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Pd. 5

Proposal
AI Badminton Coach

Badminton is not a very popular sport in the US. The US has never won an Olympic medal of any kind in badminton. The majority of badminton clubs in the US are in California, and there is only one club in Virginia, located in Ashburn, with dedicated badminton facilities. In southern California, the price of badminton coaching can range from $50-100 per hour, which makes it very hard to get regular practice and coaching for lower income families. With the combined difficulties of finding, and securing transportation to, a location to practice at, on top of having to pay expensive fees for coaching, it can be a challenge for, especially lower income, athletes interested in badminton to get into the sport. We plan to develop an AI-powered app for badminton that leverages advanced computer vision and machine learning techniques to enhance players' skills by analyzing their stroke techniques and offering personalized feedback. Unlike traditional coaching, which is limited by the availability and cost of personal trainers, this AI system will enable players to receive continuous, precise feedback through video recordings, significantly reducing the need for frequent in-person coaching sessions and making high-quality training more accessible.

Background

There have been some attempts to develop an AI badminton coach. A group of three students at MIT-WPU in Pune, India have published a paper on their research developing an AI which takes data from a ‘smart racket’ and badminton videos to perform sports analysis. They do not explicitly state the accuracy they achieved, but they mention that a key issue in their research was the need for cleaner data to improve accuracy and efficiency.

To enhance our dataset, we are going to be using the VideoBadminton dataset, compiled by five students from Auburn University and National Central University in Taiwan. This dataset is derived from high-quality badminton footage, and could be a useful starting point for developing our dataset, providing clean, high quality footage of badminton form and technique.

Additionally, the software tools that we are going to use have also considerably improved over time. The MIT-WPU team, for example, used YOLOv3 for object detection, we will adopt YOLOv9-a more recent version. Newer versions of YOLO indeed have different enhancements, including accuracy improvements, faster processing times, and better usage of computational resources. For example, YOLOv9 has enhanced capabilities for occlusion handling and multi-scale detection, which means it will be even more reliable in identifying players and shuttlecocks under different conditions. This will further enable more accurate and smooth analysis for improving players.

Jacob Dipasupil

I've had a passion for computer science from a young age, and I've been expanding my knowledge and expertise during my time here at TJ. Before TJ, I completed the Harvard CS50 course online which provided me with a strong general knowledge and foundation for computer programming and web development. This past summer I also took a machine learning course at MIT for a summer program called MITES. At TJ, I've taken Foundations of Computer Science, Data Structures, and Artificial Intelligence 1&2, and I am currently taking Machine Learning. This project concerns a great deal of AI and ML knowledge, so my background in those topics will be particularly helpful. However, this project also requires knowledge of computer vision concepts and techniques along with mobile app development, which I am not very familiar with. Fortunately, there are pre-existing projects which can serve as a stable stepping stone for us into the world of computer vision. Mobile app development tutorials and resources are also readily available online so we will have to apply those concepts and techniques to our specific project.

Ipek Sayar

I have a strong background in computer science, thanks to my family's influence and my own experiences. Growing up, I had watched my mother and father in the field of computer science. I would occasionally visit my Dad's work place and be fascinated by how everything worked. This summer, with the Inspirit AI program, I worked on a project called "Criminal

Justice" that aimed to decrease racial bias within the justice system. We discussed different ways to frame the definition of fairness, then identified sources of bias and reapportioned input to the AI to limit biased results. I got experience creating an AI from scratch and fine-tuning the model for better accuracy. I also got experience using TensorFlow and PyTorch to easily create the machine learning model. I also worked as an intern for Dreamwave AI for two years, a startup focused on creating realistic photos through the use of AI. The tasks assigned during my first year included writing captions to enhance the training of AI and selecting the best photos out of many to be sent to the clients. In the second year, I contributed to training the AI by picking and processing the images uploaded by the clients. This internship has provided me with practical experience in using artificial intelligence and machine learning techniques in real-world applications. Currently, I have taken or am taking all the computer science classes available at TJ; specifically AI, CV, and ML which we'll need the most knowledge of for this project. These classes, along with my projects and internship experiences, have given me solid programming skills and a deep understanding of the field.

Project Summary

Objective

We plan to develop an AI-powered coach for badminton that leverages advanced computer vision and machine learning techniques to enhance players' skills by analyzing their stroke techniques and offering personalized feedback. Unlike traditional coaching, which is limited by the availability and cost of personal trainers, this AI system will enable players to receive continuous, precise feedback through video recordings, significantly reducing the need for frequent in-person coaching sessions and making high-quality training more accessible.

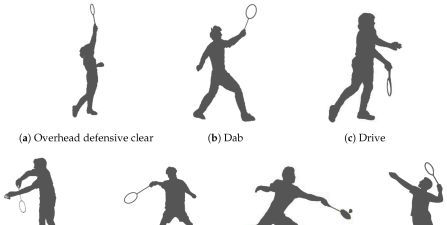
To maximize accessibility, we will make this AI coaching system available as a mobile app. By doing so, players from various backgrounds, especially those who cannot afford the high-priced coaching resources, can benefit from the AI's feedback anytime and anywhere. This mobile platform will ensure users can easily upload videos, receive tailored feedback, and track their progress over time from the convenience of their device. Our overall goal is to make badminton training more accessible and inclusive than ever for athletes of any skill level.

Steps

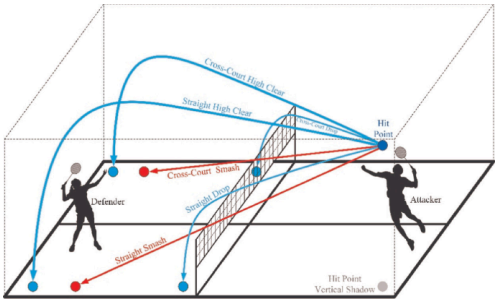
- Record videos of ourselves playing badminton to create the “Novice”
    - Novice’s data is the one we're trying to improve. The player's data will be compared against the professional standard in order to help them get better.
- Use the VideoBadminton Dataset for “Professionals”
    - This dataset will provide our benchmark of professional movements. The Professionals’ moves will serve as the target for which the Novice is trying to match or improve upon.
- Use YOLO for shuttlecock detection
    - YOLOv9 will help us automatically detect and localize the shuttlecock in each frame. By providing bounding boxes, it ensures we can focus on our movements and the shuttlecock’s position.

- Clean and preprocess the data: remove any noise or distractions from the frames, so only the player and shuttlecock are visible.
    - We’ll clean the dataset by cropping out the unnecessary parts and ensuring only the relevant moves and players are left. This keeps the data focused and clear for better analysis.
- Use OpenPose on both the Novice and Professionals datasets to both detect the player and do joint recognition.
    - OpenPose will track and analyze body joints (arms, legs, torso) to capture how we move. By applying OpenPose, we’ll generate skeletal data for each player, allowing us to compare our movements directly to those of the professional player.

- Use TrackNet to generate a heatmap showing where the shuttlecock lands during different types of shots.
    - The shuttlecock’s flight path is crucial for understanding the effectiveness of a shot. TrackNet will help us understand how effective our shots are by tracking the shuttlecock’s flight path.



- Organize the data by labeling each frame with both the type of move (e.g., "Smash," "Lift") and the corresponding joint and shuttlecock data.
    - Our recorded videos need to be labeled to give context to the AI. Each frame or image should be categorized by the type of move so the AI understands what it's analyzing. Additionally, once we've used OpenPose for joint recognition and TrackNet for shuttlecock tracking, we'll label the joint and shuttlecock data. This provides a full picture of our performance, helping the AI understand how our body movements impact the shuttlecock's path.



- Train the neural network using the Professionals' training set
    - The AI needs to learn from our labeled data to understand the relationship between body mechanics and shot success. By using unsupervised learning, we can analyze the effectiveness of each shot without relying on predefined labels (as done in the MIT-WPU paper) . This approach allows the model to find patterns in the mechanics of different shots and their outcomes, helping us understand which movements lead to more successful plays.
- Feed in the Novice's dataset and have the model classify the accuracy for each move.
- Have the model give feedback on our weaknesses, showing us which moves are incorrect or inefficient.
    - By comparing our movements to the Professionals', the AI will highlight where we need to improve. We'll use this feedback to improve our form and performance over time.
- Develop a Database to quickly identify the Next Best Move (NBM) based on relevant and actionable data.
    - Collect comprehensive match data, including birdie trajectories, player actions, and court positions of both players. The database should document every rally, capturing both successful plays and mistakes.
        - This database is the core of the AI's decision-making process. By compiling extensive real-game scenarios, we provide the AI with a realistic foundation to learn from, allowing it to make informed

recommendations based on actual patterns of play rather than hypothetical models.

- Calculate the probability of success for various moves. Use the metric: number of shots that an opponent fails to receive compared to total attempts when positioned in specific areas of the court.
    - These probabilities help the AI understand which plays are most likely to succeed under different circumstances. It models real gameplay dynamics, where success often depends on exploiting the opponent's weaknesses.

- Put Everything into an App for Easy Access
    - Create an AI-powered app to make high-quality badminton training accessible to a broader audience, especially lower-income athletes.
        - Put in the form correction and the game play analysis as separate options.

Background: what has been done so far? What do you bring to the table (skills/knowledge, family member with knowledge, internship experience)

Actual part: what you plan to do and HOW you plan to do it. Be very very detailed and as specific as possible

References: if you say something is commonly known and gabor does not know it…… (include the place that said that it was common knowledge). If you say that such and such companies work on doing research on __. Include what the companies are in the references.

Normally about 1-2 pages total. 1.5 spacing. Double too much

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