7th ECCOMAS Thematic Conference on Smart Structures and Materials
SMART 2015
A.L. Araújo, C.A. Mota Soares, et al. (Editors)

Abstract ID-089

MODELING AND VALIDATION TEST OF UNDERACTUATED ROBOTIC FINGER

José Ramirez, Astrid Rubiano, Laurent Gallimard, Mohammed Nabil El Korso, Nicolas Jouandeau, Olivier Polit

LEME, Université Paris Ouest Nanterre la Défense, France
jl.ramirez_arias@u-paris10.fr ; a.rubiano_fonseca@u-paris10.fr ; laurent.gallimard@u-paris10.fr ; m.elkorso@u-paris10.fr ; n@ai.univ-paris8.fr ; Olivier.Polit@u-paris10.fr

Keywords: Robotic Finger, Artificial Muscle, Mathematical Modeling Of Kinematics

Summary: This work is part of the ProMain project concerning the modeling and design of robotic hand prosthesis, actuated by artificial muscles and controlled using electromyography signals of the human upper limb. In the first step, we design a robotic finger to imitate the capabilities of a human finger. Three joints of the human finger are modeled to propose a mechanical equivalent model: the metacarpophalangeal joint, with two Degrees of Freedom (DoF) (abduction-adduction and flexion-extension), the proximal interphalangeal, with one DoF (flexion-extension) and the distal interphalangeal also with one DoF (flexion-extension). As a result, the mechanical finger has three joints with four DoF. The finger is designed to be underactuated and the mechanism of transmission is based on tendons, which means that only one engine will actuate the whole finger and the motor will be coupled to the finger through flexible wires. Consequently, in this paper, we propose a new kinematic model of the finger; this model allows to know the position of the fingertip with regard to the reference frame of the finger. The proposed model uses the so-called DHKK convention (which was proposed by Denavit et al. 1955, but was modified by Khalil et al. 1986). This DHKK convention simplifies the development of the model and increase the computational efficiency. Another mathematical model is developed to get the inverse kinematic of the finger. The inverse kinematic consist of finding analytical solutions for joint angles, for a given fingertip position ensuring angular limits, see Hugel et al. 2013.

In this paper, we validate the proposed model and evaluate the mechanical constraints using an experimental setup which main components are: (i) a support plate for the actuator of the finger, (ii) the finger prototype, which was manufactured using a 3D Printer, (iii) a camera Prosilica GE2040 to measure the position and (iv) a force sensor to measure the force at the fingertip. Based on our first results, requirements and characteristics of the artificial muscle are proposed and two kinds of materials have been taken into account: the shape memory alloys and the electroactive polymers due to their performance and specific characteristics.