Engaging the Elderly in Exercise with Agents: A Gamified Stationary Bike System for Sarcopenia Management

Demonstration Track

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ABSTRACT

This paper introduces a portable, gamified exercise system with an embedded agent, specifically designed to aid the elderly in lower-body workouts using stationary bikes. The system integrates a custom-made Internet of Things (IoT) sensing unit, a gamified application, and an agent-embedded backend platform. By leveraging real-time feedback along with historical user data, the agent actively contributes to exercise safety and adherence by customizing the intensity of workouts and managing break periods. This novel approach aims to make cycling exercise for sarcopenia prevention and intervention more engaging and effective, promoting regular participation and potentially improving health outcomes.

KEYWORDS

Gamification; Sarcopenia; Elderly; Stationary Bike; Agent

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1 INTRODUCTION

Sarcopenia is an age-related skeletal muscle disorder characterized by accelerated muscle loss, significantly affecting lower body strength, mobility, and increasing the risk of falls in the elderly [2, 5, 7]. Resistance training, particularly through stationary bikes, has been identified as a safe and effective method for rebuilding lower body muscle and combating the effects of sarcopenia [3]. However, the monotony of stationary biking often undermines exercise adherence, posing a challenge to sustained engagement [1, 4]. Addressing this, we propose an agent-embedded, portable, gamified exercise system designed specifically for lower-body workouts that aims to boost player motivation and ensure effectiveness of the exercise.

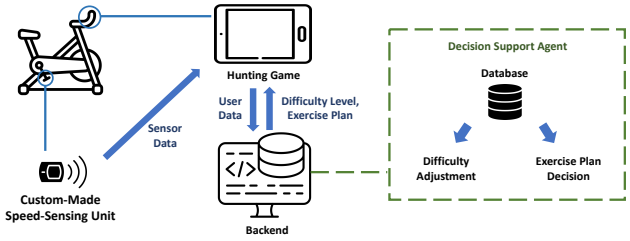

Figure 1: The conceptual framework of the gamified stationary bike system.

Figure 2: A custom-made speed-sensing unit mounted on a stationary bike.

2 DEMONSTRATION

The exercise system[1] consists of a custom-built speed-sensing unit for detecting cycling motion, a gamified exercise program designed for tablets, and a backend server responsible for data processing and decision-making, as illustrated in Figure 1.

2.1 Speed-Sensing Unit

The speed-sensing unit (Figure 2), housed in a 3D-printed casing, comprises of a 3-axis gyroscope sensor, a Bluetooth module with an embedded microcontroller unit (MCU), and a rechargeable battery. Gyroscope offers precise and real-time measurements. The

[1] http://tinyurl.com/mrbrk25s

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(a) Searching for rabbit track (b) Spotting a rabbit (c) Chasing the rabbit

(d) Maintaining close distance (e) A successful chase (f) A failed attempt

Figure 3: Screenshots of gameplay.

embedded MCU runs an algorithm that computes both the rotational speed and direction based on the gyroscope data regardless of its orientation at installation. The Newton-Raphson method for square root derivations was applied to reduce the computational complexity. The analysis results, reflecting the pedaling movement in real-time, are wirelessly transmitted to the game application. This sensing unit is powered by a rechargeable battery, allowing for long-term operations. Magnets were embedded within the casing for easy installation and removal on any stationary bikes with metal crank arms.

2.2 Game Application

The game is set in a cartoon-style forest where the player takes on the role of a fox chasing rabbits (Figure 3). Once the player comfortably sits on the stationary bike, the game activates upon detecting foot placement on the bike pedal. To simplify game control, pedaling is the only required action, as the game automatically navigates the fox avatar. Player's pedaling speed directly translates to the fox avatar's speed, establishing a real-time correlation between exercise and in-game actions.

To introduce dynamic gameplay experiences and HIIT-style exercise, the game implements different chasing tactics that require variations in pedaling speed: casual pedaling while searching for rabbit tracks (Figure 3a), gentle pedaling to mimic a stealthy approach (Figure 3b), and vigorous pedaling to simulate a full-speed chase (Figure 3c) once the rabbit becomes aware of the fox and starts escaping. To successfully chase down a rabbit, the player needs to maintain current pedaling speed for a short duration when getting close to the target (Figure 3d). Points are awarded when the player successfully chases a rabbit (Figure 3e), adding a rewarding element to the experience. A smaller amount of points are also awarded upon failed attempts as encouragement (Figure 3f). A typical exercise session lasts for fifteen minutes as advised by the medical professionals.

2.3 Decision Support Agent

The rule-based Decision Support Agent (DSA) adjusts the game's difficulty and customizes exercise routines. To adjust difficulty, the DSA compares the player's current and historical performance, including average speed and in-game scores. It adeptly modifies the rabbit's alertness, speed, and the required high-intensity pedaling duration to set an optimal challenge level. This adjustment ensures the game remains engaging without being overly simple or daunting, maintaining player interest and motivation. In addition, the DSA incorporates safety measures, employing context-aware monitoring and regulating break times during exercise. Upon detecting irregular pedaling motion, a set of safety checks is activated to evaluate the player's well-being. Any alarming responses lead to an immediate cessation of the game, prohibiting further play for the day. The DSA also adjusts exercise duration to match the player's physical capabilities.This personalized approach is informed by a comprehensive analysis of preliminary study data, which incorporates factors such as individual profiles and frailty statuses to set foundational parameters and thresholds [6].

3 CONCLUSION

This demonstration presented an affordable, portable gamified system for stationary bikes, aimed at tackling sarcopenia in the elderly, potentially boosting user engagement and exercise effectiveness through the integrated agent.

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