Analysis of EMG signals in human fingers using MSE method

T-T. HO, C. HANSEN, C-H. CHANG, J-S. SHIEH. ***Analysis of EMG signals in human fingers using MSE method.*** Gerontechnology 2014;13(2):203; doi:10.4017/gt.2014.13.02.296.00 **Purpose** The movements of human fingers are very complex; few instruments that can mimic these complex exercises. Current artificial limbs and rehabilitation equipment are designed for a large range of motion, or other applications such as hybrid assistive limbs (HAL)[1] for ambulatory assistance, but not for delicate movement such as finger exercises. This project presents a standardized process that can be used to measure and analyze the muscle activity of the human hand using electromyography (EMG). We wish to build a database of finger movements with corresponding EMG patterns, and to distinguish each finger EMG pattern separately. This can be used to drive mechanical hand prostheses in the future. **Method** Subjects were asked to repeat specific movement patterns, such as the flexion of each finger separately for 20 s with 20 s rest period between. The EMG signals were collected using a custom-made system. The electrodes were placed approximately 5 cm proximal to the wrist joint at an angle of 45° to the arm. A 60Hz band-pass filter and notch filter were used to eliminate noise from the EMG signal. Furthermore, an empirical mode decomposition method[2] was applied to filter the high frequencies of the signal (*Figure 1*). Since only one pair of electrodes was used, a multidimensional analysis of multi-scale entropy (MSE)[3] was used to differentiate the signal into the corresponding motions of each finger. To quantify the differences between each finger movement, the complexity of the signals was calculated as the integral of each MSE curve in comparison with traditional EMG measurement (muscle power of the area under the curve). **Results & Discussion** The results show that it is possible to identify some of the fingers even though only one pair of electrodes was initially used. The complexities of the signals show specific patterns for some fingers (*Figure 2*). The results are valuable for the development of an artificial hand with a mechanical prosthetic device, because some fingers can be driven individually using the MSE approach and only one pair of electrodes is necessary. More subjects and a larger database are necessary to improve the results. The signal processing of filtering especially needs fine tuning to detect which frequencies are selected for the reconstructed signals. However, despite its current limitations (i.e. small sample size), the system and application appear to be very promising for research related to both rehabilitation and gerontechnology applications. Particularly, in the rapidly aging population in China and Taiwan, this system may help the elderly to strengthen their finger movements.

References

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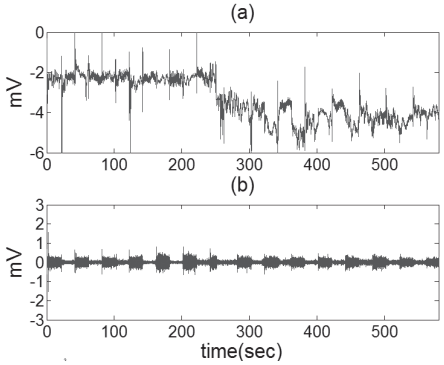

Figure 1. (a) Before filtering (b) After filtering by EMD

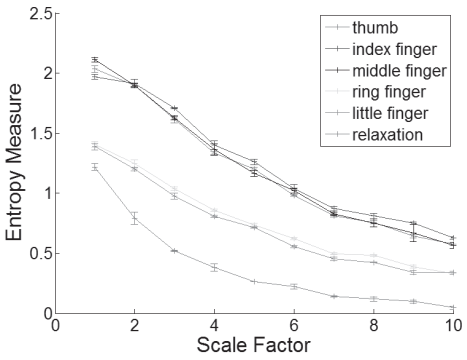

Figure 2. The complexities of the signals show specific patterns for some fingers