Ludic system for therapy exercises of wrist and hand phalanges

Amaury Perez Tirado,

Advantage Engineering Center (CIA),
Faculty of Engineering, National Autonomous University of Mexico, Mexico City, Mexico, and
Aachen University of Applied Sciences, Aachen, Germany

E-Mail: aptur@hotmail.com
Web: https://www.unam.mx/

Abstract – The rehabilitation process use therapeutic exercises, they require consistence and a correct execution of the movements realized by the patients, then there will be progress in their recovery; those exercises, generally, are made at home where the persons are susceptible to the boring and abandonment, because of that, the treatment is longer and tedious. [1]

The present project consisted in the development of a device that allows to the persons realize the therapy exercises, using ludic activities. In this case, it was used the hand because It is a vital element in the daily life of the persons, the hand is conformed for phalanges, carpus, metacarpus. It was analyzed the movements of the finger, the flexion and extension of phalanges and the rotation movement of the wrist, abdution and adduction, and we add the pronation and supination like complement movements for the interaction. [2]

It is proposed implement a system based in gamification, that is, the application of mechanics that belong to the games [3]. In this way, we use psychologic elements of video games like: Competence, Challenge, Fantasy, Immersion, that makes more attractive the activities for the users. [4]
There are works before about using serious games in the recovery of a patient, like in the case of rehabilitation of a cardiovascular accident, where it was applied virtual reality in the therapy of the superior member, with positive results. [5]

The method to design the system begin with the analysis of the problem, and then it obtains the technical requirements, which are measurable. In this case was considered that the system will be a domestic device, for that the maximum space needed is 30 [cm] * 30 [cm] * 30 [cm] and a maximum weight 3 [kg]. In terms of the software, it required maintain attention of the user for at least 20 [min]. And according with the goniometry it's proposed 30 [°] for the movements of the wrist and 80 [°] for the proximal phalange.

Later the configuration of the system make able to the user realize different exercises of mobility, amplitude and resistance. Using different sensors and actuators. First, we have the finger movements, is read by the flex sensor, it was conditioned using Wheatstone bridge an operational amplificators, then an ADC, using a microcontroller. Additionally, for the register of the movement of the wrist it was used an inertial measure unit (IMU), using a Kallman filter, we combined the accelerometer, magnetometer and gyroscope data, and it was obtained use 3 degrees of freedom, pitch, roll and yaw. The actuator used is a motor connected to a potentiometer to use a feedback control system, with a PID controller, we can control the resistance that the user can feel, which is reached using a system of strings and pulleys.

The structure of the system was designed according with the requirement of volume and the configuration of the electronic components (Figure 1). It was designed a semi spherical base to make viable the rotations and compress all the circuit system, and a joystick form for the conformity of the user, using the average size of ten different persons.

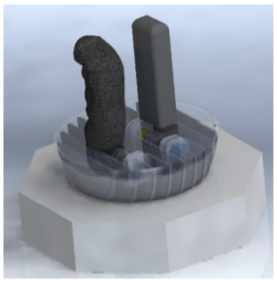

Fig.1: The render of the virtual design of the structure.

In a software level, the games were developed in XNA and Unity with the C# language to create the virtual environments. Using a protocol of RS-232 receive the data of the sensors, it's possible to convert the information in the control of the interface. The games developed contain a score system, a variable time challenge, different speed and resistance changes, progress screen, which provide to the user and the physiotherapist, all the information needed to be sure the goals are reached.

The functional model was used in different users inside of the university (figure 2) and was evaluated by the sport medical unit of the university, where they made some observations of the possible future changes, like to include exercises for the thump. Further it is possible to adapt the system to a phase of rehabilitation where the patient can realize exercises without supervision of a specialist, only when the user doesn't feel pain making movement.

Fig.2: Completed functional model used by one of the testers.

Finally, we can add that it will be need more studies in the future to probe the motivation of the users, but it required the development of a different games or situations, to maintain the attention of the users; but it's notable the persons are curious and interested in test this kind of systems. The work develops here it was will work like base for future projects of system that pretend combine the exercise or therapy with the gamification.

References

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