2.1.4. Artificial Neural Networks (ANN) / Convolutional Neural Networks (CNN)

The deep learning models used to analyze football performance are based in artificial neural networks (ANNs) and convolutional neural networks (CNNs). In particular, CNNs are the perfect tool to analyze images and videos, since they learn features automatically from images without any intervention required. CNNs can take on analyzing complex patterns in player positioning, ball trajectories, and movement sequences in football. As an example, CNNs can extract [2] patterns on a player's dribbling technique, such as body motion coordinated, or analyze a player's game [3] sense in defensive as an example. Analysis of video data requires ANNs and CNNs, which are able to process vast amounts of video data in order to identify the subtle performance details, like how a player moves his position around the ball or the opponent.

2.1.5. Google Colab

The deep learning models are built, tested and iterated upon inside of the cloud based development environment Google Colab. This gives us easy access to the computational resources, which are essential for processing big set of football videos and training of complex models [4] like YOLOv8, HAR and CNNs. Given its utility, Google Colab can help developers and researchers run models for large scale these football dataset with real time feedback to improve the model. Integrating with the popular Python libraries such as Tensor- Flow, OpenCV, and PyTorch, Performance Coach [5] makes it easy to collaborate between coaches, data analysts, and developers to foster fast iterations and seamless deployment of performance accelerating systems.

3. Conclusion

Therefore, the suggested approach represents an integrated and original framework in increasing the performance of the athletes, most especially those involved in the precision- intensive sports other than shooting. The oversubscribed program that leverages HAR technology, advanced concepts like Deep Learning, and YOLOv8 allows real-time performance tracking and instantly recognizes errors explaining how to fix it. It is achieved with the help of integration of AI and computer vision techniques, which provide accurate feature extraction for providing coaches with useful information regarding training and tactical decisions. This approach is as helpful for honing player technique as it is for helping extend the capabilities of sports analysis to create a more effective model for athlete cultivation. That the proposed solution relies on platforms like Python, OpenCV, YOLOv8 then it is probable to present improvements in future sports analysis.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest to be disclosed.

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