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Finding the best match between EMG and muscle activity prediction by musculoskeletal modeling during normal walking activity

Adhi Dharma Wibawa[1], Verdonschot N[3,4], Halbertsma J P K[2], Diercks R L[2] and Verkerke G J[2,4]
[1]Institute of Technology Sepuluh Nopember, Indonesia
[2]University of Groningen, Netherlands
[3]Radboud University Medical Center Nijmegen, Netherlands
[4]University of Twente, Netherlands

The use of musculoskeletal modeling to describe a complex reality like the human body is increasing. It is not only a useful tool for understanding the biomechanical aspects of the living body, but it also can be used to optimize new surgical techniques and rehabilitation procedures. The AnyBody Modeling System (AMS) is a musculoskeletal modeling system that predicts muscle activity based on prescribed model movements. This study focused on validating muscle activities predicted by the AMS against measured muscle activity (EMG) from ten healthy subjects who performed a normal walking task. The Gait Lower Extremity model was used in this study. Eight EMG electrodes measured the activity of eight different muscles of the right leg: Vastus Medialis, Vastus Lateralis, Rectus Femoris, Semitendinosus, Biceps Femoris, Gastrocnemius Medialis and Lateralis and Tibialis Anterior. Four different thresholds were applied on both curves (predicted and measured muscle activity): 10%, 25%, 35% and 45% of the mean of the RMS envelope. EMG and predicted muscle activity were compared quantitatively. Number of onset, offset, hills and duration of muscle activity were used to quantify the level of agreement. For the parameters, number of onset, offset and the number of hills, the weighted kappa method was used, while the concordance correlation coefficient analysis was used to compute the level of agreement of the duration of muscle activities. Visual inspection of the muscle activity pattern showed good agreement between EMG and predicted muscle activity. Quantifying the muscle activity by using a number of onset/offset, number of hills and duration of muscle activation showed that, in general, for all parameters, the 45% threshold level showed the best agreement compared to the other threshold levels (10%, 25% and 35%). For the number of onset and offset, two muscles (Tibialis Anterior and Vastus Lateralis) showed a fair agreement (0.20<kappa value<0.40) and four muscles showed a slight agreement (0<kappa value<0.20), the other two muscles (Vastus Lateralis and Semitendinosus) showed a poor agreement (kappa value<0). For the number of hills, two muscles (Gastrocnemius Medialis and Tibialis Anterior) showed a fair agreement and five muscles showed a slight agreement while only one other muscle (Vastus Medialis) showed a poor agreement. For the duration of muscle activity, all muscles showed poor agreement (concordance correlation value <0.90). This first attempt in a quantitative point of view showed that the parameter number of hills was the best result. The differences between AMS and EMG patterns can be attributed to the nature of the AnyBody modeling process, the choice of parameters and the absence of a gold standard.

Biography

Adhi Dharma Wibawa finished his Bachelor degree at the year 2000 majoring in Electrical Engineering, Institute of Technology Sepuluh Nopember Surabaya. In year 2004, he continued his study in Master degree in Electrical Engineering, at the same university, while he works as a lecturer in Hang Tuah University, Surabaya. In the year 2007 he took a Database Management course in Seoul, South Korea under the program of Ministry of Communication and Information, Republic of Indonesia. In 2008, he got another scholarship from TU/e Eindhoven to have a special course in one month in using Matematica programming for engineering. In the mid-year 2009, he got a short research visit scholarship from University of Tokushima, Japan for doing a Biomedical Engineering workshop for two weeks. In November 2009, he started his PhD in the University of Groningen, the Netherlands, under supervision Prof. G.J Verkerke. During his PhD study, he once had a two weeks course in Aalborg University, Denmark in Biomechanics analysis and modeling. He finished his PhD study in Biomedical Engineering Department, University of Groningen in 11 June 2014. He is now staff lectures in department of Multimedia dan Network Engineering, Institute of Technology Sepuluh Nopember, Surabaya.

wibawa.adhi@yahoo.co.id

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