

Mixed Reality Gaming Combined with a Novel  
Treadmill for Low Back Pain

Study Protocol

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# Mixed Reality Gaming Combined with a Novel Treadmill for Low Back Pain Preliminary Report

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**Project Overview:** The From the Future and University of Alabama at Birmingham (UAB) team aimed to develop a virtual reality (VR) game that integrated with the features of a specialized self-driven treadmill, the KineAssist-MX (KAMX, Figure 1) to provide accessible and progressive walking challenges for individuals with chronic low back pain (LBP). The game was designed to go beyond typical VR research efforts and provide a truly immersive and engaging experience that would motivate individuals with high pain-related fear to keep moving.



Figure 1: KAMX Treadmill

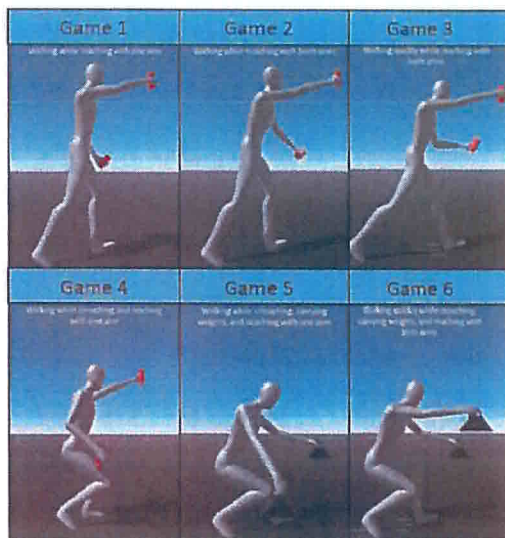


Figure 2: Progressive VR Challenges

The result is Lucid, a fantasy themed VR game that utilizes the KAMX to allow users to naturally self-select their own walking speed and progression in the game. Users wear a head-mounted display to view the VR game as they walk on the KAMX treadmill. In each of the six VR levels, users walk for three minutes completing in-game objectives like fighting monsters and collecting goods. The six levels are designed to progressively increase in difficulty and physical effort required by encouraging users to perform a different combination of physical challenges (Figure 2). Unlike other rehabilitative VR systems which limit user maneuverability, the integration with

the KAMX allows users to move naturally and not be limited by physical obstacles or room size.

The HTC Vive VR system was used to track player head and hand movement. Custom hand-held controllers were fabricated for some of the levels to add carrying weighted objects to the physical challenge. One controller resembled a shield while the other was a sword. The grips and heft of the controllers were designed to feel realistic in movement while fighting the game monsters.



Figure 3: Weighted Sword Controller

In the HTC Vive head-mounted display, users see themselves walking along a sky path while holding a shield in one hand to protect themselves from monster attacks and projectiles while using the other hand to wield the sword (Figures 4-8). The monster attacks were designed to engage the player in a variety of movements. User walk, reach, and crouch in real life to accomplish game objectives as they move along the virtual path fighting monsters and crouching beneath limbs. Powerups and other pickups encourage players to reach in different directions. Some features in the landscape were designed for the player to duck down to pass.

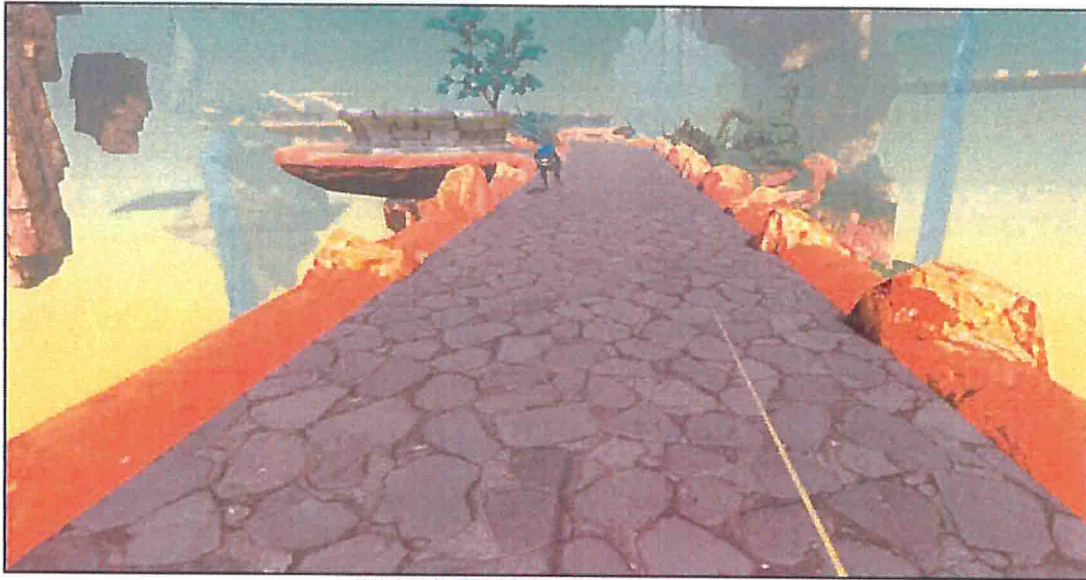


Figure 4: Blue Frogman on Skypath



Figure 5: Flying Blue Projectile Monster



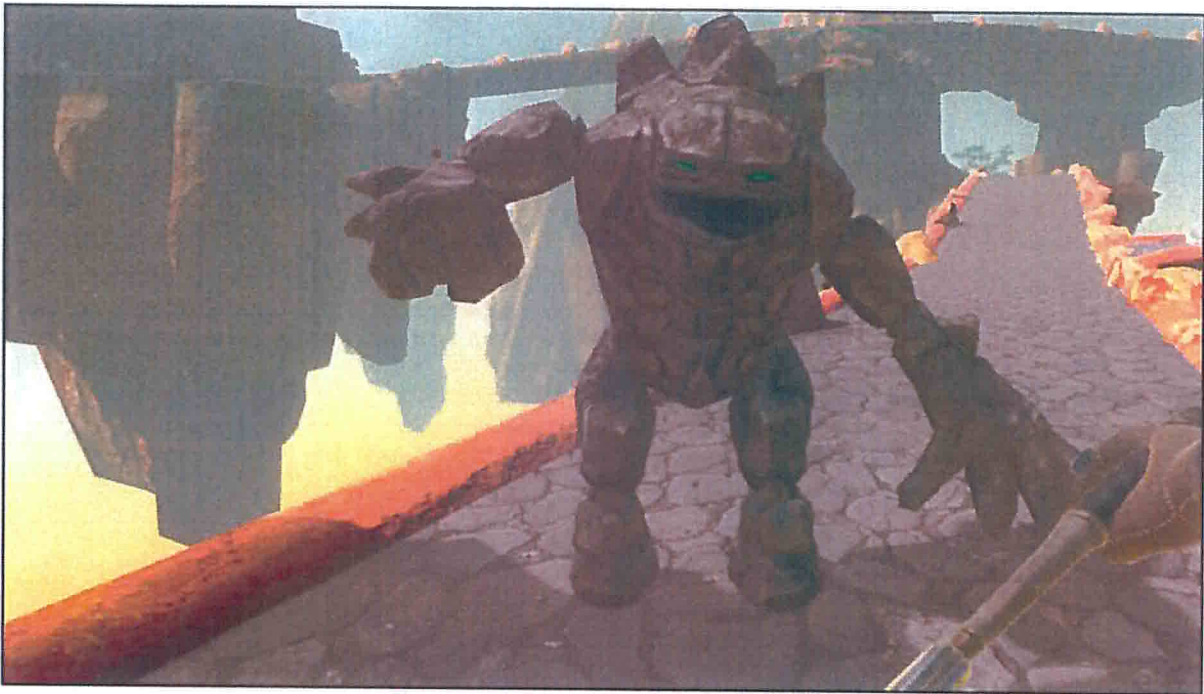


Figure 6: Boulder Throwing Rockman

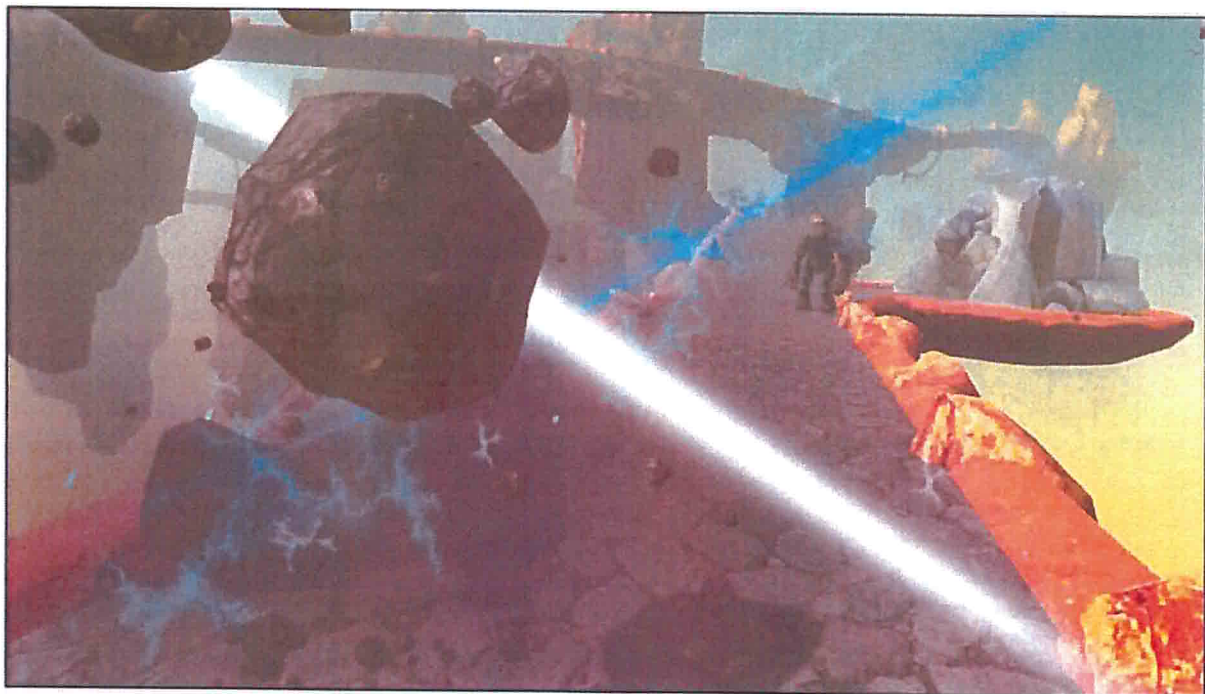


Figure 7: Rockman Destroyed by Player

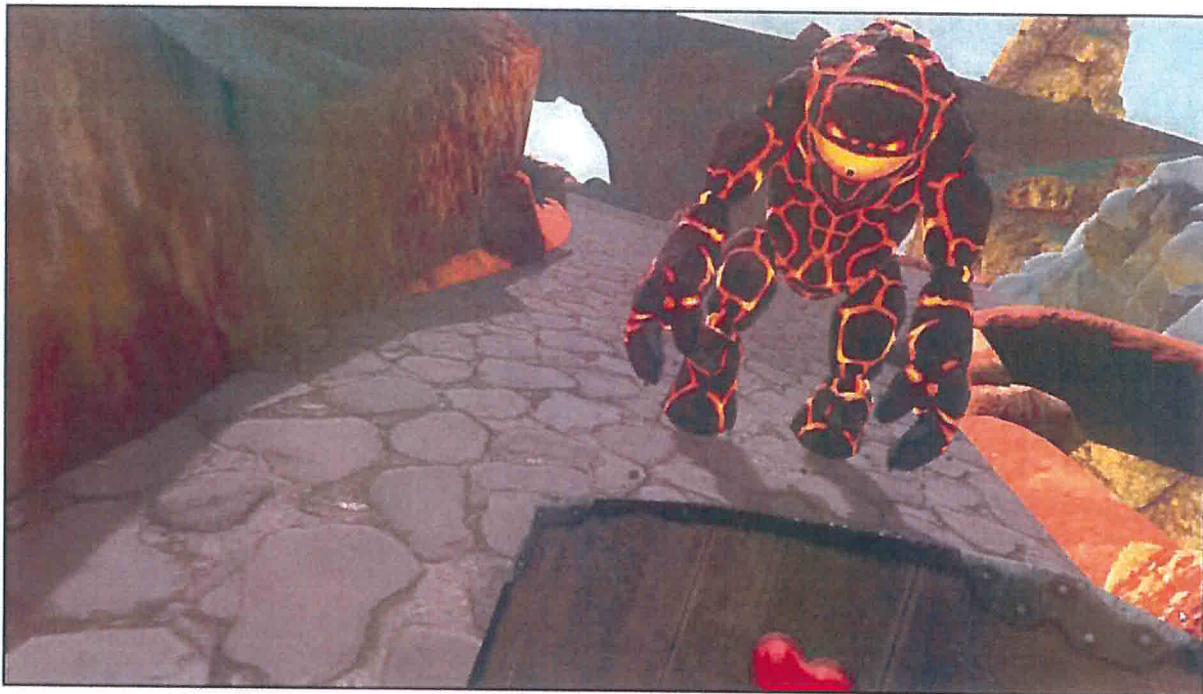


Figure 8: Lavaman Encounter

To view an example of the VR-real world interaction, please view this video compiled from a demonstration at the 2018 American Physical Therapy Association Conference: <https://www.youtube.com/watch?v=IHTNKVG1wlk>.

**VR Feasibility:** To test the feasibility of using the VR walking environment as a chronic LBP intervention, we recruited participants who visited the lab three times over a one-week period, testing two VR modules at each visit. Additionally, participants filled out a baseline and follow-up questionnaire packet and reported their daily pain throughout the course of the study.

Specifically, the following measurements were recorded:

Primary Outcome Measure(s):

1. Walking Distance [Time Frame: Day 1 through Day 3 of study]

Secondary Outcome Measure(s):

2. Walking Speed [Time Frame: Day 1 - Day 3 of study]

**Preliminary feasibility results:** 13 participants (8 females) with chronic LBP were recruited from the greater Birmingham area. Of the 13 who completed the first day of

Participants walked an average of 1,134.24 meters (SD=200.14) over the course of the six VR modules. Overall, participants walked, on average, 1.05 meters/sec (SD=0.19).

**Project Summary:** While data analysis and reporting are still ongoing, preliminary results suggest that it is feasible for individuals with chronic LBP to engage in the VR interface. All individuals who began the games were able to complete the games and perform the challenging activities, like bending and reaching. Future studies will further examine the treatment potential for VR games as an intervention tool and future game development will integrate more functional movements to improve the gaming experience.

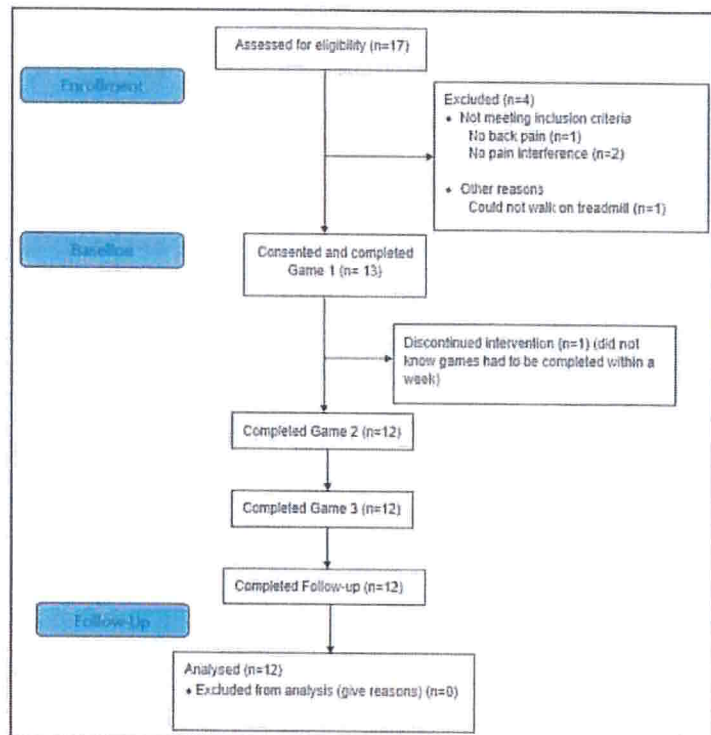


Figure 9: Feasibility of Recruitment and Retention