Evaluate Leap Motion Control for Multiple Hand Posture Recognition

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Abstract

Leap Motion is a device that turns hands and fingers into input devices, it is possible to control the computer by replacing the mouse and / or keyboard. The Laboratory of Educational, Auxiliary and Multimedia Technologies of the Federal University of Rio Grande do Norte develops prototype gloves and virtual games, that are used in rehabilitation sessions for people who have suffered a stroke. The objective of this work is to verify if it is possible to replace the prototypes by Leap Motion and to qualify the interactions with the user at the moment of the rehabilitation.

1 Introduction

Yang [18] organized into two classes the hands recognition devices: vision-based and non-vision-based. The Non-vision-based class uses sensors with Microelectromechanical Systems (MEMS). The vision based uses Computer Vision techniques and algorithms to detect hand posture. According to Jaimes [7] human interactions captured by computer vision techniques can be classified in: large-sacle body movements, hand gestures and gaze. The Leap Motion [9] device, subject of this study, would be classified as hand gesture type.

Leap Motion is a USB peripheral device that transforms hands and fingers in input devices, it uses cameras and infrared sensors to create a hemispheric area where movements are captured and processed by your Orion software in a manner not disclosed by the company, it is possible to control the computer by replacing the mouse and/or keyboard depending on the application.

The purpose of this study is to evaluate the movement control, provided by Leap Motion, in the recognition of multiple posture of the hands, and depending on the results use Leap Motion in stroke rehabilitation activities as reported by Burke [4] and [5], and Rego [13], also as a future parameter in the analysis of the data obtained in these activities and even in activities that use other input devices (such as data gloves [14], for example). Our hypothesis is that Leap Motion will be able to replace the data gloves for stroke rehabilitation applications, with the advantage of being a device that leaves the hands free, while the data gloves, by being dressed, generate a restriction in the movement of the hands.

Way [16] developed a system based on vision, but integrated with MEMS in order to capture wrist gestures. The device has a camera mounted on the wrist and it is used for recognize the pinch gesture with all fingers. Karashanov [8] develops a study about the use of Leap Motion Control for hand rehabilitation with games. The project developed a set of games with different types of gestures as input control. The work concludes thar Leap Motion works well for this kind of application, but dont presents the method to evaluete the system. Rahman [12] is presented a framework for modeling virtual rehabilitation therapy applications. This system uses Microsof Kinect and Leap Motion, in the same time, in order to archive a more precise data from gesture recognition.

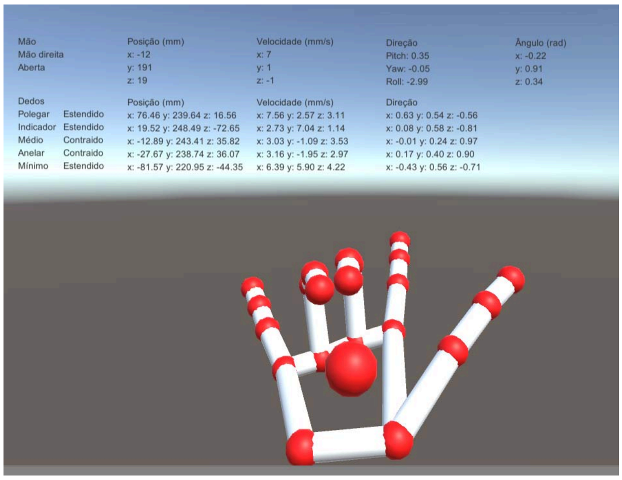

Figure 1: Main screen InfoLeap

All applications have been developed with Unity, the first application is called InfoLeap and allows you to see in real time the variables created by Leap Motion and the values assigned to them. With these variables it is possible to develop games controlled by Leap Motion, and was developed three games, one game in two dimensions and the other two games in three dimensions, called Fatbird, Leap runner and Lost in space respectively. In Fatbird and Leap runner the player has only one degree of freedom, in the Lost in space has six degrees of freedom and is designed to test all the variables together.

2 Configuration

Using the Leap Orion 3.2.0 version +45899 Motion, Unity 5.5.4 f4 with asset Leap Motion 3.0.0 version, simply include the Leap library in Unity to have access to all functions and variables of Leap Motion.

2.1 InfoLeap

This application shows a virtual hand model and the values of all variables described in this document in real time, see Fig. 1, with this application is easy to discover the ranges of these variables, if the values are in accordance with the pose of the hand at that moment, and how one variable relates to the other. All data in each frame are saved in an XML file for detailed analysis later.

2.2 Fatbird

This was the only game not developed by us, is a third-person application is available on Unity asset store [15], see Fig. 2, the character is always moving forward and the player controls only vertical movement, his goal is to deflect as many obstacles as he can, we just change how the character's control is made, and the name of game to create a context, now control is done flexing the wrist.

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978-1-5386-3588-9/17 $31.00 © 2017 IEEE
DOI 10.1109/SVR.2017.49

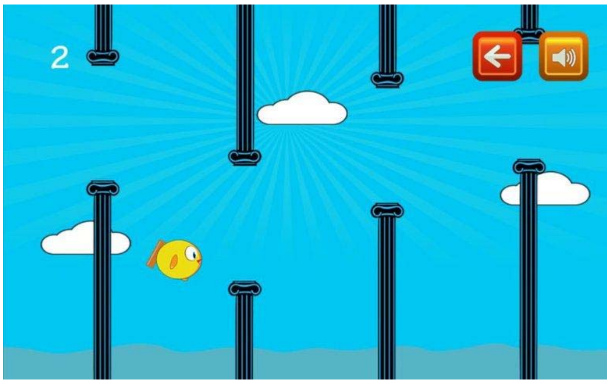

Figure 2: Main screen Fatbird

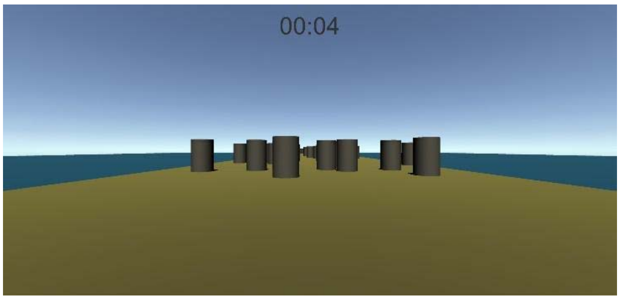

Figure 3: Main screen leaprunner

2.3 Leap runner

In this first-person application, see Fig. 3, the character is always moving forward and the player controls only horizontal movement, his goal is to deflect obstacles for at least forty seconds, control can be done in two ways. One is moving the hand to the left and right more intuitively,or opening and closing the hand in a less intuitive way, open hand moves the character to the left and closed hand moves the character to the right.

2.4 Lost in space

In this third-person application, see Fig. 4, the player has full control over the vehicle, the control is done by moving the hand within the capture space of the Leap Motion and combines all the variables of direction, position, and speed of the hand, to move and rotate the ship at x, y, and z axis. The ship replicates all movements of the player's hand with the same intensity, the faster he moves his hand the faster the ship moves. It is also possible to fire projectiles to destroy the asteroids, opening and closing the hand. Its goal is to find and rescue three astronauts lost amidst the obstacles represented by asteroids.

3 Test and Results

A qualitative research was done only with Fatbird and Leap runner, the research was done to know how engaged people are with the developed games. Although the final objective of the research is to use Leap Motion for stroke rehabilitation sessions, due to its initial stage, a previous usability test was necessary. Therefore, only healthy adult volunteers participated in this test, because there is no need to go through the ethics committee.

We chose a quantitative evaluation as defined by Bowman [3] and adopted a post-hoc questionnaire based on the Likert scale [1]. The questionnaire was composed of eleven questions and the

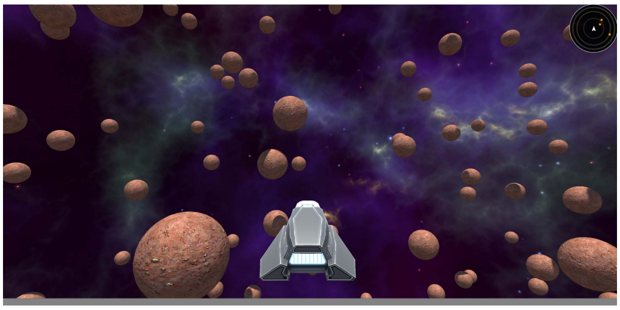

Figure 4: Main screen Lost in space

questions were based on two previous papers: questions 1 to 8 were extracted from Natapov [10], and questions 9 to 11 are adapted from the device design questions presented by Poupyrev [11].

The experiment was conducted with eight volunteers. The group consisted of seven men and one woman, aged between 18 and 29 years. The mean age of the group was 20 years. The questionnaire itself presented the following questions, where the participant should give a score from 1 to 5, where 1 represents Very Low and 5 Very High:

1. How smoth is the interaction during the game?
2. What is the degree of mental effort to perform the operation?
3. How accurate is the control in responding to your interaction?
4. How fast is the interaction?
5. How much fatigue does your fist have after the interaction?
6. What is the degree of fatigue of the fingers after the interaction?
7. What is the general comfort level?
8. Was the overall device gone?
9. What is your interest in continuing to play the 2D version of the game?
10. What is your interest in continuing to play the 3D version of the game with the movement of opening and closing the hand?
11. What is your interest in continuing to play the 3D version of the game with the movement of just moving the hand to the left or right?

Based on the responses of the questionnaire, two different graphics were produced presenting the results. In the first graph we have the general mean of the answers of questions 1 to 8. The results can be seen in Fig. 5.

In these results we can see that users considered the iteration smoothness (question 1) and the degree of mental effort (question 2) medium (approximately 3 for both). The accuracy of the control (question 3) was considered to be above average (approximately 4), but this was not reflected in their perception of the game interaction velocity (question 4), whose mean value was almost 3. Fatigue Control was considered low (mean of approximately 2 for questions 5 and 6). The general comfort (question 7) was between Normal and High (average of approximately 4) and device in general (question 8) was very well evaluated (average above 4), being considered as High degree of satifation.

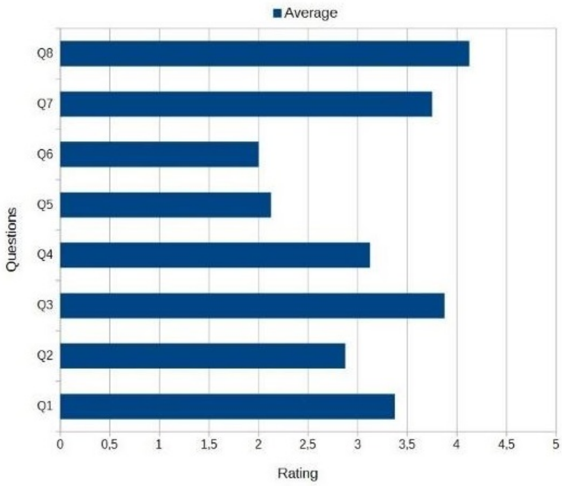

Figure 5: Average answers 1 to 8

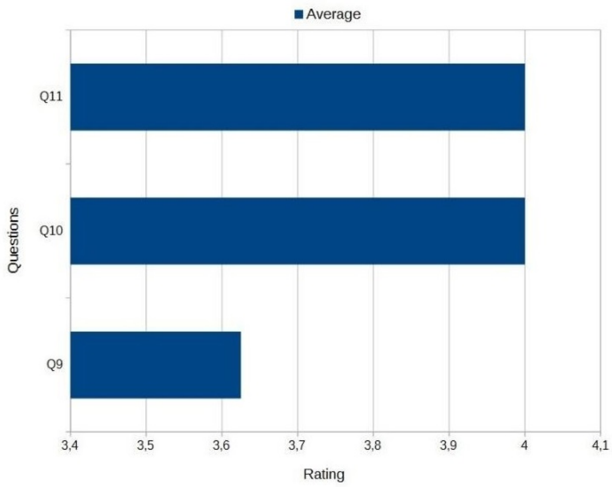

Figure 6: Average answers 9 to 11

For questions 9 to 11 a second graph is made and can be seen in Fig. 6. The questions in this graph are linked to the design of the game interface and to the design of the interaction with the control. Question 9, which deals with interaction with the 2D game (FatBird) has on average less interest to users than the 3D version (LeapRunner). The 2D game had a better visual quality and a more playful appeal, but communication problems between Leap motion and game during the execution of the test may have compromised the result of this question, therefore we believe that the test should be redone for this question.

Comparing issues 10 and 11, we can see that there was little difference between the two interactions for the 3D game. Although our original hypothesis was that the hand-opening game would be less intuitive, this was not reflected in the users' analysis.

4 Conclusion

In this work we developed a set of applications to evaluate the hand gesture capture provided by Leap Motion control. This device is able to recognition multiple hands posture. Based on the preliminary results we could plan to use Leap Motion in rehabilitation activities. In order to make a preliminary evaluation was executed a quantitative analysis based in a post-hoc questionnaire.

Unfortunately the number of people who participated in the test is low, due to the difficulties of finding willing volunteers and bringing them to the laboratory for evaluation. All volunteers are healthy because there is no need to approve the evaluation on the ethics committee before. According to the test results the users have felt that the acuracy of the device and the comfort of using it are high. However, they believe that the response speed in game interaction is still low, which can mean a problem in communication with the game engine. This same problem was detected in the test with the 2D game, so new tests should be done, with a much larger number of people to re-evaluate these two factors.

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