# Spiral VR: A Virtual Reality Sports Game for Studying Aim Assistance Under Pressure

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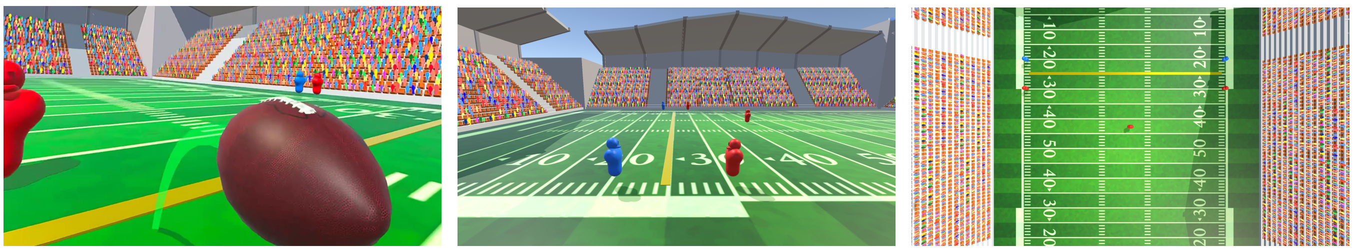

(a) (b) (c)

**Figure 1: *Spiral VR* gameplay environment. (a) Quarterback view with receivers, defenders, and rusher that follows the player. (b–c) Alternate views showing spatial layout and player positioning.**

## Abstract

Accurate throwing remains challenging in virtual reality (VR), particularly in dynamic scenarios that require rapid decision-making. While aim-assistance techniques have been studied in digital games, their effects on embodied VR tasks under pressure remain underexplored. In this paper, we present *Spiral VR*, an arcade-style American football passing game designed as a testbed for studying aim assistance in immersive under-pressure environments. The system integrates physics-based throwing, moving receivers, defensive interception, approaching rusher, and reactive stadium feedback to induce pressure. We present the implemented aim-assistance technique and propose a study to examine aim conditions across different pressure levels during simulated quarterback throwing tasks.

## CCS Concepts

• **Human-centered computing** → **Virtual reality**; **User studies**.

## Keywords

aiming, computer games, virtual reality, head-mounted display, pressure, sports

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## 1 Introduction

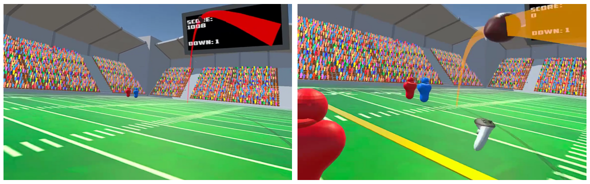
Passing and throwing are common interactions in both sports and virtual environments, yet achieving accuracy in VR remains difficult. Prior work shows that throwing performance in VR is significantly less accurate than in the physical world, partly due to differences in release timing and motor control [Zindulka et al. 2020], [Boz 2025]. In contrast, aim-assistance techniques have been widely explored in digital games to support and facilitate player interactions such as shooting and targeting [Vicencio-Moreira et al. 2014], [Kocur et al. 2020]. In VR, their effectiveness on embodied tasks that require full-body coordination and rapid decision-making is less well understood.

Pressure plays a critical role in performance during sports and time-sensitive tasks. Prior work has shown that immersive VR environments can induce anxiety and affect performance [Stinson and Bowman 2014], and that high-pressure scenarios in games can lead to performance breakdowns such as choking and clutching [Beres et al. 2021]. Differently, the interaction between pressure and aim assistance in embodied VR sports tasks remains underexplored.

To address this gap, we present *Spiral VR*, a virtual reality American football passing game designed as a controlled testbed for studying aim assistance under pressure. This work contributes to a real-time VR system that combines embodied interaction with controllable pressure conditions, together with a study framework integrating performance, subjective, and physiological measures.

## 2 *Spiral VR*

*Spiral VR* is an arcade-style passing game designed for short, repeatable interactions while preserving embodied throwing mechanics.



(a) (b)

**Figure 2: Aim assistance visualization. Predicted trajectory and force-based color feedback. (a) High-force throw overshoots the target. (b) Low-force throw falls short.**

The Player is embodied as a quarterback and throws a football to moving receivers using a VR controller. Each play includes two receivers, two defenders, and one rusher (Figure 1). Receivers run routes into open space, defenders track receivers and can intercept passes, and the rusher moves toward the player to reduce the available decision time. Pressure is further reinforced through stadium feedback that celebrates successful plays and discourages failed attempts. The combination of adversarial agents, time constraints, and evaluative feedback creates a dynamic and controllable pressure environment. To estimate release velocity, the system stores recent hand positions over a short temporal window and computes the average motion vector across samples. At release, this estimated velocity is applied to the ball, along with a scaling factor that enables long-distance throws without requiring excessive physical effort. The velocity is computed as:

$$V = \frac{\sum_{i=1}^{n} (H_i - H_{i-1})}{\sum_{i=1}^{n} \Delta \, t_i} \tag{1}$$

where $V$ is the velocity vector, $n$ is the number of sampled frames, $H_i$ is the hand position at frame i, and $\Delta t_i$ is the time difference between frames. This formulation follows prior approaches for estimating throwing velocity in VR and helps reduce sensitivity to tracking noise while maintaining responsiveness [Ghasemaghaei et al. 2024; Zindulka et al. 2020]. For aim assistance, the system predicts the ball's trajectory using the estimated velocity and renders a parabolic preview that indicates the expected landing position (Figure 2). The trajectory visualization includes a color-based encoding of throw force, providing real-time feedback.

## 3 Pressure and Aim Assistance Conditions

We propose a 2 × 3 within-subjects design. The first factor is aim assistance, with two levels: no assistance and assistance enabled via trajectory visualization and correction. The second factor is rusher behavior, which controls how quickly the rusher reaches the player, with three levels: low (no movement), medium, and high velocity. These conditions progressively increase urgency and reduce the time available for decision-making. We ground the task in an American football passing scenario, as it naturally combines throwing to moving targets with time pressure and defensive interference. To maintain experimental control, we simplify the scene to preserve core task demands—target selection, throw execution, interception risk, and urgency—while reducing visual clutter and occlusion. Defenders introduce interception risk, whereas the rusher provides a direct, controllable source of pressure.

## 4 Planned Study

Participants will complete all six conditions in a counterbalanced order using a Latin square design. We propose 10 trials per condition (60 total) to provide sufficient repetitions for stable performance estimates while limiting fatigue and learning effects commonly observed in VR interactions. We will record performance metrics, including pass success rate, interception rate, incomplete pass rate, and task completion time, for each trial. To capture interaction behavior, we will log through velocity and spatial data, including ball trajectories and player positions. In addition, we will collect electrodermal activity (EDA) using a skin sensor as a physiological indicator of pressure-induced arousal. Prior work has shown that EDA is a reliable signal for detecting stress in VR environments [Ishaque et al. 2020]. Analysis will include baseline-corrected mean skin conductance for each condition, as well as event-related responses following high-pressure moments.

After each condition, participants will report perceived anxiety using the State Anxiety Inventory (STAI) [Zsido et al. 2020], engagement using selected subscales of the Intrinsic Motivation Inventory (IMI) [Ryan 1982], and workload using the NASA Task Load Index (NASA-TLX) [Hart 2006]. Together with physiological measures (EDA), this enables a comprehensive evaluation of performance, engagement, workload, and pressure-related responses.

## 5 Conclusions and Future Work

We introduced *Spiral VR*, a virtual reality American football passing game designed to study aim assistance under pressure. By combining embodied interaction, controllable pressure mechanisms, and physiological measurement, the system offers a practical testbed for investigating performance in immersive VR environments. The proposed study will allow us to examine whether aim assistance improves performance under increasing pressure, how pressure affects decision-making and motor execution, and whether physiological arousal aligns with performance outcomes. Future work will explore adaptive assistance techniques and training-oriented applications in VR sports and simulation environments.

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