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AI Applications in Sports Training: A Case Study on Table Tennis

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ABSTRACT: This paper describes an AI-driven system for skill assessment and feedback related to table tennis. Thanks to pose estimation, object detection, and edge detection, the system monitors how players use their bodies and contact the ball and racket. The resulting system demonstrates that AI can boost coaching by giving instant feedback in the form of both visual and analytical data. This research identifies how artificial intelligence might greatly change current ways of coaching sports.

KEYWORDS: AI in Sports, Table Tennis, Pose Estimation, Edge Detection, Computer Vision, YOLO-NAS, Object Detection, Sobel Filters with AI.

I. INTRODUCTION

Many fields, such as sports, now use AI to improve how teams are analysed and coaches operate. Since precision, speed, and coordination are important in table tennis, real-time suggestions help boost your abilities. When hand coaching occurs, it is not always possible to accurately identify and evaluate the motion correctly every time. In this paper, we examine how AI and computer vision can make skill assessment easier by providing feedback that is easy for trainees to see.

II. LITERATURE SURVEY

Recently, sports training has seen AI integrated, mainly into activities such as estimating poses, assessing motions, finding object edges, and providing feedback on training skills. The method looks at how to estimate human poses and analyze their movements. Pose estimation is among the most important advances in sports AI. OpenPose, first described by Cao et al. [1], is a system that can detect multiple persons and their joint locations using part affinity fields in real time. It forms the base for many different tools that athletes use when training. Liu et al. [2] made a system that uses deep learning to observe a player's poses and movements during tactical training in badminton. Information from pose analysis helps to guide players and build strong skills important for success in table tennis.

Identifying edges and following objects with CCTV. The method of edge detection is employed to show boundaries, which is advantageous for sports that need careful tracking of the playing area. According to Szeliski [3], Canny edge detection is a useful algorithm for finding image structure. Using video analysis, this idea has worked for soccer [4] and tennis [5] to locate players and balls, and it can be useful for table tennis when highlighting boundaries, bats, and nets along edges.

Audio Intelligence in Systems for Coaching and Feedback: It is now believed by experts that AI can be used to provide feedback and perform coaching tasks. Zhang et. al [6] trained a CNN model to recognize the different tennis serves found in gameplay videos. A similar system was developed by Wang et al. [7], providing visual advice and movement instruction which helped improve table tennis performance during training sessions. They reveal that combining AI and video analytics improves sports coaching for individuals. Some of these applications have succeeded but require either advanced tools or are mainly useful for experts. The research area I've reviewed is important, but what I add goes beyond it because I use tools that beginners can understand and use, like OpenCV and Google Colab.

III. METHODOLOGY

The system was implemented using Python in a Google Colab environment, utilizing libraries such as OpenCV, NumPy, and Matplotlib. The methodology included:

1. Capturing input frames from video footage.
2. Applying edge detection algorithms to identify the outline of players and the table.
3. Simulating ball movement using random pixel plotting and frame iteration.
4. Overlaying visual elements such as lines and markers for training feedback.

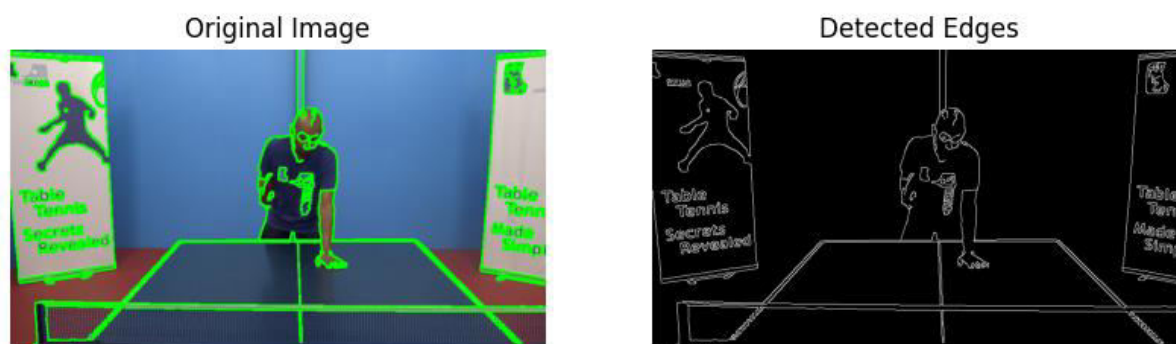
The system includes three important parts:

1. Pose Estimation Cognitive systems use these libraries to check the player's posture, with most attention on their hand and arm movements to assess shots.
2. Detection of Objects and Tables Using Edge Information: Edge detection with the Canny filter easily brings out the important borders in the video, such as those of the table, the player, and the racket.
3. Random Ball Throw Model: The system tests players by throwing balls at various angles and speeds and records when they detect them.

All steps in the pipeline were performed in Google Colab using both annotated videos and labelled frames.

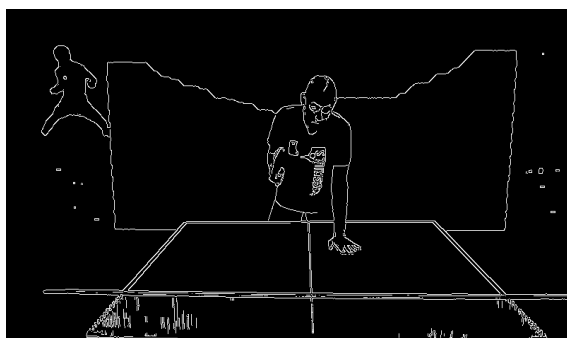
IV. EXPERIMENTAL RESULTS

✦ FIGURE 1: POSE ESTIMATION AND EDGE DETECTION



"ORIGINAL IMAGE WITH DETECTED EDGES AND HUMAN POSE OVERLAY"

✦ Figure 2: Enhanced Edge Detection



"Refined edge detection of player and table using OpenCV"

✦ Figure 3: Random Ball Simulation



"Simulated red dot to mimic random ball throw during training"

The AI model makes it easy to see and understand information about each player. Since we don't measure precision or recall numbers, coaches or players can observe mistakes in movement patterns from the annotations. Relying on open-source tools makes the system both economical and flexible.

V. CONCLUSION

With the use of AI, this table tennis training tool assesses someone's visual ability. Though at present we rely on edge detection and pose estimation, future efforts may use deep learning algorithms for comparing poses and scoring them automatically. This project demonstrates how AI is becoming essential in today's coaching systems, mainly for table tennis.

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