Rhythm-based serious game for hand function improvement

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Abstract

Hand paralysis, resulting from various causes like hemiplegic stroke, raises significant challenges to a patient's daily life and psychological well-being. [1] Therefore, there is a strong need for continuous rehabilitation to improve hand function.

Hand rehabilitation is categorized into physical therapy, occupational therapy, and pharmacological treatment [2]. This paper focuses on occupational therapy, referring to preceding examples [3][4][5] that use applications.

Sustained motivation is crucial for successful rehabilitation. Thus, the purpose of this paper is to introduce a rhythm game, a representative genre of music-based games, as a digital therapeutic tool to promote continuous rehabilitation based on studies that utilize music to stimulate patients' motivation [1][6][7].

At the initial game launch, users directly measure their ranges of finger motion within the application and select either their left or right hand to play . During gameplay, they conduct rehabilitation along with the music using notes as input. However, unlike general rhythm games, notes are presented in a rehabilitation-specific format. Each play session generates a brief score summary. Subsequently, users can check their rehabilitation progress through weekly or monthly reports that provide score data for each type of rehabilitation exercise.

There are two types of input devices in this game. Glove-shaped hardware includes sensors linked to the Arduino board to capture the movements of each finger. It communicates with the Unity game engine to utilize data for judgment during the play. Users should wear this device on their unaffected hand while the paralyzed hand uses a device that rehabilitates their hand through movement synchronization.

The other way to input data is using the touchscreen. As the previous research assumes, patients at the Brunnstrom stage of stroke recovery stage 4 and above, who can grasp with or release their fingers, are applicable in this way [1]. However, it is hard for some devices that have small screens to expect effective rehabilitation, so tablets or multi-touch displays will be needed.

The rhythm-based serious game developed in this paper accommodates users of various ages, not only between 60 and 80 years old but also other patients of different ages [8], by incorporating a diverse range of music genres. The game primarily uses royalty-free music and music generated by AI. Furthermore, the system automatically recommends difficulty levels based on the user's range of motion to enhance user experience. While some guidance by medical team or caregivers may still be necessary, this feature promotes self-directed rehabilitation.

Keywords: *digital therapeutics, artificial intelligence, rhythm, hand function, hand paralysis, serious game*

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