Hand Rehabilitation with Virtual Reality Games: Fizyosoft™ LeapBall

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ABSTRACT

Virtual reality is defined as simulating the real world with computer technologies. A three-dimensional (3D) computer generated environment provides exploration and interaction of user with the objects by giving the sense of being in a real world. Virtual reality based digital games are very popular because of ensuring rich media to the users. Today, physical rehabilitation applications based on virtual reality games have gained importance. The scientific and clinical studies state that those games have positive effects on the patients. At classical physical rehabilitation in clinic, the patient must repeat the same exercises many times and this process becomes annoying especially for pediatric patients. However, the patient does his physical exercises while playing games at digital game based rehabilitation. Patients needing rehabilitation are high motivated and have fun during the games. Besides, the measurements recorded during the game are stored in the computer and the results are reported. By the way, the recorded data is analyzed later and the change of the patient with respect to time is presented in an objective manner.

This study presents a new virtual reality hand rehabilitation game named Fizyosoft™ LeapBall. The game is played with the developed software and a Leap Motion Controller. The Leap Motion Controller models the right and left hands in 3 dimensions and determines the position and orientation the fingers and joints. Data gathered with Leap Motion controller is transmitted to the computer and the user can see his hand on screen in real time. When the user puts his hand above the sensor, the 3D positions and orientations of each joint are determined and the hand is shown on the monitor. The user can see his hand and the movements of hand simultaneously on the monitor.

The purpose of the game is grasping a ball and putting it in the colored baskets according to the given voice instructions. The position of the hand is important for playing the game and the hands should be placed 20-30 cm above the Leap Motion controller. When the game starts, voice instructions like "grasp the blue ball" or "put the blue ball in the yellow basket" are automatically given. When the pediatric patient makes the grasping action with the sufficient flexion joint movement, he simultaneously sees the grasping process on the monitor and feedback is given by highlighting the color of the ball. In the game, the number and color of the baskets are determined with different levels. After the patient grasps the ball, he should put it to the right basket that is defined with the voice instructions. When he brings the ball on the basket, he should open his hand and the ball falls into the basket. If the duration determined by the expert ends the game ends. The game is user-specific where the duration and difficulty of the game can be set by the physiotherapist according to each patient's condition. Data gathered through the game are stored in the database. Information like the time and duration of the game period, the maximum joint movement angles and the game scores are stored for future analysis. By this way, the play of each user at different times can be reported and the changes during the hand rehabilitation process are objectively analyzed by experts. Rehabilitation with Fizyosoft™ LeapBall presents a new, motivating, functionality based and patient-specific treatment for the physiotherapy experts.

Keywords: Rehabilitative game, virtual reality, hand rehabilitation, Leap motion