

Stroke Rehabilitation via a Haptics-Enhanced Virtual Reality System

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Abstract. Stroke is one of the major diseases causing brain injury, its sequela will, depending on persistent nervous injury, derive different types of limb and body exercise barriers, which will cause large challenge to the daily life of the patient and will seriously affect the quality of life of the patient. Along with the development and popularity of technology, scholars in the medical care and rehabilitation fields are trying to integrate all kinds of new technologies to perform the development of new rehabilitation training system.

In this study, for the rehabilitation of upper extremity, trainings are provided respectively for fore arm, for the endurance, stretching and flexibility of the wrist. Here game technology, force feedback technology and stereo image technology are associated to develop virtual reality body perceptive training task. In the rehabilitation process, multi-dimensional experimental results are acquired, for example, clinical test assessment, task performance, exercise track historical data and psychological emotional data. The research objectives are to verify the functionality of the system, to verify the effectiveness of the system on rehabilitation, to develop new assessment method and to investigate topics related to human machine interaction.

After initial pilot test is done on stroke patient, the experimental result has verified the functionalities of this rehabilitation training system in several aspects. Meanwhile, it can acquire reliable and valuable information successfully, for example, through the exercise analysis using exercise track historical data and using the statistical analysis of the task performance in the past therapeutic sessions, the medical therapeutic effect can be verified in the future, and new clinical assessment method can be developed. Not only so, according to the measured psychological emotional data as perceived subjectively, this system indeed can urge the patient to engage continuously rehabilitation therapeutic session that is based on this training system and enjoy it, besides, the authors are very confident on the possibly generated rehabilitation effect of these two training tasks.

1 Introduction

According to clinical data, it can be seen that within six months after the stroke, 88% of the acute stroke patient will have upper extremity hemiplegia, which includes the lack of strength in the arm muscle, incapability of stretching, heteronomous spasm, the loss of original acting scope of the wrist and palm, the loss of the capability to catch and take, sometimes, the loss of muscle strength or incapability of normal movement of the finger due to abnormal spasm might happen [7]. When the patient performs Activities of Daily Living, for example, the button-up of the clothes, the hanging of the clothes and dining, etc., all these actions will cause serious challenge to the patient, not only the living quality of the patient will be seriously impacted, the social cost accompanied due to the medical care need, for example, the human resource, material and medical resources needed for the medical care system, will also be pretty large.

Neurological exercise disorder originates the injury on the cortex exercise area of the brain, however, the cortex of the brain of human beings and the related nervous system are always in the plasticity state [6] and nervous re-organization processes [10], which in turn will affect and accelerate the learning (recovery) processes of the exercise function, and related researches also prove that systematic and group exercise rehabilitation model can indeed assist the enhancement of rehabilitation therapy, in addition, some researches also pointed out that for the learning of a new exercise technical model, the providing of the behavioral performance of the user to be used as expanded feedback mechanism is one of the important rings in the learning principles of enhancing the learning effectiveness. Similarly, exercise rehabilitation of brain injury can be seen as one type of exercise learning process, and the above principle can also be used to provide continuously the patient with rehabilitation performance as feedback [6][10], in another view, the feedback of vision and hearing is also one of the important factors to keep the exercise function [11].

However, for the action training method and therapeutic session design used in traditional physical therapy or occupational therapy, no matter in practice or economically, the above goals will all be difficult to be reached, and some inherent limitations do exist. In the mean time, the effect of rehabilitation therapeutic session will to certain extent be dependent on the level of engagement of the patient. Since the rehabilitation session is tedious, lots of external factors might reduce the participation or the motivation to complete the session from the patient, for example, when the therapeutic session content is too repeated or boring, or the traffic inconvenience factor, etc.

The constant advancement of 3D animation technology and internet technology not only provides technological enhancement, but also provides economic popularization, hence, lots of scholars performing medical rehabilitation related researches and the front line doctor or therapist in the world have tried to integrate the above technologies, and they try to use virtual reality, Augmented Reality and mixed virtual reality e as the theoretical basis, meanwhile, User Centered design concept is also put in, furthermore, user's perception on the system and usability and immersion of the system are also considered, and finally, the interactive model and strategy provided