Towards Smart Rehabilitation: Integration of Smart Sensing with Gamification

Boon Giin Lee[a,*], Yongfu Wang[a], Renzhi Han[a]

[a] *School of Computer Science, University of Nottingham Ningbo China, Ningbo 315100 China*

[*] *Corresponding author, E-mail: boon-giin.lee@nottingham.edu.cn*

Abstract. This paper introduces an innovative rehabilitation framework that seamlessly integrates the capabilities of wearable inertial measurement units (IMUs) with highly interactive virtual reality (VR) environments built using advanced game engines. The primary novelty of this approach lies in establishing a robust real-time biofeedback loop. Continuous streams of tri-axial acceleration and angular velocity data captured by strategically placed IMUs on the user's body are processed to extract relevant kinematic parameters, such as joint angles, movement velocity, and range of motion. These parameters are then directly mapped to control and modulate the dynamics of therapeutic exercises within the immersive VR environment. This enables a dynamic and personalised rehabilitation experience where task difficulty, visual cues, and haptic feedback are adaptively adjusted based on the individual's performance and physiological responses in real-time. Furthermore, we explore the potential of employing adaptive algorithms, potentially drawing inspiration from state machine diagram paradigms, to autonomously optimise rehabilitation protocols over time, ensuring continuous challenge and promoting sustained engagement. This integrated system promises to offer a more engaging, data-driven, and potentially more effective alternative to traditional rehabilitation methods, facilitating objective assessment of progress and enabling convenient at-home therapy for a wide range of neuromusculoskeletal conditions.

Keywords: Wearable Sensors, Virtual Reality, Serious Games, Rehabilitation, Real-time Feedback, Personalised Therapy

Acknowledgements: This work was supported in part by the Ningbo Science and Technology Bureau through the Major S&T Programme, in part by the UNNC Education Foundation through Li Dak Sum Innovation Fellowship.