Dragon Boat Simulation: An Immersive Experience Beyond Traditional Gaming

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ABSTRACT

Immersive sports are emerging recently after the metaverse hype. This paper investigates an immersive setup that leverages virtual reality to recreate the kinetic and sensory nuances of dragon boating. We employ a body-centric approach to enable users to engage with authentic paddling actions, e.g., mobilising iron sticks on the boat with reasonably emulated water resistance. The virtual environments mirror real-world scenes, e.g., Pearl River (Guangdong). We employed multi-modal experiences to replicate the visuals and tactile, kinesthetic, and environmental intricacies of dragon boating. Our Dragon Boat simulator serves as a groundwork for redefining the boundaries of immersive sports training that bridges the gap between virtuality and the real world.

CCS CONCEPTS

• **Human-centered computing** → **Virtual reality**; **Interaction devices**.

KEYWORDS

Dragon Boat, Virtual Reality, Immersive Sports, Digital Twins

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(a)   (b)

Figure 1: Virtual Dragon boat (a) with a first-person view (b).

1 INTRODUCTION

Exergames, sometimes called exertion games, are a kind of digital game whereby the player's physical exertion significantly influences the results [8]. These activities have the potential to enhance positive emotional reactions towards physical exercise, often seeming less demanding compared to traditional sports. Hassan's study shows aerobic dancing exergames favourably impact the rating of perceived exertion (RPE) and emotional states among young people in China [2]. Costell et al. conducted a study in which they noticed that older persons often consider physical workouts tedious. However, they found that exergames have the potential to provide increased enjoyment and reassurance, particularly among hospitalised seniors [1, 3]. In summary, physical exertion games revitalise the tangible relationship between gaming and the human body, facilitating a re-establishment of one's physical connection [4–7]. These games provide enriched sensory stimulation, including visual clues, haptic devices, and continuous movement, enhancing the sense of immersion in virtual reality. Thus, we aim to create a game that combines deep immersion and collaborative social interaction. We build a dragon boat in virtual reality for physical exercises (Figure 1). Simultaneously, our dedication to meticulous modelling ensures that users may experience genuine virtual journeys, ranging from group rowing activities on the Pearl River to the scenic canals of Venice, providing them with immersive encounters in various cultural environments. In addition to enhancing the metaverse with cutting-edge technology, we're committed to preserving and promoting cultural heritage. Our realistic virtual journeys—from group rowing on the Pearl River to Venice's scenic canals—offer immersive experiences in diverse cultural settings
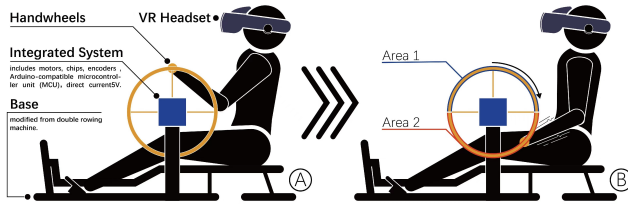
2 TECHNICAL SETUP

Figure 2: The mechanics and feedback illustrations.

To measure the user's rotational data, we integrated an absolute encoder with a handle wheel that present a paddle in VR (Figure2 (A)). This absolute encoder accurately determines the paddle's absolute angular position. Subsequently, the digital signals are processed by an Arduino-compatible microcontroller unit (MCU) program, generating voltage signals (high and low levels) to command a relay system precisely (Figure 3).

Our design utilizes a DC-geared motor in braking mode and resistor to mimic real-world paddling resistance, governed by an MCU through a relay system operating in two states: open and short circuit, corresponding to minimal and maximal resistances, respectively. In Figure 2A, handle rotation to Area 1 keeps the circuit open, mimicking low resistance like a paddle above water. In Area 2 (Figure 2B), the MCU adjusts relay control for haptic feedback, simulating water resistance during rowing Notably, the MCU's functionality extends to encapsulating the wheel's rotational data within a User Datagram Protocol (UDP) network data packet via a Wi-Fi-enabled router (Figure 3).

3 DESIGN FOR IMMERSIVENESS

The VR attempts to enhance levels of immersion and realism. As such, the VR environment containing multi-modal feedback offers sensory (e.g., visual, audio, and haptics) and evokes realistic perceptions of a boat race.

Body Movement: Paddle Mechanics in VR offers an authentic simulation of boating by enabling users to manipulate a tactile iron stick. This technology provides kinesthetic experiences that closely
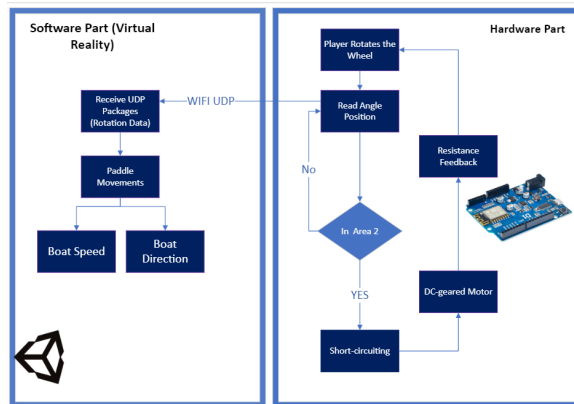

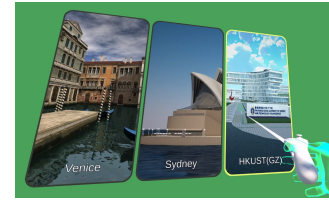**Figure 3: System Infrastructure**

Figure 4: Traversing World-Famous Locations.

mimic real paddling, complete with the heft and motion inherent to boating. Additionally, users can sit in a physical mock-up of a dragon boat, facilitating realistic body movements such as leaning forward and backward.

Resistance: VR Dragon Boating delivers a nuanced experience of maneuvering through varied resistances, facilitated by haptic feedback. A DC motor simulates paddle resistance, dynamically adjusting for factors like direction, speed, and rotation (Figure 2B).

Digital Twins: In Dragon Boat VR, users navigate through highly detailed digital twins of iconic locations like Venice, Sydney, and the Hong Kong University of Science and Technology's Guangzhou Campus (Figure 4). This meticulous design offers participants a convincing sense of traversing their real-world counterparts as they paddle through the virtual environments.

4 LIMITATIONS AND FUTURE WORK

In our VR-based dragon boat experience, we're planning two key updates: a) **Multi-User Interaction** – Real-time syncing will soon enable cooperative racing on a shared boat, opening up global competitions. b) **Accessibility and Immersion** – The system will work with basic VR headsets and aims to integrate haptic and biomechanical feedback, merging physical activity with gaming.

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