

Wakeboarding: An Exertion Game in Virtual Reality

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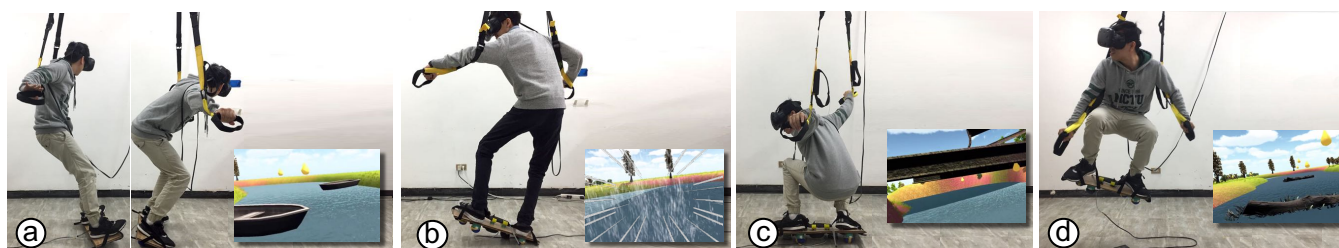


Figure 1: Wakeboarding is an exertion game in virtual reality developed with bodily haptic experience. Players riding a balance board ski on a meandering river to perform (a) sliding, (b) leaning, (c) squatting, and (d) jumping to avoid obstacles.

CCS CONCEPTS

• **Human-centered computing** → **Interaction design**; *Systems and tools for interaction design*;

KEYWORDS

virtual reality, exertion game

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1 INTRODUCTION

Recently there is increasing attention giving to haptic-enhanced virtual reality. Blending visual immersion with haptic feedback suggests improved engagement [Rheiner 2014]. This project starts with the integration of exertion design and bodily haptic interaction, for the increased engagement can lead to increased exertion and enjoyment in exertion games.

We present a wakeboarding exertion game (Figure 1), in which the player riding a balance board in the reality skis on a meandering river in the virtual reality. The balance board allows the player to steer by leaning the weight left or right. A suspension kit hanging from the ceiling helps players' balance and allows them to perform extreme movements at play. A vibrotactile speaker is further attached to the board to enhance overall haptic experience.

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The design of wakeboarding experience fulfills several desirable features as an exertion game [Mueller et al. 2011]. Firstly, our passive bodily haptic design enabled by the suspension kit suggests players experiencing through exertion. Their movements are achieved by sustaining the weight and balance with the support of the kit. Skilled players can express themselves by performing extreme moves such as turbo leaning or jumping actions. Finally, this game helps muscle development and improves balancing skill through plays.

2 SYSTEM IMPLEMENTATION

The system consists of three components, (1) a VR display using HTC Vive VR set, (2) a customized wakeboard that suggests feet steering actions, and (3) a suspension kit modified from TRX allowing players to balance and gain the sense of secure. Details are described as below.

2.1 Wakeboard for Feet Steering

The wakeboard is made of a piece of wood flooring measuring 205 mm x 615 mm in dimensions. To add tracking capability on the board, we coupled a Vive controller with the board as shown in Figure 2a. This controller is attached to the board with connectors made by a 3D printer.

We attach four tee balls on the board backside (Figure 2b). The malleable balls allow players to steer the board by leaning their weight. Meanwhile, the ball deformations allow for a good range of board tilting. In addition, a vibrotactile speaker (20 watt) is screwed on the backside to enhance haptic experience during play. Finally, four Velcro strips, two for each foot, affixed on the board keep the player's feet on the board by wrapping around the shoes (Figure 2c).

2.2 Suspension Kit for Balance and Extreme Plays

The suspension kit is modified from a profession TRX Suspension Trainers. As shown in Figure 3, we attached the kit on the ceiling in our lab but it should be easily attached to a truss in a demo event. Two handles of the kit in players' hands help their balance and gain the sense of secure while performing wakeboarding moves.

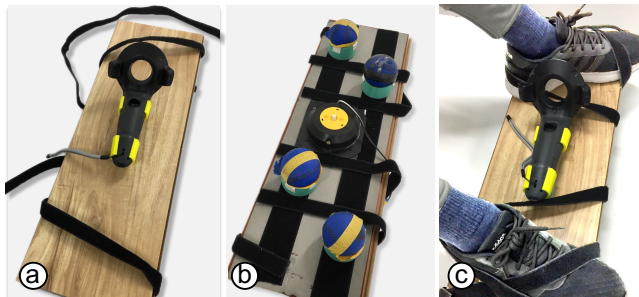


Figure 2: The wakeboard: (a) The front-side with a Vive controller, (b) the backside with malleable tee balls and a vibrotactile speaker, and (c) the Velcro strips affix the player's feet on the board.

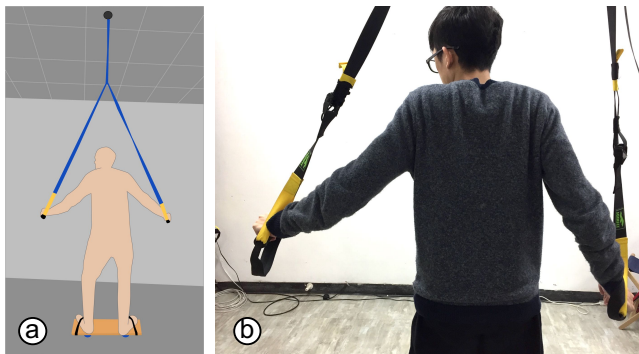


Figure 3: (a) The suspension kit hanging from the ceiling (b) helps players gain balance and secure while making actions on the balance board.

3 EXPERIENCE DESIGN

In the game, players will encounter obstacles such as rocks, logs, bridges. Bonus such as stars or coins are to intrigue players to exert more for higher scores.

3.1 Exertion Interactions

Sliding Left / Right. Players slide left or right to avoid obstacles by physically tilting the board sideways (Figure 1a). Vibrotactile feedbacks are added on sliding to enhance the haptic feel of drifting. Meanwhile, water splashes and sound effects in virtual world are presented with board drifting.

Leaning Backward. Players speed up by leaning their weight along the board backward (Figure 1b). Similarly, vibrotactile feedbacks are displayed in response to the speeding action.

Squatting. When obstacles come from top (e.g., a bridge), players lower their body by squatting, passing through it from the underneath (Figure 1c). It is usually difficult to squat on a balance board while keeping balance. While squatting, the handles are important support for the players to retain balance and secured, and help them stand back on the board.

Jumping / Supporting. When obstacles coming from bottom, players jump over it by leaving the board off the ground to get extra bonus (Figure 1d). This is achieved by players lifting their weight all the way up on the handles. On falling back the river, strong vibrotactile feedbacks with water splashes from all directions are presented. Players can also chose to avoid the obstacles by sliding to available pathway.

3.2 Before and After the Game

Some players may feel insecure and could lose balance at play, as most of them were new to this bodily haptic experience in virtual reality. It is also noteworthy that the handles should be used as support only when it is needed e.g., when users are going to lose balance or intended for extreme moves, similar to ski pole. Thus, players are encouraged to keep balance using their bodily skills, and learn to improve the skill through plays. We have designed the experience to start with a tutorial for players to familiarize themselves with the setup and learn basic movements.

This tutorial demonstrates each of the actions starting from casual sliding action. The game then starts right after the player succeeds all actions in the tutorial. We calculated the score and completion time for each play to reflect how much exertion and how fast the player has made. To increase the sense of participation, we display the player's score with all score distribution, and also the leaderboard.

4 ACKNOWLEDGMENTS

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