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DESIGN, DEVELOPMENT AND CONSTRUCTION OF A MEDICAL WRIST REHABILITATION DEVICE

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ABSTRACT

This project consisted on the design, development and construction of a medical device for the rehabilitation of the wrist. The construction of the actual prototype was carried out with off-the-shelf components. The objective was to develop a functional and low cost device. The system is divided into two main components, one for the rehabilitation of the wrist and the other one to perform proprioception exercises, providing relaxation of the patient's pain due to injuries on the wrist. All the hardware is assembled in one portable support, capable to carry out vertical and horizontal adjustments. Both systems are fully controlled through a software specially designed for being used by both physiotherapists and patients, allowing at the same time the control over the progress of rehabilitation.

Keywords: biomechanics, wrist, rehabilitation, proprioception, arduino.

INTRODUCTION

Fracture of the wrist is one of the most complicated pathologies, because it is associated with a wide range of movements; in a healthy pulse one can consider three main groups of movements; flexion and extension, adduction and abduction, pronation and supination. This type of injury has a large incidence in adulthood, and occurs mostly in women, since osteoporosis increases the brittleness of bones, and, as such, in case of impact there is a great susceptibility to bone breakage. In relation to the younger individuals, this type of fracture is mainly due to sports injuries (Lana, 2013).

THE REHABILITATION DEVICE

This project began with the adaptation of an already existing product called Powerball, which was designed to perform fitness exercises on the wrist, forearm and shoulder. Through the modification of this product, the Bioball was created (see Figure 1). This device uses an A28L brushless outrunner motor, powered by a 12 V-2 A power source through a MAG8 electronic speed controller, with an eccentric mass coupled to its shaft for creating vibration, which is useful for proprioception and relaxation purposes. It also uses a Superior Electric M062-LE04 stepper motor, NEMA 23 (Oriental motor, 2017), powered by the same power source and controlled through a TB6600 driver; this motor is coupled to an eccentric bar having at its end the Bioball. Combining the position adjustment of the support, this device enables the reproduction of the movements associated with the wrist. The control of both motors and respective drivers is carried out with Arduino, through an especially designed software

created in LabVIEW (by National Instruments™). The validation of this device was accomplished by physiotherapists at the Hospital of Braga, based on their own experience in the rehabilitation of patients with wrist pathologies (Ferreira, 2017).

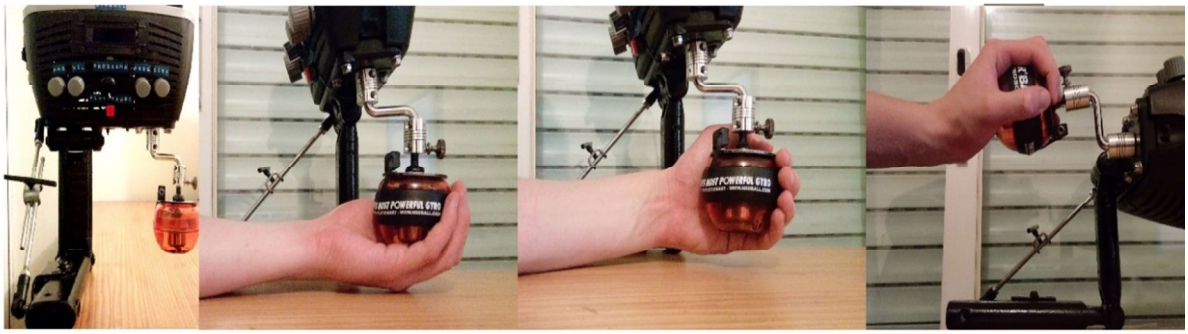

Fig. 1 - The Bioball and possible rehabilitation exercises capable to be performed on this device

RESULTS AND CONCLUSIONS

This device enables two types of rehabilitation: active and passive. For active rehabilitation the patient creates resistance to the movement generated by the device, exercising therefore the muscles on the wrist, forearm and hand. In passive rehabilitation the device helps the patient to perform each exercise (see again Figure1). This procedure helps to increase the amplitude of each movement of the wrist; the data corresponding to each one of the exercises can be computed by the developed software (see Figure 2).

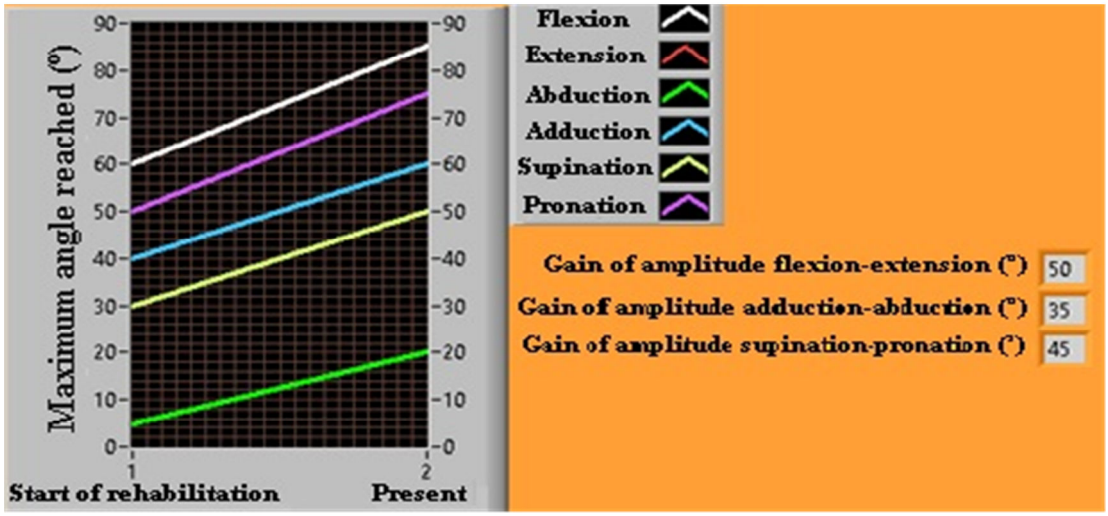

Fig. 2 - Some of the results obtained on the gains of amplitude

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