BIO-IMPEDANCE FOR ELECTRONIC BRAILLE: A PRELIMINARY INVESTIGATION ON THE BEHAVIOR OF THE FINGERTIP TISSUE

J. Souza* and Y. Shen**

* Student at Instituto Federal de Santa Catarina, São José, Brasil
** Associate Professor at University of Nevada, Reno, United States
E-mail: jessica.s@aluno.ifsc.edu.br

Introduction: According to WHO (2014)[1], the world has about 285 million people with visual disabilities, whereas many equipments have been developed to help visually impaired people reading and writing. However, their prices are usually high, being most of time inaccessible to the needed people. In order to solve these problems, it was started the project called E-Braille, which its purpose is to develop a low-cost equipment that converts characters captioned in a camera to Braille. The equipment uses electrical pulses to stimulate the fingertip, in order to send each alphabetical letter to the brain. This study focuses on the preliminary stage of the project: the bio-impedance identification of the human fingertip based on frequency-voltage variation. It is important to determine the bio-impedance because is needed the application of correct frequencies and current to the users, for a clear Braille dot perception. The fingertip of the human hand is the region that most provides tactile information to the brain, due to its high quantity of nerve endings[2]. It is important to study its anatomy in order to understand how the visually impaired people use their hands for Braille reading.

Materials and Methods: To conduct the experiment, it was used a Texas Instrument body measurement composition board AFE 4300, a computer with DAQ and software interfaces of the board. It was developed a custom-built platform, with a high resolution load cell embedded with PCB electrodes, which has eight electrodes organized. Two of them collect the signal from the finger and two send the voltage frequency from the board. Two types of signals were collected on the experiment: bio-impedance, through the electrodes, and contact force, through the load cell. The frequencies used to measure the bio-impedance and the force varied from 1 KHz to 1 MHz, with intervals of 10 and 100 Hz, performing a total of 21 different measurements.

Results: The data collected on each frequency range suggest that force and bio-impedance are inversely proportional. Frequencies lower than 100 KHz seem to be noiseless and comfortable for the user. When frequencies were higher than 500 KHz, the user experienced some difficulty to move the finger on the platform and the graph of bio-impedance showed a high noise. The only frequency for which bio-impedance and force were inexplicably not inversely proportional was the 5 KHz. Finally, we could see that higher bio-impedances do not come from higher frequencies.

Conclusions: The measurements recorded during the experiment were important to map the bio-impedance characterization in different frequencies with the proposed method. This project will be extended to obtain extensive results of bio-impedance measurement from large amounts of users. Also, hardware improvements have been studied to be implemented.

References: [1]World Health Organization. Visual impairment and blindness. [2]Vallbo, A. B., Johansson, R. S. . Properties of Cutaneous Mechanoreceptors in the Human Hand Related to Touch Sensation. Human Neurobiology, Vol. 3,Springer-Verlag 1984. pp. 3-14..

Keywords: Electronic Braille. Electrocutaneous stimulation. Electrotactile Display. Bio-impedance. Tactile sensation.

Funding Agency: This research was sponsored by the Department of Electrical and Biomedical Engineering at the University of Nevada, Reno.