Trigger Walking: A Low-Fatigue Travel Technique for Immersive Virtual Reality

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Abstract

We present Trigger Walking, a low-fatigue travel technique for immersive virtual reality which uses hand-held controllers to move about more naturally within a limited physical space. Most commercial applications use some form of teleportation or physical walking for moving around in a virtual space. However, teleportation can be disorienting, due to the sudden change in the environment when teleported to another location. Physical walking techniques are more physically demanding, leading to fatigue. Hence, we explore the use of two spatial controllers that accompany commercial headsets to walk by taking a virtual step each time a controller trigger is pulled. The user has the choice of using the orientation of a single-controller, the average of both controllers, or that of the head to determine the direction of walking, and speed can be controlled by changing the angle of the controller to the Frontal plane.

Keywords: Tracking, training, entertainment, immersion, HMD.

Index Terms: I.3.6 [Computer Graphics]: Methodology and Techniques—Interaction Techniques; I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Virtual Reality

1 Introduction

Many recent virtual reality (VR) applications use virtual travel methods to move around the virtual space. Teleportation [3] and auto-locomotion [6] are the most common. Teleportation is more useful for moving around larger spaces, but results in reduced spatial awareness and orientation [2]. However, auto-locomotion, where the user is moved along by the system, is well known for inducing motion sickness and nausea. Other techniques such as walking-in-place (WIP) movement use natural physical movements, like walking or running in the place and arm swinging [5], but their prolonged use induces fatigue.

Exploring and designing techniques which do not break the sense of presence nor induce motion sickness are the main objectives of this research. One of the main ideas behind designing this technique is the fact that users tend to feel less nauseous when they have control over their own motion.

Studies have shown that when participants were asked to drive a car, rather than be a passenger, they experienced less motion sickness [4]. Anticipating, and/or having control over, movement may play a major role in the comfort of users [6]. This poster explores the effect of giving low-fatigue control of movement to users in immersive settings even over long periods of time, while still providing adequate expressiveness of motion. We introduce a new way of movement that utilises the triggers of common hand controllers to mimic leg movements in real walking.

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The idea is that if we can induce users to undertake the trigger control as if they were moving their legs, they can keep their arms at their sides, reducing the gorilla arm effect felt when using other techniques [1], such as flying or teleporting where you point.

2 Problem Definition

Most VR applications require users (or players) to move around in a potentially infinite virtual space, while being limited to a finite physical space, such as a lab or a living room. While moving about is not always the primary focus of the experience, it is none the less an integral part. In order for techniques to be effective for long periods of time, and to be used by many users across many applications, locomotion interfaces need to (1) add little extra work for the player, (2) be expressive enough to accomplish multiple types of movement (e.g., precise, short-distance movement, efficient, long-distance movement), and (3) take advantage of common, multi-purpose interface devices. The work presented here is motivated by these three design goals, and presents our preliminary exploration of one set of such techniques called Trigger Walking.

3 Trigger Walking

Trigger Walking uses the concept from natural walking of taking steps to reach a destination, but replaces the legs with the triggers of common spatial VR controllers. One controller is held in each hand in the natural grip, and the arms are allowed to relax at the sides of the user (Figure 1, left). In this pose, the user is expending minimal energy, and has the hands in close proximity to the legs.

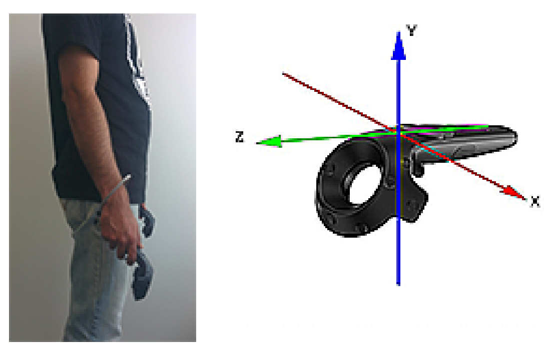

Figure 1: Neutral pose of the user (left). Coordinate frame of the controller (right).

In many VR applications, navigation is not the main focus task and the triggers will be used for other tasks like selection or manipulation. To make navigation intent explicit, the user touches the thumbpad while Trigger Walking in order to travel within the virtual world. We also envision having the system track where the user's hands are, and activate Trigger Walking automatically only when the hand positions are within some threshold of the resting arm position, removing the need for an explicit mode switch using the thumbpad. Each time the trigger is pulled, the user's viewpoint is moved one step in the indicated direction. We chose a constant stride length of 76 cm (2.5 feet), the average stride length of a man, and a walking speed of 1.4 m/s (4.5 ft/sec), which is the average human walking speed.

Trigger Walking is a low-fatigue technique since there is no need to actually walk, swing the arms, or keep the arms outstretched. A linear-interpolation (lerp) function is used to make the step motion more natural and to avoid nausea. The user takes one "step" each time the trigger is pressed, rather than having to continuously control the direction, which may lead to motion sickness. Trigger Walking also supports standing and seated users, allowing them to stand, sit, or even take physical steps around the tracked space, as the task requires.

3.1 Manipulating Speed

Since the stride length is constant, the speed is manipulated using the angle of the controller to the Frontal plane (the plane that divides the front of the body from the back). The maximum speed is scaled according to the angle of the controller with the plane. As the angle increases, the speed of the movement increases. The user can achieve maximum velocity by tilting the controller so that it makes a 90-degree angle with the Frontal plane. In the neutral or no fatigue position, the angle is around 30 degrees and the walking speed is 1.4 m/s. The angles are clamped between 30-90 degrees. If the angle between the Frontal plane and the X-axis of the controller is θ, then the movement speed is scaled using the equation

$$Movement\ Speed = \left(2 + \frac{\theta - max\ angle}{max\ angle - min\ angle}\right) \times 1.4$$

3.2 Direction Control Using a Single Controller

We implemented three ways of controlling the direction of walking, using either a single controller, both controllers, or head orientation (Figure 2). In the single-controller approach, the difference between the heading of the front of the right controller and the current head yaw, denoted θ_1 in Figure 2, is used to determine the direction of stepping. The user can alternate between pulling the left and right triggers to take steps, but the direction is always defined by the right controller. The left controller is used for left handed users. This mode can also be used when the task demands one controller to do another task (e.g., shooting while moving).

3.3 Direction Control Using Two Controllers

In the two-controller approach, the bearings of both controllers, denoted θ_1 and θ_2 in Figure 2, are averaged, and this average bearing is used for calculating the difference between it and the current head yaw, which determines the direction of stepping. Again, the user can alternate between pulling the left and right triggers to take steps.

3.4 Direction Control Using Head Orientation

For the final approach, current head yaw, denoted θ_3 in Figure 2, is used to determine the stepping direction. Unlike the other conditions, the user can only step in the direction the head is pointing, removing the need for orienting the controllers, thereby reducing cognitive load, but also movement expressiveness.

Figure 2: Direction control

4 Conclusions and Future Work

Trigger Walking is a technique which substitutes controller triggers for the legs in actual walking, and gives movement speed and direction control to the user. It is designed to make the locomotion experience less fatiguing and to avoid motion sickness during locomotion. Studies have to be carried out in the future on the ideal situations where Trigger Walking is useful. We observed that participants were comfortable using Trigger Walking, however we did not find the optimal balance between speed/efficiency of movement and occurrence of motion sickness. There is a need to study the interface parameter settings more to support these often-conflicting goals.

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