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HAND TENSOR: A FULL MOTION HAND PROSTHESIS WITH MECHANISMS BY ONE SINGLE TRACTION ENGINE

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ABSTRACT

This project sought the development of a hand prosthesis model by myoelectric drive, using only one engine. The differential characteristics from the models available were: the lateral variation in the thumb position, the movement at all fingers, with articulations at the phalanges, and a grasping forces distribution system. The traction by just one engine simplifies the myoelectric signal control system, which works only with commands of open and close, and the prosthesis mechanism applied to movements allows better adjust to the shape of the objects, for a safe preention. The process used for structural construction was the additive manufacturing, searching for versatility to obtain the final dimensions and customization to the prosthesis user.

Keywords*:* additive manufacturing, articulations, mechanism, prosthesis.

INTRODUCTION

In a literature search is possible to find a great number of researches related to prostheses, as well as proposals for new models or innovations that may be incorporated to the existing models, but even with this diversity of academic researches and also by manufacturers, the commercially available hand prostheses models commanded by electromyographic signals (EMGs) are restricted in two groups: the tridigital tweezers with the thumb, forefinger and middle finger actuating, but not articulated in the phalanges; and the group quoted by Timemy *et al.* (2013) as advanced commercial devices, like the Michelangelo Hand, by Otto Bock, the I-limb Hand Ultra by Touch Bionics, and Bebionic 3 by RSL Steeper, able to perform total hold positions, as well as to control each finger of shape independent. The differences between these groups are noticeable, both in the movements offered, as in their commercial values.

The model obtained at this work does not allow the individual grasping command for each finger, but an adjustment of them to the shape of the objects, having appearance and functionality very close to the most advanced prostheses group, but the control system may be the same of the simple one, of only an actuator.

RESULTS AND CONCLUSIONS

A threaded spindle coupled to the motor, turns rotating movements into linear, applied to a nut that moves articulated arms linked to the fingers, distributing the traction force for the grasp. In order to have relative movements between the phalanges, a mechanical system with

internal tensors was developed, based on the four-bar hinged mechanism system, as shown in Figure 1, where the index finger is shown in a cut, for identification of the bar points.

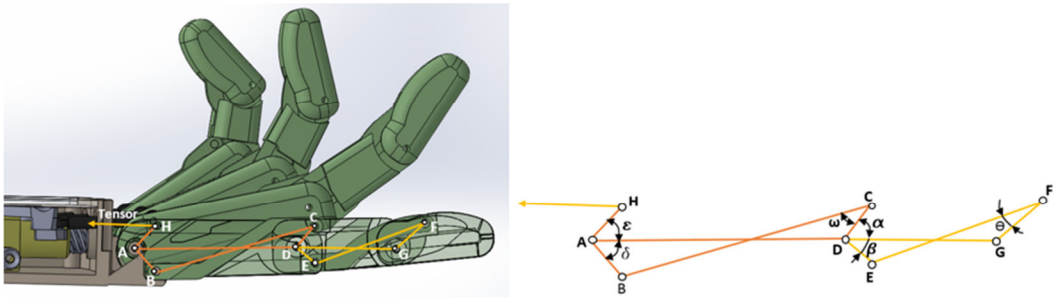

Fig. 1 - Four-bar mechanism applied to the relative positions of the finger's phalanges

In the study of the four-bar mechanisms applied to the phalanges, the angles ε and α have fixed values, being a constructive part of the proximal and middle phalanges. The variation of the angles δ and ω, called "Proximal-Middle Relation" can be observed in the BAD and BCD triangles, which has the segment $\overline{BD}$ in common. In continuity to this, the variation of the angles β and Θ, called "Middle-Distal Relation", based on the triangles DEG and FEG, having in common the segment $\overline{EG}$. For each variation of δ at the proximal phalanx, is a relative position of ω, at the middle one (Eq. 1), in consequence a variation of β at the middle phalanx causes a variation of Θ, at the distal one (Eq. 2).

$$\boldsymbol{\omega} = arc\,cos\,[(\overline{CD}^2 + \overline{CB}^2 - \overline{AB}^2 - \overline{AD}^2 + 2\,\overline{AB}\,\overline{AD}\,cos\boldsymbol{\delta}) / (2\,\overline{CD}\,\overline{CB})] \quad (1)$$

$$\Theta = arc\,cos\,[(\overline{FE}^2 + \overline{FG}^2 - \overline{DE}^2 - \overline{DG}^2 + 2\,\overline{DE}\,\overline{DG}\,cos\boldsymbol{\beta}) / (2\,\overline{FE}\,\overline{FG})] \quad (2)$$

It's possible to affirm that the initial proposal was reached, of develop a functional hand prosthesis mechanism, with simplified control and command system, using low cost mechanical components, easily found on the market, and adopting a flexible manufacturing process for the structure, independent on the shapes complexity.

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