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Become your Avatar: Fast Skeletal Reconstruction from Sparse Data for Fully-tracked VR

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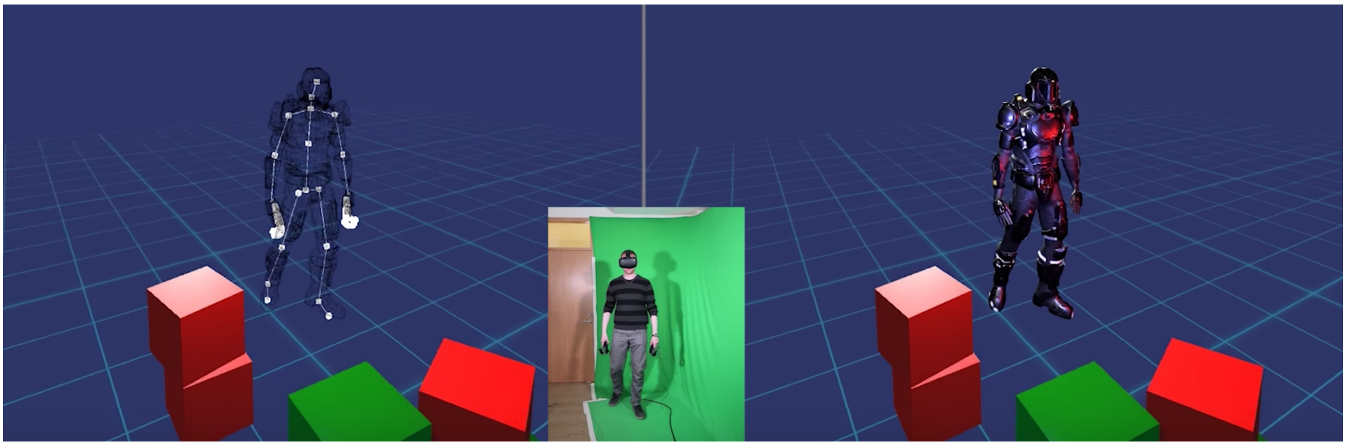

Figure 1: *Full-body user motion mapped to a first-person avatar, integrating data both from an HTC Vive and a Kinect V2.*

Abstract

SomaVR enables users to become their own avatar in room-scale virtual reality (VR). The technology uses motion tracking and VR devices to create a data model of the user's body. An avatar of the user is then dynamically created, such that the user experiences the avatar as his own body. The software is designed to increase VR immersion, present new opportunities for research and create a new way to experience games and other VR applications. Integration of the software is designed to be easy and require minimal configuration.

Categories and Subject Descriptors (according to ACM CCS): I.3.7 [Computer Graphics]: Three-Dimensional Graphics and Realism—Virtual Reality

1. Introduction

The availability of virtual reality (VR) to consumers has improved greatly in recent years, especially with the introduction of new headset devices. Current experiences, however, typically do not track or represent the user's body, due to a lack of data about its position and orientation in the world. The result is that the user's body is not visibly a part of the environment, which risks damaging the user's immersion. The SomaVR project aims to solve this problem by pairing a motion-tracking sensor with room-scale VR, creating a virtual body that fully tracks the user's body in real-time.

SomaVR enables virtual reality experiences in which a user has a virtual body that moves and acts as their own, and can be perceived from a natural first-person perspective. The virtual body completely reproduces and thus replaces the user's body inside a room-scale virtual environment. With SomaVR, a user equipped with only the HTC Vive's standard devices can walk around in a 3D environment and see a full representation of his body with no additional sensors equipped. The only addition to the standard HTC Vive setup is a single Kinect V2 sensor placed at the edge of the play area.

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2. Related Work

There have been previous attempts to use the Kinect V2 for VR applications. Unfortunately, the Kinect V2 suffers from similar tracking faults as the Kinect 1, including inconsistent tracking, jittery behaviour, and unreliable data [TAL13]. The Kinect V2 sensor also poorly tracks the rotation of body parts. These faults become even more apparent when viewed from the perspective of a virtual head-mounted display. Furthermore, a single Kinect V2 can only represent a user that is facing the sensor, and the sensor cannot handle occlusion such as when limbs go out of its sight. These faults have limited some previous attempts at full body VR experiences [Kin16, Bab16]. Multiple sensors could potentially solve these problems, but each sensor would require its own computer, which would likely not be viable for the average consumer.

3. Proposed Approach

To solve the aforementioned problems, SomaVR performs an in-depth analysis of the data provided by both the Kinect V2 and HTC Vive and creates a full skeletal model of the user (Figure1: Left). It constructs the model in real-time using adaptive-weighted movement prediction, re-calibration algorithms and hardware sensor corrections, posture and movement analysis, and occlusion handling. To minimize the user's experience of latency, SomaVR both interprets and adaptively predicts their movements. More specifically, it analyzes the user's posture and movement to understand what the user is doing and decides how to best represent or adapt their actions inside the virtual environment. By creating a model that interprets the user in this way as well as analyzing hardware inputs, SomaVR is able to infer the orientation of body parts and make informed predictions when they are occluded, thereby minimizing any negative effects that such occlusions might have on the user's experience. Using its skeletal model, SomaVR then dynamically maps a 3D character avatar to the user's body based the user's specific measurements, and ultimately produces a fully-tracked VR avatar (Figure 1: Right). User avatars made with SomaVR can be fully networked, allowing multiple users to interact with each other's avatars.

4. User Experience

When a user is ready to begin the experience, they perform a simple one-button calibration and their virtual body appears inside the virtual environment. As the user moves around and explores different virtual spaces, their virtual bodies will react to their movements. Looking down, the user will see a virtual body instead of their own, where each virtual body part moves and rotates in synchrony with the user's (actual) body (Figure 2). During their experience, the user can perform physical gestures and interact with virtual objects using any part of their body. Such interactions include crouching, dodging, waving, kicking, pushing, grabbing, throwing or any other gesture using physical movement. The user will be able to try out different avatars within these virtual spaces, such as a becoming a knight in a castle (Figure 2) or a futuristic space explorer (Figure 1: Right). Within each environment, the user will be able to see a reflection of their avatar through a mirror in the environment. Each user is expected to try the demo for 1-5 minutes.

Figure 2: *A first-person perspective of the user looking down at their virtual body. The inset shows the user's actual body.*

5. Discussion & Future Work

SomaVR introduces a room-scale full body simulation that solves the aforementioned problems, while striving for easy integration and high accessibility and affordability for consumers. With a full physical representation of the user as an avatar, new possibilities for projects and research become available. The technology could substantially expand the capabilities of VR games while requiring only a relatively small investment in hardware from users. A player can now act fully as any game character and his body is extended into the game world. Players become physically grounded as their virtual body replicates their own walking motions inside the virtual environment, which is expected to improve the feeling of transportation while increasing physical immersion. Finally, full body simulation can be used to introduce physical game mechanics or serve as increased visual feedback for the player.

SomaVR is currently supported within the Unity game engine, and support for the Unreal 4 game engine and Oculus Touch VR devices is planned for late 2017. SomaVR is easy to integrate into new or existing projects, and developers can use their own humanoid models with minimal configuration.

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