SetterVision: Motion-based Tactical Training System for Volleyball Setters in Virtual Reality

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ABSTRACT

Volleyball, a sport characterized by unpredictable factors such as ball trajectory, teammate actions, and strategic positioning, presents a challenge when it comes to modeling and training due to its high levels of complexity. Successful gameplay relies on the coordinated efforts of all team members in the receiving, setting, and attacking phases. In real-life competitions, the setter's on-ball ability and decision-making are particularly crucial to the team's offensive success: To improve the training of setters in observing player movements while running and making informed attacking decisions, we propose the design of a virtual reality (VR) system which aims to enhance players' setting skills and strategic thinking to achieve more successful offensive plays with a lower cost.

CCS CONCEPTS

• **Computing methodologies** → **Virtual reality**.

KEYWORDS

volleyball training, tactical training, setter training, virtual reality

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1 INTRODUCTION

Volleyball is a widely popular sport, particularly in the Eur-Asia region. In a volleyball game, each player has a specific role and responsibilities that contribute to the team's overall performance. The primary roles of players includes Setter, Outside Hitter, Middle Blocker, Opposite Hitter, and Libero. Notably, the setter plays a central role in the team's offense: Often referred to as the" Floor general," this player governs the flow of a team's offense and initiates tactical plays. Their main responsibility is to set up the ball and place it in the best position for the hitters to facilitate an effective attack. Setters need excellent ball-handling skills, decision-making abilities, and court vision to create scoring opportunities for their teammates. In other words, when the ball is hit by the serve, the setter must move to the appropriate position and observe the players using court vision, make a decision in the sudden moment, then perform the corresponding setter actions to handle the ball.

Current training approaches for setters training can be divided into motion-based practices and technique-based practices [2, 4]. While motion-based practices improve overall athleticism and physical capabilities, technique-based practices refine the specific skills required to perform effectively on the court. Combining both approaches in training programs can lead to comprehensive player development, enhancing players' physical abilities while also honing their technical skills and game performance. However, while team practices are essential for fostering teamwork and overall gameplay, they may not fully address individual player needs. Tailoring training to specific positions or skill sets can be challenging, as coaches often have to cater to the needs of the entire team during practice sessions. In addition, lack of available courts or limited access to training facilities can restrict the amount of time and opportunities players have to practice and refine their skills. To address these challenges, our aim is to transfer the core aspects of volleyball setter training into a virtual reality setting, thereby reducing the costs and space associated with this activity.

Another major drawback on these motion- or technique- based practice methods is the lack of integration on tactical or awareness training, which supports decision making and awareness being

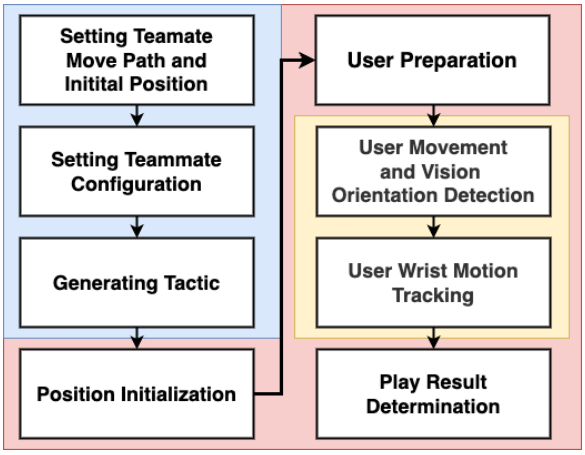

Figure 1: Overview of our proposed system framework. Highlighted in *Blue* is the Tactic Board Module, in *Yellow* the Motion Input Module, and in *Red* the Immersive Gameplay Module

(a) (b) (c)

Figure 2: Screenshots of the Proposed System. (a) Tactic Board (b) Immersive Gameplay (c) Setter Motion/Action

a crucial part of most team sports. Previous attempts have either utilized perspective-based immersive visual systems without user motion [3] or step-based static models with pre-decided actions and limited gestural input [5, 7], which cannot be directly translated into on-field scenarios. Our objective is to integrate both motion (or dynamic) components of actual competition as well as strategy and tactics into a single immersive system, enabling efficient situational practice while addressing the aforementioned problems.

SetterVision presents an attempt to overcome existing shortcomings on tactical training of volleyball setters which are not adequately addressed by current technology-incorporated solutions [1, 6] by designing a generalized VR system optimized to provide a better experience. These include space constraints, due to traditional training methods requiring at least half a full-sized volleyball court; the lack of teammates and opponents, since tactical training requires situational awareness of real-time gameplay; and the translation from tactic board to first-person gameplay, as converting on-paper graphs to actual player routing poses difficulties.

2 SYSTEM DESIGN

Figure 1 presents the system framework of SetterVision, which is created with Unity version 2021.3, runs on HTC Vive XR Elite, and controlled with the Vive Wave XR Controller Plugin. Our created volleyball training system is designed to consist of multiple technical modules, with its implementation details and system structure thoroughly explained in the following:

Tactic Board Module: To fully emulate current methodology of tactical training, we integrate a tactic board module to simulate plays of teammates' positions and running trajectories. These plays can be created directly by the VR users within the VR environment or imported by professional coaches. With this feature, not only could setters be trained through playcalling, but coaches could also specify and customize set-pieces using the immersive gameplay simulation system, thereby improving the overall design of plays.

Immersive Gameplay Module: Once a play is selected, it could be thoroughly simulated in our gameplay system with virtual teammates running the given play to certain positions. The VR users have to utilize their court vision to run and arrive at the suitable position for setting within a limited time period. Once the VR users move to the correct position, they have to observe the positions and actions of their nearby teammates for setting using their decision-making ability. Moreover, the VR users have to perform correct setting actions with its corresponding passing teammate using their ball-handling skills. We modeled random realistic scenarios, including unready teammates, illegal actions, and ineligible attackers, to train situational awareness. Additionally, by switching between our tactic board and gameplay system, players can learn from both third-person videos and first-person perspectives, facilitating a more comprehensive understanding. Combining advanced simulations and realistic scenarios, our immersive gameplay system offers a solution that bridges the gap between on-paper strategies and on-court execution.

Motion Input Module: Unlike traditional emulation systems for sports, which usually rely on button-based state selection, our system utilizes motion-controlled inputs to replicate movements required during real gameplay. The Vive Wave XR Controller Plugin is applied to obtain the head movement of the VR users, and achieve hand tracking as well as gesture interaction when using our tactic board system in VR. Two additional Vive Wrist Trackers are used to acquire information from accelerometers and gyroscopes to understand wrist rotations and recognize which setter action (i.e., forward/backward set, jump forward/backward set) is performed. In this way, players can experience a higher level of immersiveness with more intuitive inputs, blurring the lines between virtual and real-world performances. This approach enables training in a more realistic manner for users.

3 RESULT AND FUTURE WORK

This work presents a novel approach to enhance the tactical training of volleyball setters by leveraging virtual reality technology. By providing an immersive and dynamic training environment, the proposed system aims to overcome the limitations and challenges associated with traditional training methods. More details about SetterVision can be viewed at https://youtu.be/sh85QFnReIc.

In the future, we will focus on the development and evaluation of this virtual reality system, with the aim of enhancing the skills and performance of volleyball players. We plan to expand this work into a full-blown, multiplayer volleyball gameplay simulator and explore into interactions among users in different virtual spaces playing in the same game.

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