Adventure Fit Explorer - Revolutionizing Children's Fitness using Augmented Reality

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ABSTRACT

Physical play involves engaging in activities that utilize physical movement, enabling children to accomplish tasks while fostering the development of both gross and fine motor skills. In contemporary times, there is a growing inclination among children toward indoor activities rather than outdoor ones. This change may threaten their physical play experiences, potentially leading to increased passivity and introversion. The purpose of this research is to present an Augmented Reality (AR) fitness game called Adventure Fit Explorer, which promotes physical fitness while engaging in an adventurous game. With the integration of AR technology, children play a game and interact with various virtual elements with wearable devices such as Xbox or Kinect, etc., just like they play outdoor games in a real-world environment. The game has several challenges that enhance various physical fitness exercises like racing, cycling, jumping, lifting, pushing, etc., while telling different stories. Additionally, an approach to gaming pedagogy is incorporated into the game to escalate the physical fitness learning experience in children. This broad inclusion of game challenges and fitness activities enhances children's well-being by engaging in gameplay using Augmented Reality, which simulates real-world outdoor activities.

Keywords: Augmented Reality, Physical Fitness, Game Design, Xbox Kinect

INTRODUCTION

Physical fitness activities are generally divided into two forms, namely: healthy, where the body is free from all diseases, and fit, where the body can perform various daily activities without excessive fatigue. Physical fitness refers to health including range of motion, muscle strength and endurance, and flexibility. It is very beneficial for children in their daily life activities (Valianto, 2019).

However, nowadays, lack of adequate physical activity at home and excessive consumption of non-physical recreation are leading to serious health concerns among children worldwide (Hsiao, 2013). Gaming fitness apps are emerging these days to engage children in physical activity and enhance their health and wellness behavioral interventions. Augmented reality (AR) and virtual reality (VR) technologies have been used in these fitness games to simulate real-world activities (Alturki and Gay, 2019). However, existing games mainly focus on specific fitness exercises, and the gameplay only provides the kind of environment where kids get bored of playing after a while. Most games mainly consist of running and cardiovascular exercises. There are many other types of exercises to improve physical fitness in children.

In response to these challenges, AdventureFit Explorer emerges as a pioneering solution that harnesses Augmented Reality (AR) technology to create a compelling and interactive fitness experience. Grounded in empirical research supporting the efficacy of gamification in health interventions (Johnson et al., 2016), AdventureFit Explorer seamlessly integrates physical challenges, an immersive narrative, and imaginative elements. By combining these components, the game aims not only to capture children's attention but also to inspire and motivate them to meet specific fitness standards.

The inclusion of imaginative elements within AdventureFit Explorer draws from educational psychology, emphasizing the importance of context and storytelling in motivating children and enhancing learning outcomes (Behnamnia et al., 2020). By immersing players in an engaging narrative, the game not only encourages physical movement but also stimulates their imagination and curiosity about various imaginative realms.

By leveraging AR technology, adding physical challenges, and incorporating engaging elements, this innovative fitness solution aims to inspire children to adopt an active lifestyle while experiencing the thrill of exploration and discovery.

Comparison of AdventureFit Explorer with Existing Games:

In this research, different fitness games are analyzed and each game has its own set of fitness challenges and activities as shown in Table 1. However, most of the games lack challenges that enhance strength and agility exercises, and cycling workouts. Games like Beat Saber (AR Ed.) and FitXR promote almost all fitness challenges in addition to gaming pedagogy features. Aside from these two, other games are not designed with gaming pedagogy such as educational emphasis on physical fitness and storytelling strategies. Additionally, all games except Wizards Unite offer running-based fitness challenges and gameplay that contribute to cardiovascular exercises.

While existing fitness games offer specific fitness challenges, AdventureFit Explorer introduces multiple physical activities by combining different elements of fitness, innovative storytelling, and an educational focus on holistic wellness. The inclusion of cycling skills, obstacle courses, and an immersive narrative sets it apart from other games. The game allows children to engage in gameplay with wearable devices and experience real-time action through the integration of Unity's AR Foundation. With a dedication to storytelling and a gaming pedagogy approach in various adventures, the game enhances physical well-being and educates children about various physical fitness exercises. This integrated combination of gaming activities, challenges, and design approaches not only engages children in a game to increase their fitness, but it also benefits children who have an addiction to excessive screen time and sitting for longer periods.

Table 1. Comparison of Proposed Game with Existing Games.

Feature / Fitness Activity	Outdoor Exploration	Running-Based Fitness	Cardiovascular Exercise	Strength Training	Agility Enhancement	Cycling Skills	Immersive Storytelling	Educational Emphasis
Pokemon GO	Yes	Yes	Yes	No	No	No	No	No
Zombies Run!	Yes	Yes	Yes	No	No	No	Yes	No
Wizards Unite	Yes	No	No	No	No	No	Yes	Yes
Beat Saber (AR Ed.)	No	Yes	Yes	Yes	Yes	Yes	No	No
FitXR	No	Yes	Yes	Yes	Yes	Yes	No	No
Walkr	Yes	Yes	Yes	No	No	Yes	No	No
Ingress Prime	Yes	Yes	Yes	No	No	No	No	Yes
Run An Empire	Yes	Yes	Yes	No	No	Yes	No	No
AR Runner	Yes	Yes	Yes	No	No	Yes	No	No
AdventureFit Explorer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

OBJECTIVES

AdventureFit Explorer aims to explore and encourage physical fitness in children through innovative storytelling and adventure challenges in a simulated environment. The game's design is to achieve a harmonious balance between fun and education, thereby promoting outdoor activities and aligning with fitness benchmarks. This research seeks to promote the AdventureFit Explorer game by improving physical fitness and fostering sustained interest in outdoor activities among children.

METHODOLOGY

The proposed Adventure Fit Explorer game is a multi-fitness challenging game that integrates various fitness activities while playing the game with several adventures. The game uses the Unity game development framework to create a game that enhances physical fitness by playing games in conjunction with AR devices. By engaging in this proposed game, children can inadvertently strengthen their fitness through physical activities such as aerobic and muscle-strengthening activities and agility training.

Adventure Fit Explorer offers a variety of adventures for children to engage in play to provide different experiences and increase physical fitness through the use of AR technology. These adventures include obstacle courses to increase aerobatic or cardiovascular fitness, daring treasure hunts to encourage children to be active, standardized fitness tests to test muscular strength as well as cardiovascular fitness, monster dodges to enhance muscle strength and energy, and bike racing for cycling workouts. This diverse set of gaming challenges integrates both narrative and ludic strategies of game design by using storytelling and robust game mechanics. The game also has an educational emphasis, a gaming pedagogy that enhances children's fitness knowledge through play experiences, and a scoreboard that assesses their fitness level. This combination of versatile activities in the game provides a rich experience and fun entertainment for children to promote fitness and the simulation of outdoor activities.

To design obstacle courses, Unity's AR raycasting in AR foundation is used to identify the obstacle in real-world 3D coordinates and position the AR symbol accordingly, and Unity's physics engine integrates real forces into the objects for realistic interaction. Gameplay uses the AR foundation to track children's actions in the real-world and support their physical fitness through cardiovascular and aerobatics exercises, and muscle strength and agility exercises.

For Treasure Hunts with AR, Unity's geolocation services are harnessed to scatter virtual treasures in real-world environments. AR markers, strategically placed through Unity's AR marker tracking, guide players through a narrative-rich journey. Each virtual treasure becomes a pivotal point in the unfolding story, motivating players to conquer fitness challenges seamlessly integrated into the quest. Unity's animation system brings the narrative to life, linking exercise achievements to the unravelling of the captivating storyline.

Fitness Challenges leverage Unity's UI system to display exercise instructions and progress tracking. Unity's animation rigging is employed for dynamic character movements, syncing with the completion of real-world exercises.

Monster Dodge introduces the physical movements necessary to dodge or defeat virtual opponents with Unity's New Mesh system for intelligent navigation and Unity's mechanism for realistic animations linked to physical movements.

Bike Racing utilizes Unity's AR Foundation for real-world mapping and Unity's Input System for responsive control integration. Unity's Particle System enhances visual effects during races, and Unity's Asset Store provides customizable bike models and race tracks. This activity promotes cardiovascular exercise and cycling skills and turns physical biking into an in-game activity.

Leader boards and Rewards, facilitated by Unity's multiplayer services, stimulate competition among players by tracking fitness achievements and contributing to a sense of accomplishment.

The Educational Emphasis integrates Unity's TextMeshPro for informational pop-ups and Unity's event system for interactive educational challenges. The game balances physical activity with engaging storytelling, providing players with informative pop-ups and challenges that enhance their understanding of the benefits of different exercises.

Architecture:

The game follows a client-server architecture as shown in Figure 1, with Unity 3D as the game engine managing core functions. Unity 3D handles connections to the server, Xbox 360 Kinect Sensor, and HMD (like Oculus) for immersive experiences. It stores user information, loads exercises, and calculates scores. This architecture emphasizes Unity 3D's central role in connecting the game, external devices, and data storage.
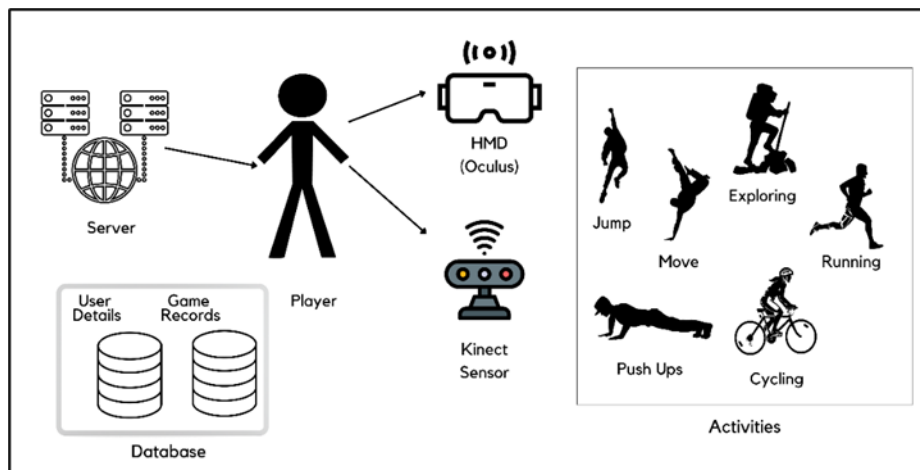

Figure 1. Architecture of proposed Adventure Fit Explorer.

CONCLUSION

In this proposed game study, the Adventure Fit Explorer stands as a pioneering solution addressing the prevalent issue of childhood inactivity. By seamlessly integrating technology with physical challenges within the game, it offers an innovative approach to actively involve children in outdoor activities. This game aims not only to entertain but also to encourage and facilitate physical activities, ultimately contributing to the overall well-being of the children.

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