



## Serious games using upper limb adjustable support for rehabilitation

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**Background, Motivation and Objective.** There are people who have suffered injuries that prevent them to do some tasks by themselves, due to a limb that lost their movements or, even with movements, did not have the strength to sustain a contraction position without supports. In these cases, medical attention is required so the person can recover its movements. However, rehabilitation process can be a longstanding and boring experience. In a research published by Burke et al. [10.1007/s00371-009-0387-4], the authors say that it is noticeable that patients can accomplish better results when rehabbing in a funny way. In addition, for the physiotherapy, exercises combined with games can help to restore lost movements by motivating the patient with a game. When there is a serious game, it is possible to deliver data over the rehabilitation, to also improve and make it easier to define the way of treatment chosen by the health professional. The objective of this project is to enhance the rehabilitation method for those who had their upper limb movements affected. To do it, the authors are developing a serious game to be used in therapy process by people with different injuries, with or without the need of a mechanical support.

**Methods.** The game is being developed on a platform called Unity3D, using C# programming language. The Kinect V2 implementation in the game was made using its SDK and a plugin downloaded from the Unity Asset Store, which allows the creation of scripts that work with the sensor and to convert the player's real world movements in the ship's movement on the screen. The game, named Galaxy Motion, is inspired on the classic 80's game Space Invaders, where a ship needs to destroy as many aliens as possible. The game is being designed to be used combined with a mechanical support, called Armon Edero. This mechanical support compensates for the full weight of the arm by a spring compensation system. Some additions were made in the support to make possible the use by people that have a loss of wrist movement, as well. These additions were made with 3D printed parts that, when assembled, works as an extender for the Armon Edero, adding support to the wrist and hand of the user. These parts, modelled on SolidWorks 2017, are adjustable for most sizes of limbs.

**Results.** Since Galaxy Motion were made to enhance physiotherapy sessions, the controllers and the goal were adapted so the user could get a softer experience in comparison with its inspiration game, Space Invaders. With this adaptations the player needs do dash from comets, collects gas gallons and reach an astronaut, which generates the feedback parameters for the professional. Therefore, the Galaxy Motion can gather data over the evolution of its user, such as response time and speed. The parameters are calculated when the astronaut is collected, using the initial distance between the ship and the astronaut and the time between spawn and collection of the object. During tests with its developers, the game could be played with both right and left upper limbs, without differences for collecting feedback parameters for time and speed. Since the Kinect works tracking the user's limb – hand, elbow and shoulder, the game can be played with the

support, without suffer interference or lost the referential and to result in reliable data. Likewise, the Galaxy Motion works also without the support Armon Edero. Both the support and the game are unilateral, so the limb injured to be used, must be chosen before starting. Moreover, the adaptations made for the support were tested and proved to work properly for different kinds and sizes of users.

**Discussion and Conclusions.** The game seeks to turn therapeutic sections funnier for the patients, but, in its background, collecting important data over the treatment for the professional, that will increase the control that the professional has over the treatment. Tested by the authors, the Galaxy Motion's reproducibility and repeatability of the results showed a real potential to succeed in this aim. As a differential, the game was designed to be played with or without the upper limb support, increasing the number and the degree of impairment of the patients benefited by this technology. The support follows the natural movement of the user's arm, which may allow movement in all directions and can easily be placed in different kinds of objects such as tables and chairs, which is the main reason why it was chosen over all the market options [10.1109/ICORR.2007.4428563]. In addition, since the support has a spring compensation system which can be regulated, in some cases, it will possible to adding force and imply a greater resistance to movement to be ruptured by the patient. So, the treatment can start offering a total relief of the gravitational force and, as the patients improves his/her performance, the support is adjusted to decrease the amount of aid provided, even hindering the movement. The next steps for the game include, mostly, the insertion of a user interface that makes easy to the health professional personalize the treatment for each patient and to handle the data collected by the game. Also, the implementation of KinectV1, so that older computers, that do not have a USB3.0 port, the game can be played. After the end of the development and the improve of data collection, the project will be submitted to the approval of the ethics committee to start de clinical trials and, once the game is validated, distribute it so it can helps people to recover their movements faster and funnier.

**Figure.** Galaxy Motion game screen, with the time (in seconds) and the objects to collect (astronaut and gas gallon) and the comets to dash.



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**Keywords.** Rehabilitation, Serious Games, Upper Limb Mechanical Support.