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# Estimating Hill-type model parameters for hand gestures with EMG measurements

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*Abstract*. In this study we are adjusting the Hill type model parameters for hand gestures after we built the musculoskeletal model of the hand muscles that contains activation dynamics to compute the muscle activation function from EMG input signals, and contraction dynamics depending on Hill type model to make the values of muscle forces that are estimated from the model fit the measured ones.

**Introduction.** The essence of understanding and transferring the human grasps to a robotic arm is the quantification of internal hand loads such as muscle forces and joint reaction forces. For such matter, musculoskeletal models were approved to outcome an estimate of muscle forces using in vivo measurement of external data i.e. Electromyography (EMG) to reduce the technical and ethical impossibility for adopting a direct measurement system to measure about 40 different muscle that control the hand movements. Our task is to adjust the parameters of a musculoskeletal model that we have built, e.g. using optimization procedures to reduce the gap between the dynamometric measurements of subject strength and the estimates provided by the model.

**The main part.** The previous study was to build a musculoskeletal model that contains both muscle activation and contraction dynamics, process the input neural commands recorded using electromyographs, compute the muscle activation function from activation dynamics part, formulate the muscle contraction dynamics using Hill type model and estimating the generated hand muscle forces under detected tasks. The main part of this study is to adjust the model parameters in order for the estimated muscle forces values to fit the measured ones. The ground truth data that are used were divided into two parts, the first 50% of data for the adjustment process while the second 50% is to verify the validity of the adjustment for a new data. We recalled that the output of the entire process, based on the EMG input values, is joint moments. The described model needs the following musculoskeletal parameters to be known or estimated: (i) The optimal physiological muscle length, (ii) The maximum isometric muscle force, (iii) The tendon slack length, (iv)The coefficient A as (shape factor which determines nonlinearity), (v) The moment arm, and (vi) The musculotendon length change. The latter two parameters were allowed a 10% variation with respect to values obtained from Mathematical equations in order to take into account possible inaccuracies in the determination of the wrist angle. we need nonlinear optimization algorithm to estimate the six parameters. Having constructed the model), the predicted joint moments were compared to the moments exerted by the hand and the measured ones from the ground truth data. The root mean square error (RMSE) between predicted and measured joint moments was used as the objective function to be minimized for the estimation of the six parameters.

**Conclusions.** The results of this study will be implemented as an essential step to the model validation to be trusted and used in the next task of transferring human hand gesture to a robotic arm, which is developing an algorithm that maps the reference trajectories and interaction forces from human kinematics and dynamics to robot kinematics and dynamics.

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