MyoCognition, a rehabilitation platform using serious games controlled with myoelectric pattern recognition

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***Abstract*—Stroke is one of the leading causes of disability and patients do not receive sufficient rehabilitation to avoid permanent impairment. Here we present a new rehabilitation platform using serious games controlled with myoelectric pattern recognition which can potentially be made available in the home environment to increase the amount of rehabilitation. Preliminary testing shows promising results, and the platform will be used in a future trial.**

Keywords—stroke, electromyography, rehabilitation, serious games, orthosis

I. Introduction

Stroke is a condition which in Europe affects more than 1.1 million people annually and is projected to increase by 27% by 2047 [1]. Stroke causes a reduction in upper limb function that can be (partially) restored through rehabilitation. Commonly in the sub-acute stage of stroke, rehabilitation is performed with a therapist, but at the chronic stage the patient is expected to follow a rehabilitation program on their own. However, the patient often does not follow the program due to a lack of motivation and therefore ends up with permanent impairment. A stroke rehabilitation program which motivates the patient is needed to ensure that stroke rehabilitation continues into the chronic stage of stroke.

In a recently concluded clinical trial, our centre used Myoelectric Pattern Recognition (MPR) to decode motor volition from participants with chronic stroke. MPR is a method to decode motor intent from electromyographic (EMG) signals measured using skin surface electrodes placed on the skin above muscles in the arm using pattern recognition techniques. The results of this trial are promising (manuscript in preparation, see [2]). The trial was based on a previous trial for a treatment for phantom limb pain [3]. However, we found that certain parts of the protocol were not suitable for people with stroke such as the augmented reality environment and the games. Furthermore, we found that people with stroke needed limb support and movement assistance/resistance to help them perform the movements and to limit the effect of spastic contractions.

In this paper we present a software rehabilitation platform called MyoCognition, which is specifically designed for rehabilitation based on our experiences using MPR for stroke rehabilitation and is a step in our ambition to provide MPR based stroke rehabilitation in the home setting. MyoCognition has been designed to be user friendly and has undergone user testing with physiotherapists to ensure that it is user friendly for people without an engineering background. In addition, MyoCognition extends our previously used software by adding a serious game (game that provide a benefit beyond entertainment such as training) which has been designed for rehabilitation at the level of body functions. The serious game is controlled using MPR and the benefit of using MPR is that motor intent can be decoded even when there is minimal movement of the affected limb. This is in contrast to other control systems which requires movement of the limb (e.g. Nintendo Wii, Microsoft Kinect or sensorised gloves)

In this paper we present MyoCognition as a proof-of-concept for home-based stroke rehabilitation used with an in-house custom-made modular orthosis which provides limb support, restricts compensatory movements and locks the wrist or elbow joint to focus on certain movements.

II. Methods

A. Serious game

MyoCognition currently contains one serious game called Space Journey, in which the player must collect stars and/or avoid asteroids depending on the mode, see Fig 1. The game is designed to be played using one or two degrees of freedom (DoF). In one DoF mode, the player must catch stars by moving the hollow cube to either side of the yellow cube. By default, the hollow cube is in front of the yellow cube and a constant contraction must be held to move and keep the hollow cube in position. In two DoF mode, the player must also avoid asteroids by moving the yellow cube to one of the sides. By default, the yellow cube is in the centre of the spaceship and a steady contraction is required to move and keep the yellow cube in position.

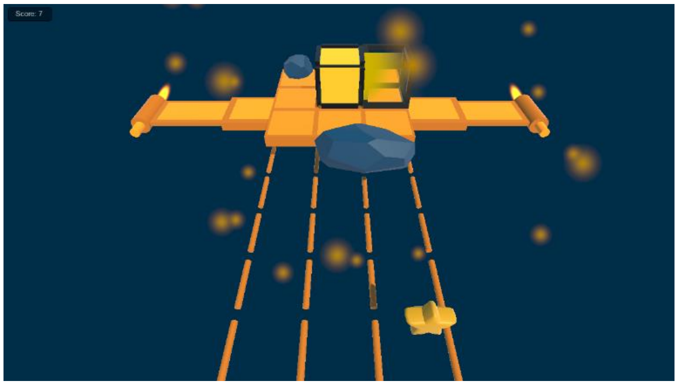

Fig. 1. Space Journey game. The player controls the cubes. The hollow cube (rightmost) can be move on either side of the yellow cube to catch the stars. The yellow cube can be moved from side to side to avoid the asteroids.

B. *Myoelectric Pattern Recognition and EMG acquisition*

The classification algorithm for MPR was stochastic dual coordinate ascent which require labelled data. Data labelling was done using the recording session procedure in which the participant follows the movement of a virtual hand on the screen while EMG is recorded. The EMG is then labelled accordingly and split into overlapped time windows following the procedure described in [4]. To measure EMG, we used the ADS_BP4 [5] which transmitted the EMG to a computer wirelessly using WiFi at 1000 Hertz.

C. *Orthosis*

An upper-limb orthosis was designed and built specifically for use with MPR, see Fig 2. The orthosis was designed so it would not cover the areas of the arm where the electrodes should be placed. The orthosis has joints at the elbow and the wrist and the range of motion of both joints can be adjusted. In addition, the orthosis provides limb support and locks rotation of the torso using an attachment to a wide belt to reduce compensation of the trunk and shoulders.

D. *Assessment*

Two participants in the chronic stage of stroke who had participated in a stroke trial using MPR for stroke rehabilitation was invited to test and give their opinions on the serious game and the orthosis. The participants were fitted with the electrodes and the orthosis and performed the recording session to train the MPR classifier. The participants then played three levels of the game with one DoF control while being observed by the study team. At the end, the participants were asked to rate the comfort and function of the orthosis via questionnaire.

III. Results

Based on the engagement of the participants and their comments while playing the game they enjoyed the game. One participant managed to catch all the stars in one level and was extremely focused during gameplay. The participants also liked the orthosis, rating all scales at *agree* or *strongly agree*. The participants expressed that they think the game and the orthosis will motivate them to train.

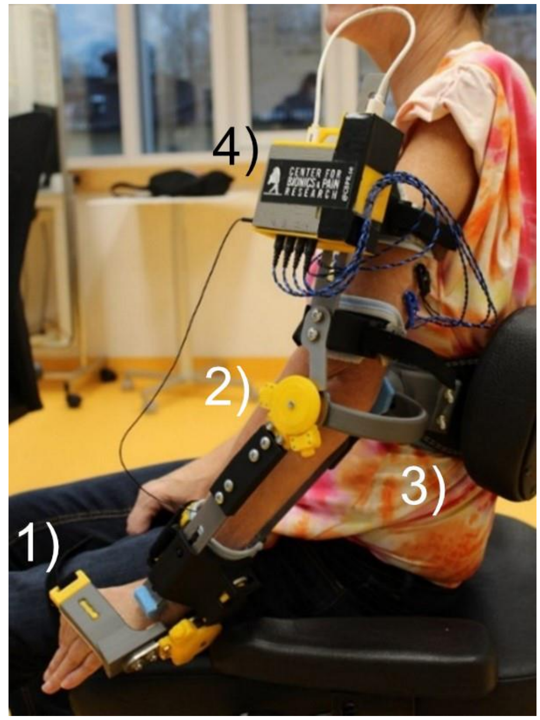

Fig. 2. Orthosis. 1) Removable wrist part. 2) Joint with adjustable range of motion. 3) Belt attachment. 4) ADS_BP4 with leads for measuring EMG.

IV. Discussion and Conclusion

In this paper we present a new platform for stroke rehabilitation which we aim to use in a future clinical trial. Future work will focus on making the orthosis easier to put on and make electrode placement more intuitive, as we consider these the two main obstacles for providing this rehabilitation platform in the home setting.

V. References

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