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PROPOSAL OF A VIRTUAL ENVIRONMENT TO SUPPORT THE FUNCTIONAL UPPER LIMBS REHABILITATION USING THE MICROSOFT® KINECT® MOVEMENT SENSOR

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SUMMARY
Researches involving the use of virtual environment that helps the rehabilitation of people that have suffered brain injury by strokes, show great advance in the physical and in the cognitive aspects. This study presents the proposal of a virtual environment to help the upper limbs rehabilitation in a playful way, in addition to show the use of the Microsoft® Kinect® movement sensor as a tool of input to the virtual environment, with the aim of getting quantitative information that will help the occupational therapists to make their conclusions during the patient treatment, allowing to evaluate his development. During the virtual environment developing we rely on the help of Dr. Henrique Santilo Rehabilitation and Readaptation Center (CRER) professionals.

INTRODUCTION
In Brazil, the number of lethal victims caused by stroke in the year of 2010 reached 99726, and in 2011 has occurred 179185 hospitalizations due to strokes [1]. According to the National Stroke Association, 15% die and 85% require some type of treatment [2], that can be holistic programs, developed by inter and multidisciplinary professional team with ecological validity and using qualitative and quantitative methodologies. In this process the patient participation is crucial to a successful treatment. The virtual environment requires greater participation of the patients providing interfaces that create high levels of motivation.

METHODS
Based on observations of stroke patients rehabilitation procedure in CRER - that offers humanized assistance and it is specialized on rehabilitation for people with physical or hearing disability, emerged the idea of creating the Virtual Environment to Support the Functional Upper Limbs Rehabilitation, that uses the Microsoft® Kinect® movement sensor.

During the development of the virtual environment, one of the most challenging steps was the creation of activities that could attend the most movements of the upper limbs of the patients, since every patient has his own physical, cognitive and visual limitations.

The solution for this problem was found during the interviews with the Occupational Therapists that make a qualitative clinical evaluation, aiming to define pre-morbid characteristics, the current disease conditions and the patient daily activities. Observing the patient it is possible to define behaviors and conducts to detect the presence of cognitive changes.

The proposed activity in the virtual environment consists in a connecting dots game, aiming to verify the movement trajectory and/or the time that the patient takes to conclude the activity. Based on the interviews and observations in CRER, it was proposed an activity that requires the participation of the Occupational Therapist in defining the dots positions on the screen according to patient's needs and possibilities.

The virtual environment was developed using the IDE Visual Studio 2012 Ultimate, with the Visual C# templates for WPF Application. The entire visual part was developed in WPF forms that use the interface language from Microsoft® XAML on the Operational System Windows 7 Professional. Thinking about future changes in the environment, it was used the MVC standard. In order to identify the patient's hand (left or right) position (X,Y) on the computer screen, we have used the library that accompany the Kinect® for Windows SDK 1.5. The Kinect® version used on the tests was the one made for PC, which has better resources than the Kinect® for BOX 360®. The Microsoft® Kinect® movement sensor gives in real time the tridimensional position (X,Y,X) of 20 human body joints [4] that permit to evaluate the patient's posture [5] (Figure 1).

The virtual environment works as follows: the patient is pre registered in the environment, the therapist creates the activity and the movement sensor is used to capture the hand position (X,Y) in the computer screen, where, after a time set by the Therapist, a numbered point appears in the screen and this process continues until the Therapist determines the end of the activity creation (Figure 2). Then this activity is saved in the data base.

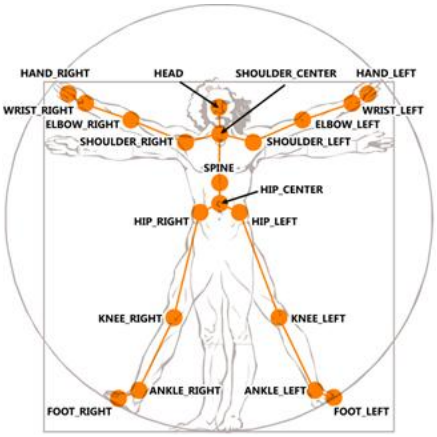

Figure 1: The 20 joints that make up a Kinect skeleton [6].

Figure 2: The Therapist creating the activity, capturing four points on the computer screen.

The patient executes the activity as follows: the Therapist chooses the saved activity, the patient is positioned in the same position the Therapist occupied during the creation of the activity. After the patient is correctly positioned a white point appears in the middle of the patient's hand (left or right). When the Therapist clicks in the start button, the first point becomes red, and from that moment on the patient should put the white point in his hand into the red point. When this task is concluded, the next point becomes red and the current point becomes green (Figure 3). During this procedure, the (X, Y) coordinates of the patient hands are captured by the Kinect® movement sensor that generates the patient movement trajectory during the activity. Finally, these coordinates are stored in a data base.

At the end of the session the Therapist can show to the patient how his performance was (Figure 4).

RESULTS AND DISCUSSION

Virtual environment for support to the rehabilitation treatment makes possible an unprecedented patient immersion to the activity, and it is a different alternative to the traditional rehabilitation activities. The Microsoft® Kinect® movement sensor used in this kind of environment adds a touch of fun which holds the patient attention, making him forget his physical condition and concentrate only in the presented activity. In addition it is possible to provide quantitative data for the Therapist in order to monitor the patient's treatment progression.

Figure 3: The patient doing the activity

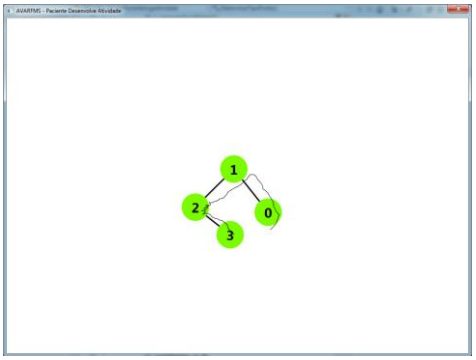

Figure 4: Resulting patient trajectory compared to the optimal trajectory.

CONCLUSION

The aim of this study is to present the Virtual Environment to Support the Functional Upper Limbs Rehabilitation and show the use of the Microsoft® Kinect® Movement Sensor as an input device to capture the patient motion.

The proposed virtual environment is an alternative tool in stroke patient rehabilitation where the Therapist creates the activity according to patient needs and possibilities, increasing the playful aspect and the dynamism of the activities which in turn holds the patient attention.

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