Immersive VR Exergames for Health and Wellbeing*

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ABSTRACT

This paper describes a Virtual Reality (VR) exergame platform used to investigate player motivation and experience of physical activity through variations of game designs. The VR-Rides platform combines a desk cycle, real-world imagery, an HTC VIVE head-mounted device (HMD) with controllers and a Microsoft wrist band, such that the player can navigate locations in a safe immersive virtual environment. Panorama images come from Google Street View. Two games were developed to explore motivation, enjoyment and their link to player's perceived experiences in immersive VR exergaming setup. The platform acts as a test-bed to iteratively design and evaluate theory driven immersive VR game designs to support activities pertaining to player's health and wellbeing goals.

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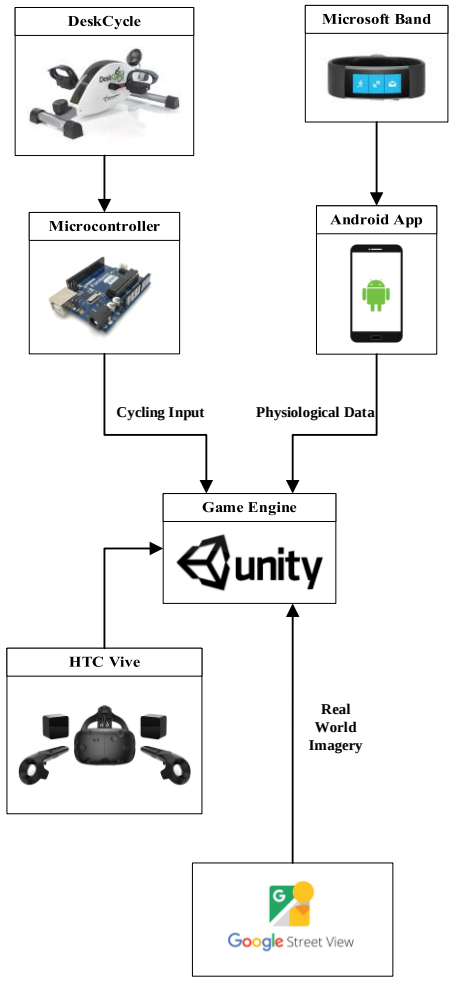

Figure 1: VR-Rides Architecture: A DeskCycle connected through microcontroller, VR HMD & Controllers, Google Street View Service, Microsoft Wristband & Android App; all connected to games in Unity Game Engine.

CCS CONCEPTS

• **Human-centered Computing** → **Human computer interaction (HCI)**; HCI design and evaluation methods; Interactive systems and tools

KEYWORDS

Virtual Reality, Exergames, Motivation, Wellbeing

1 INTRODUCTION

Motivation is a determining factor that leads users to participate and engage in an activity. Understanding the design tradeoffs likely to motivate and engage users is key to designing for health and wellbeing [1].

Video games are powerfully engaging because they offer inherently fun experiences. In most video games players are static and don't engage in physical activity, but an increasing number supports physical activity (exergames). Exergames have been investigated in both academia and industry alike. Kim et al. (2014) used Nintendo Wii and Microsoft Xbox Kinect to examine the embodied experience and behavior of young adults with video games [2] while Theng et al. (2009) employed Nintendo Wii to explore the efficacy of video games for engaging older adults in exercise [6]. However, motivation, which impacts users' long-term engagement with these exergames and therefore exercise has rarely been explored. We use VR-Rides to research and understand player's motivation.

Motivation and its determinant have been researched in psychology for several decades [5]. Psychological theories of motivation (e.g. Self-Determination theory (SDT)) are gaining increasing attention in Human-computer Interaction (HCI) research [4]. Studies on motivation and engagement with exergames have suggested that different game design factors can support motivation [3]. We incorporate affordances in exergames design using our VR-Rides platform [7] that specifically impact motivation for physical activity. These design elements range from underlying immersive VR environments design to game mechanics. These elements allow researchers to design games as platforms to study motivation and contribute to our knowledge about exergames in HCI. In user studies, we specifically investigate player's experiences and behaviors in relation to:

- Player's motivation
- Enjoyment
- Perceived experiences relative to player's background
- Vitality and physiological variables

This work demonstrates two games: 1) Pokémon Ride and 2) Balloon Shooter. In the next sections, we provide details of VR-Rides architecture and design for those two games.

Figure 2: Pokémon Ride

Figure 3: Balloon Shooter

2 VR-RIDES: AN IMMERSIVE VR EXERGAMES PLATFORM

2.1 System Architecture

Fig. 1 shows the main components of the VR Rides platform. It includes a DeskCycle, which provides a stable platform for pedaling while sitting on a stationary chair, without posing strain on user's back. A Funduino microcontroller is used to connect the DeskCycle to the computer through a standard computer USB port. An existing magnetic reed switch inside the DeskCycle and a 5v DC source is used to read the change in value triggered by the pedaling once per revolution based on the switch closure. This change of value is then used to calculate pedaling speed and distance covered before transferring data to the VR-Rides games, which are developed with Unity game engine.

The game environment communicates with Google's Street View service, fetches the full 360° panorama images of real-world locations that generate an Open World. This imagery is presented to the user via an HTC VIVE VR headset, which allows them to freely navigate and explore the virtual environment as they pedal and move forward. User's physiological data such as heart rate (can be monitored during the game play), calories spent, and skin temperature is tracked with Microsoft Wrist band 2. Each game design has an in-built mini tutorial to familiarize the user with the environment and controls.

2.2 Game 1: Pokémon Ride

In the first game, the player rides the DeskCycle exploring a Sydney downtown in order to find Pokémons (in Fig. 2). A map with Poke' balls assists the player to navigate representing Pokémons' positions in the environment. The game involves two levels. In the first level, the player's ride close to the start location (within 1 km radius) shows small Pokémons with high probability of getting caught. The player throws Poké balls towards those using VR controllers and receives small score/reward. Riding further from the start location will lead to level two, where big Pokémons show up; those are difficult to catch (less probability of being caught) but are associated with higher scores. Finding unique Pokémons with different probability of being caught aims to engage players in the game play as they explore the surroundings. Player's real-time performance in relation to other ghost players and physiological information are displayed on a user interface.

2.3 Game 2: Balloon Shooter

Our second VR game allows the player to ride near Sydney Hyde Park on a DeskCycle. A map of the game environment indicates places (using small red balloons) where players can find balloons to shoot. Audio cues allow the player to stay alert for approaching balloons. The game has three levels: the player starts on level one with a handgun to shoot balloons and collect reward scores. On scoring 50 points, level two will be unlocked, where a bow and arrow replace the handgun, which is more difficult to shoot the balloons with. Finally, level three can be unlocked

Table 1: Games Design Components

Game	*Open World*	*Narrative/Goal*	*Levels/Stages*	*Leaderboard /Points/Weapon*	*Physiological Data*
Pokémon Ride	✓	✓	✓	✓	✓
Balloon Shooter	✓	✓	✓	✓	✓

when 85 points are scored, whereby the player is presented with combination of small and large balloons. Introducing the game levels and change in weapon provide an element of surprise to the player and are aimed at keeping them engaged with the game. Meanwhile, the player can see real-time activity information (heart rate, time spent & calories) and scores in relation to other ghost players (min, avg. and highest) as numbers on a user interface. Fig. 3 shows some of the game components and Table 1 lists the major design components in two games.

3 CONCLUSION

This paper presents two immersive VR exergames built on the VR-Rides platform. The games aim to study players' motivation in physical activity and achieve their wellbeing goals. The games employ real-world imagery to provide an engaging tour to different immersive environments. The game designs aim to engage players with game mechanics, element of surprise, interesting choices to navigate, play and view performance and be aware of their physiological information as the outcome of their embodied movements. Designing for motivation and enjoyment with better understanding of perceived experience relevant to the player's background will help to provide the guidelines for future immersive exergames. We envision that HCI community can build on our experiences of theory driven (e.g. SDT) immersive exergames to have better in-built support for wellbeing.

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