

A Look Into Five Years of Locomotion in Virtual Reality

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ABSTRACT

Survios, a virtual reality (VR) game developer dedicated to building active, immersive experiences that push the limits of VR innovation, developed a range of proprietary locomotion systems in VR to solve for simulator sickness and immersive gameplay.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality.**

KEYWORDS

virtual reality, VR, locomotion

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1 INTRODUCTION

Beginning in 2012, the founders of Survios initially spent the company's first few years developing VR hardware and software that focused on self-contained room-scale VR game systems as students at the University of Southern California (USC). The challenge they faced was locomotion in VR and that it ran the risk of causing simulator sickness due to sensory conflict: a disconnect between visually perceived movement and a lack of appropriate sense in the vestibular system. The solution was to modify the user's viewpoint in VR so that it didn't involve traditional 1-to-1 head tracking. Users could explore virtual worlds that were larger than their tracking space and overcome the systemic limitations.

2 EXPOSITION

In 2013, Oculus DK1 was released and other developers quickly discovered that traditional first-person gamepad analog controls, when directly ported to VR, caused simulator sickness due to rapidly changing direction. Early developers quickly adopted a simple solution that immediately teleported the user's position and snapped the user's forward-facing direction, avoiding sensory conflict from smooth translation and rotation. However, this system made the user momentarily disoriented after losing their sense of direction and position in the virtual world. In response, Survios built a system called "Teleshift" that avoided both simulator sickness and disorientation by translating and rotating the user's viewpoint with

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movement reference elements called "Speed Streaks" that lock in a user's position relative to their tracked position (Figure 1).



Figure 1: Teleshift speed streaks and player hands.

Survios further improved user comfort by rendering the user's in-game hands during movement to reinforce other movement reference elements through visual, aural and haptic effects. The user's hands were rendered with an alternative shade during the movement and curved speed lines during a snap turn (Figure 2). In 2016, Teleshift shipped with Survios' first VR title, *Raw Data*.

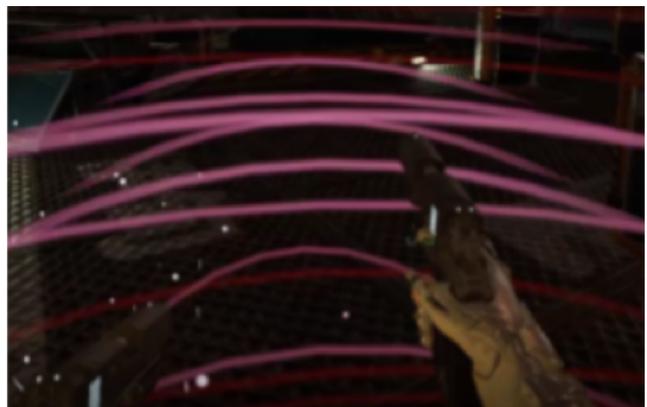


Figure 2: Surrounding arcs during a snap turn.

Survios experimented with character abilities in relation to locomotion in VR and discovered that lunging the user backward and forward in the virtual space resulted in an incredibly immersive yet comfortable experience. Eventually, these abilities would translate in Survios' boxing VR title, *Creed: Rise to Glory* to solve for highly immersive melee combat.

In 2018, Survios released *Sprint Vector*, a racing game in VR with additional locomotion systems using hand-tracking data called “Fluid Locomotion Technology.” Users enjoyed a unique control scheme where they could pump their arms to run, simulating feet landing and lifting in a running stride. Additionally, by simulating momentum, they could climb in VR using the release point of a grip and with “Grip Streams,” which create a gripping point along the surface with velocity (Figure 3).

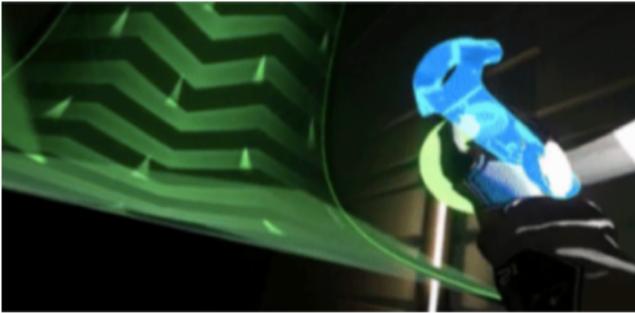


Figure 3: User holding on to a grip stream.

Two additional locomotion systems were developed to solve the rotation of the player. The first was a “Drift System” that allowed the user to grab onto a virtual point in the air and rotate their body around that point while controlling the rotation rate using the distance between their hand and their body. The second system

allowed users to steer themselves while they were flying through the air using a gesture that approximates manipulating the steering wheel of a car in the air (Figure 4).



Figure 4: Sprint Vector player steering in the air.

3 CONCLUSIONS AND FUTURE WORK

Survios continues to solve problems with locomotion in VR. *Creed: Rise to Glory*'s Fluid Locomotion System 2.0 automates the user's ability for virtual walking strides by no longer requiring the pressing and releasing of buttons. Their newest title, *Battlewake*, and its Immersive Vehicle System™ is designed to neutralize seasickness so that users can experience a ship's every pitch in the water without ill effects.