Establishment of a Personal Rehabilitation Assistive System Through Music Intervention

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ABSTRACT

Rehabilitation medical care plays an important role in care for the elderly and it can help patients recover from gait abnormalities and return to normal life. Most people with Parkinson's disease (PD) experience walking difficulties as the disease progresses. Moreover, music is often used in the rehabilitation process, especially in motor rehabilitation. Among the nonpharmacological approaches, one of the methods most studied is Rhythmic Auditory Stimulation (RAS). Besides, rehabilitation therapist uses gait analysis to know the human walking and diseases affecting the locomotor system. However, most rehabilitation therapists don't familiar with music and the PD patients are not easy to execute rehabilitation at home. Therefore, we would like to establishment a Personal Motor Rehabilitation Assistive System (PMRAS) for PD patients to rehabilitate at anywhere through music intervention. We consider the problem of gait and emotion recognition by deep learning method. In the study, we collaborate with rehabilitation physicians and occupational therapy at Hsinchu Cathay General Hospital. PMRAS will be designed to use music as a pacemaker and the music recommendation tool to provide personalized rhythmic cues that facilitate the patients' coordination during their walks.

Keywords: Rhythmic Auditory Stimulation, gait analysis,

INTRODUCTION

In 2000, Pacchetti Physician studied patients with Parkinson's disease on the musical therapy. In his study, the balance and gait of PD patients improved every week after receiving a variety of music therapies, including choral singing, voice exercise, rhythmic and free body movements, and active music involving collective invention. [1] RAS aims at the Gait abnormalities, such as shuffling steps, start hesitation, and freezing, which are common and often incapacitating symptoms of Parkinson's Disease (PD) and other PD disorders. Rhythmic auditory stimulation (RAS), such as playing marching music and dance therapy, has been shown to be a safe, inexpensive, and effective methods in improving gait in PD patients. [2] Literature shows that playing and listening to music may affect emotions, behaviors, movements, communications, and cognitive factors, modifying the activity of the brain. [3]

In the study, we set the measure environment of bio-signals and gaits to provide the datasets to be applied with machine learning algorithm in the future. The vital signs include physiological and psychological data, blood pressure, heat rate, heart rate variability, temperature, respiration, galvanic skin response, electromyography, activities and gait information. Therefore, we have to integrate the different sensors and capture vital signs and gait data on an embedded system. The vital signs will be uploaded to a cloud platform through mobile phone and we will implement the data analysis through deep learning technology to achieve the aim of music recommendation on the platform.

METHODS

- Get the vital signs and gait analysis data

To know the music assistive rehabilitation progress at the clinical environment, we will set the vital signs with the integrated sensors embedded system at the rehabilitation clinic of the hospital. The embedded system will collect the vital signs, including heat rate, heart rate variability, temperature, respiration, galvanic skin response, electromyography, step length, step width, walking speed and cycle time. We will know the physiological and psychological information of PD patients when they

exercise the RAS through different music. We will use these vital signs of the patients' electronic medical records and music hobbies to implement deep learning analysis and get our deep learning model.

- Set RAS music metadata

We will label the RAS music with a score of 1 to 7 for the music piece and 11 music features, corresponding to the listener's emotional and physiological responses. The 11 features: tempo (1 slow, 7 fast); rhythm (1 outstanding, 7 vague); accentuation (1 light, 7 marcato); rhythmic articulation(1 staccato, 7 legato); pitch level (1 low, 7 high); pitch range (1 narrow, 7 wide); melodic direction (1 ascending, 7 descending); mode(1 minor, 7 major); harmonic complexity (1 simple, 7 complex); consonance(1 dissonant, 7 consonant); sound intensity (dB). Moreover, to develop personalized RAS music, we also consider the patient personal characteristics, as like personal background (eg, education, age, gender, ethnicity, language, personality traits), personal preferences (eg, tracks, types, composers, performers, musical instruments) and personal emotion information (heart rate, respiratory rate, blood pressure, emotions and so on emotions, etc.) and physical and mental health (anxiety, depression, insomnia, dementia, action coordination, etc.).

- Construction of RAS music deep learning model

After we get the vital signs and rehabilitation activity information and medical records, RAS music features and personal features, we will develop the RAS music deep learning model to get the recommend music depended on the request of rehabilitation or personal hobbies. The RAS music deep learning model will be designed on the cloud platform and PD patients will get music recommend by APP to rehabilitate at anywhere.

DISCUSSIONS AND CONCLUSION

Though the Personal Motor Rehabilitation Assistive System (PMRAS), PD patients will be able to execute the RAS rehabilitation at home, not only at the hospital. In order to establish the innovation RAS music recommendation system, we have to get a lot of the patient clinical rehabilitation data to learn the model and evaluate the model in the future. The personal characteristics and music hobbies is an important factor, so we not only get vital sign measurement also implement questionnaires survey. The rehabilitation gaits information are captured in real time and not at lab, so the accuracy of gait recognition is an important issue. We will simulate it for more clinical trials and it would be done to provide further information for improvement.

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