# Demo: Volumetric Motion Annotation and Visualization for Immersive Sports Coaching

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Figure 1: Augmented Coach demo setup, comprising Kinect cameras, Meta Quest headsets, and TV displays for observation. Inset: Volumetric annotated view of athlete in Meta Quest headset.

## ABSTRACT

The demand for remote sports coaching is on the rise due to geographical constraints and busy schedules faced by coaches and athletes. Traditional methods of remote coaching rely on 2D video formats, which limit spatial information and interactive engagement. In this extended abstract, we introduce our technical demonstration of Augmented Coach, an immersive remote sports training tool that leverages virtual reality technologies to address these limitations and enhance the coaching experience. Our demo uses Azure Kinect cameras and Meta Quest VR headsets to host a simulated athlete-coach interaction over volumetric captures of athletic performance.

This is a companion demo to the IEEE VR 2024 Conference paper: "Augmented Coach: Volumetric Motion Annotation and Visualization for Immersive Sports Coaching."

## 1 INTRODUCTION

Remote sports coaching has become increasingly relevant in a world where geographical constraints and busy schedules often hinder athletes and coaches from being physically present during training sessions. Traditional remote coaching methods have long relied on 2D video formats and video conferencing tools such as FaceTime and Zoom. While these solutions offer a degree of remote connectivity, they come with inherent limitations, particularly in terms of providing spatial information and fostering interactive engagement.

In response to these challenges, we introduce Augmented Coach, a system that harnesses the capabilities of volumetric capture and virtual reality (VR) technologies to provide interactive guidance over the spatial data to assist in the remote sports coaching landscape. As such, Augmented Coach is designed to not only overcome the constraints of traditional coaching methods but also unlock new spatially oriented possibilities for athletes and coaches alike.

VR provides a three-dimensional and spatially accurate representation of the training environment. This helps athletes and coaches better understand the spatial dynamics of movements [1]. Besides this, VR can provide advanced annotation and visualization tools. These tools contribute to a more comprehensive understanding of the performance, allowing coaches to offer precise feedback.

## 2 SYSTEM OVERVIEW

Augmented Coach is a remote sports coaching system that employs volumetric capture and virtual reality technologies to overcome limitations in traditional coaching methods.

### 2.1 Kinect-based Athletic Capture

The Augmented Coach system is equipped with four Microsoft Azure Kinect DK sensors, strategically positioned at the corners of a 134-inch by 134-inch training space. These sensors are synchronized via audio cable and connected to a Windows computer. The Kinect
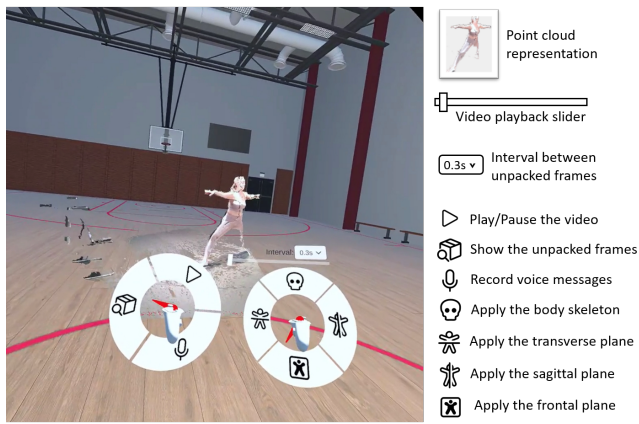
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Figure 2: Primary User Interface of Augmented Coach.



Figure 3: The Planes of Motion visualization shown here can assist this yogi in studying her alignment and weight distribution.

sensors capture volumetric data from athletes' movements with precision. Athletes perform various athletic motions within the capture space, and the synchronized Kinects record this data in three dimensions.

Captured volumetric video files are processed and stored on the connected Windows computer. From the computer, the files can be trimmed for length and labeled for access and usage in the virtual reality experience.

### 2.2 Integration with Meta Quest 2

The Meta Quest 2 VR headset serves as the interface for athletes and coaches to interact with the captured data. Upon launching the Augmented Coach application on the Meta Quest 2, users are presented with a virtual basketball court. Users select their role, coach or athlete, and access their scheduled training sessions through an intuitive user interface. The relevant volumetric data is pulled up to be viewed spatially. Coaches can use the VR headset to provide real-time feedback and guidance, creating a dynamic and collaborative training environment. Athletes can immerse themselves in their own annotated movements, gaining valuable insights into their performance.

This integration ensures that athletes and coaches can engage with training sessions as if they were physically present in the same location, regardless of their actual geographical distance. The coach/athlete duality is a key component of the Augmented Coach system's ability to deliver effective remote sports coaching.

### 3 VOLUMETRIC COACHING TOOLS

Augmented Coach offers a suite of coaching tools that leverage the captured volumetric data to provide coaches with insights into athlete movements. These tools are designed to enhance the coaching experience and fostering athlete improvement.

### 3.1 Frame Unpacking

One of the fundamental coaching tools provided by Augmented Coach is the ability to "unpack" and "repack" past-to-present frames of an athlete's performance. Coaches can break down a frame sequence by specifying the number of steps to display and the playback length. This feature allows coaches to closely examine specific moments within an athletic motion, facilitating a detailed analysis of technique and form.

### 3.2 Skeletal Overlays

To further aid in technique analysis, Augmented Coach offers skeletal overlays. Coaches can visualize the athlete's skeletal structure superimpose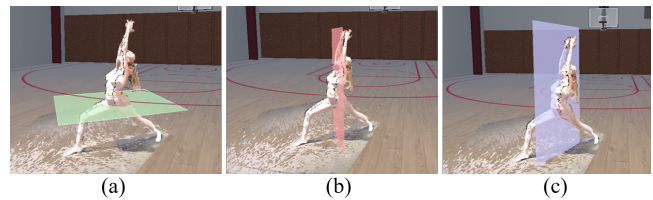d on the volumetric data. This visualization provides crucial information about limb alignment and joint angles, enabling coaches to identify areas for improvement and make precise recommendations for adjustments.

### 3.3 Joint Tracking

Joint tracking is another tool within the Augmented Coach system. Coaches have the ability to highlight specific joints of the athlete's skeleton during playback. This feature allows coaches to track the trajectory or path followed by a particular body segment, consisting of one or more joints, throughout an athletic movement. Coaches can gain a comprehensive understanding of limb movement and skeletal alignment, essential for fine-tuning an athlete's form.

### 3.4 Motion Plane Overlays

Augmented Coach also includes views of "Planes of Motion," shown in Figure 3. These planes, derived from the athlete's skeletal structure, represent different anatomical planes along which movement occurs in the human body, including the sagittal plane, frontal plane, and transverse plane. By visualizing these planes, coaches can observe weight transfer and body movement, providing invaluable insights into an athlete's performance. Coaches can choose to apply either the sagittal plane, frontal plane, or transverse plane visualization as needed for specific coaching scenarios.

The volumetric coaching tools empower coaches with a rich array of resources for analyzing and enhancing athlete performance. These tools collectively contribute to a comprehensive understanding of athlete movements, towards enabling coaches to deliver insightful feedback. We direct readers to our paper [2] for further analysis, including user studies around the system's usability and effectiveness in athlete and coach usage.

### 4 CONCLUSION

The Augmented Coach system components, including Kinect-based motion capture setup, VR headset rendering, and interactive user interfaces, form a platform for coaching review, allowing coaches to offer data-driven feedback and enhancing remote coaching interactions. Beyond this, the platform also constitutes research infrastructure for continual investigation into advanced user interface design, 3d visualization, and real-time collaborative networking systems.

### REFERENCES

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