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DESIGN OF A CONTROL SYSTEM FOR A MEDICAL WRIST REHABILITATION DEVICE

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ABSTRACT

The development of a new control system for a medical wrist rehabilitation device consists basically in the design of an intuitive controllable mechanism that aims to accept the parameters defined by the user and to respond adequately to that request. Two motors (a brushless motor "*AEO A2830*" and a stepper motor "*Superior Electric M062*") are controlled by an Arduino development board, which receives and processes the instructions for the motors as well as for the acquisition software developed in LabVIEW (by National Instruments™). Two methods were used to define the interface between the user and the rehabilitation mechanism, one of which is oriented to the electronic hardware and other one to the data acquisition software: the commands and instructions are addressed to the first one, while all the information is collected and registered on the second one. Since such rehabilitation mechanisms already exist, it is intended that the drawbacks of such equipment should also be addressed in the purpose of this study, complementing a gap in the health area.

Keywords: rehabilitation, proprioception, arduino, LabVIEW, control.

INTRODUCTION

The design of the device was focused on the dynamics of the wrist/hand, which comprises a certain number of degrees of freedom. The constant search for improvements enabled to find some existing drawbacks in the current stage of the equipment to help the rehabilitation and treatment of the wrist. Uncontrolled rehabilitation devices are, most of the times, basic adaptations from other applications. Controlled devices deal with the dynamic aspects of the wrist, but do not apply active forces on the fingers, their tendons and associated nerves (Leiras, 2017).

THE WRIST REHABILITATION DEVICE

The designed device will not cause any damage on the wrist, since it uses a low torque motor, capable to perform angular movements at lower speeds and applying lower forces. Enabling different grabbing positions of the ball to move the wrist around the motor axis, this device simulates different natural movements of the wrist. The use of vibrations can also help on the rehabilitation of this member (Martimbianco, 2008). Such functionality is present on the device since it's possible to uncouple the "ball" component, enabling this type of rehabilitation. This procedure it's also used for relaxation purposes and sensory modification through the proprioception test. When withdrawing the ball from its fixed mechanism, it is

possible to engage a handle which allows massages at controlled frequencies (the motor has an eccentric mass coupled to its shaft). Since the motor has the ability to achieve high vibration frequencies, this makes it possible to perform electromyography tests, replacing therefore the orthodox electrical stimulation, with high vibration frequencies at low amplitudes stimuli. This allows evaluating the ability of nerve cells to transmit signals of 0 or 1, by nerve stimuli and proprioception tests on different parts of the human body (MacKay, 2005).

RESULTS AND CONCLUSIONS

The designed rehabilitation device was tested and validated. Force analysis and power consumption tests with speed variation were performed, evaluating the torque/speed/power ratio and determining the optimum working ranges. Some of the obtained results are shown in Figure 1. Nevertheless further tests should also be performed in order to analyze its ability for rehabilitation and improvement of the human proprioceptive function.

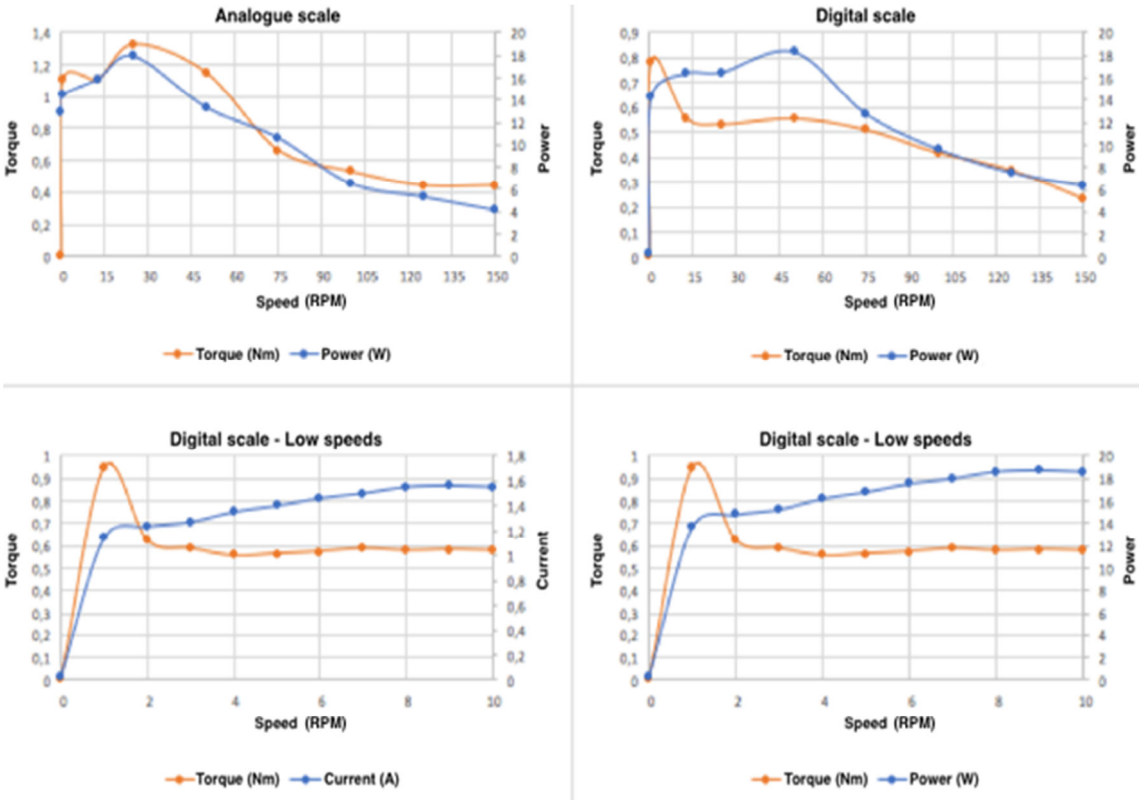

Fig. 1 - Torque/Speed/Power test results

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