Finger exoskeleton control system using MATLAB/Simulink

K. NASILOWSKI[1], J. AWREJCEWICZ[1], D. LEWANDOWSKI[1]

1. Technical University of Lodz, Department of Automation and Biomechanics, Lodz, Poland

Key words: *finger, exoskeleton, control.*

1. Introduction

A paralyzed and not fully functional hand can be supported by the properly designed exoskeleton system with motoric abilities [1, 2]. Both suitably selected geometry and specialized software are addressed applying the MATLAB environment.

2. Model

2.1. Physical and geometrical properties.

The system supporting the movement of the fingers is composed of two parallel subsystems. Each of them consists of three basic links (d, c, e) and two actuators (F1, F2). Finger leading link (k) is common for both subsystems. Figure 1 shows a basic diagram of the constructed system.

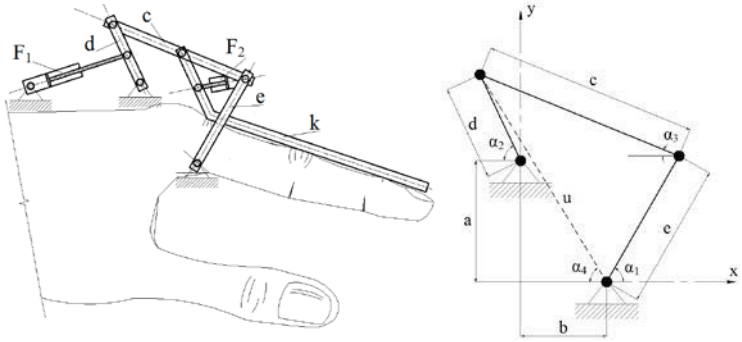

Fig. 1. Physical and geometrical model.

2.2. Governing equations.

Geometrical model is described by the following equations

$$u^2 = \left(a + d \cdot \sin\alpha_2\right)^2 + \left(b + d \cdot \cos\alpha_2\right)^2,$$

$$\alpha_4 = arctg\left(\frac{d\sin\alpha_2 + a}{d\cos\alpha_2 + b}\right), \qquad (1)$$

Corresponding author: Krzysztof Nasilowski, Department of Automation and Biomechanics, Technical University of Lodz, ul. Stefanowskiego 1/15, 90-924 Lodz, Poland. E-mail: krzysztof.nasilowski@p.lodz.pl

$$\alpha_3 = \alpha_4 - \arccos\left(\frac{u^2 + c^2 - e^2}{2uc}\right),$$

$$\alpha_1 = \arcsin\left(\frac{a + d\sin\alpha_2 - c\sin\alpha_3}{e}\right).$$

2.3. MATLAB/Simulink scheme.

Solutions of the governing equations are found using the MATLAB/Simulink scheme shown in Figure 2.

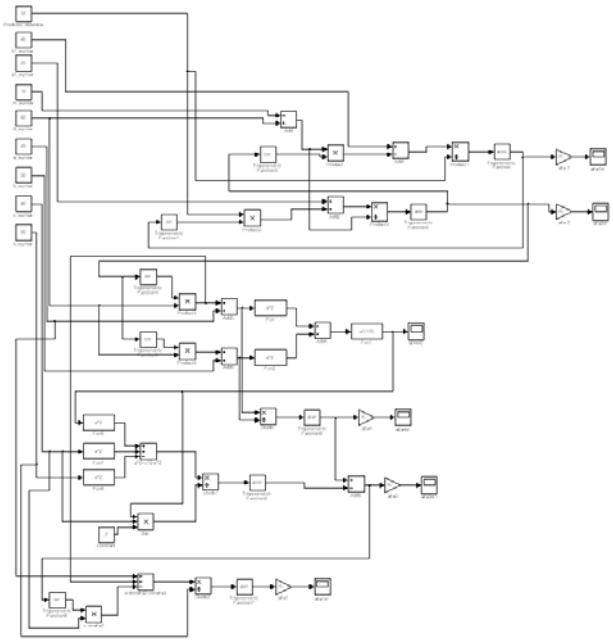

Fig. 2. MATLAB/Simulink scheme.

3. Discussion

The proposed physical and mathematical models allow to optimize and control of a human finger.

References

[1] JONES C.L., WANG F., OSSWALD C., KANG X., SARKAR N., KAMPER D.G., *Control and Kinematic Performance Analysis of an Actuated Finger Exoskeleton for Hand Rehabilitation following Stroke.* International Conference on Biomedical Robotics and Biomechatronics, Tokyo, Japan, September 26-29, 2010.

[2] LUCAS L., DICICCO M., MATSUOKA Y., *An EMG-Controlled Hand Exoskeleton for Natural Pinching.* Journal of Robotics and Mechatronics, 2004, 16(5).