Sartori M, Reggiani M, Mezzato C, Pagello E. A Lower Limb EMG-driven Biomechanical Model for Applications in Rehabilitation Robotic. (2009) *Advanced Robotics, 2009*: 1-7
Goal of paper is method to restore movement and functional abilities by a biomechanical model prediction of joint torque by surface EMG signals of muscles. Focuses is on understanding biomechanics for modeling and understand rehabilitation methods. Although EMG not stationary and not linear, use a biologically-motivated model to predict joint torque of upper limb from joint kinematics and neural activation level. Try to resolve in time delay required between activation and actual movement with a simple user interface. Muscle Activation Model represent the level of active force produced by muscles relative to maximum voluntary contraction; for every muscle corresponding raw EMG post processed to get activation envelope to calculate muscle activation, then used to calculate muscle dynamics by active and passive forces on normalized muscle fiber, to eventually calculate join torque. Multichannel EMG acquisition system, with wireless disposable bipolar electrodes used for acquisition of neural command, angle data sampled at 60Hz, force data 960Hz, EMG signals at 1kHz.
Colacino F, Rustighi E, Mace B. An EMG-driven Muscoskeletal Model for the Estimation of Biomechanical Parameters of Wrist Flexors. (2010) EMBC, 2010: 4870-4873.
Musculoskeletal model of wrist flexors comprising dynamics and limb anatomy experimentally validated with maximum voluntary contractions. EMG signals recorded from flexors were used as input, while measured torques exerted by hand were compared to torques predicted in the model where EMG signals were used to stimulate, root mean square error calculated between estimation and validation phases compared. EMG signal related to muscle acitivation a(t). Then normalized, rectified, filtered EMG transformed to neural excitation u(t) by 1st order differential equation which used to relate muscle activation with active muscle force-length relationship.
Buchanan T, Lloyd D, Manal K, Besier T. Neuromusculoskeletal Modeling: Estimation of Muscle Forces and Joint Moments and Movements from Measurements of Neural Command. (2004) *J Appl Biomech.* 20(4) 367-395
Investigate neural command taken from EMG, or estimated from neural networks. Magnitude of EMG signals change as neural command increase or decrease muscular effort is main focus, however, difficult to compare absolute magnitude of EMG signal from one muscle because magnitudes of signal depend on many factors (electrodes used, placement to motor points, amount of tissue, etc), therefore transform them into a parameter called muscle activation ai through muscle activation dynamics and output is time-varying parameter with magnitude 0 to 1. First task is to remove any DC offsets or low frequency noise and artifacts from time changing mean signal. Corrected with high-pass filtering of EMG.Simplest way to transform rectified EMG to muscle activation is to normalized EMG signal by dividing peak rectified EMG value during maximum voluntary contraction (MVC) and apply low pass filter. To represent electrical activity to activate muscle but at a delay (time constant) modeled by a first-order linear differential equation that can be processed for activation dynamics.
Bonato P, Boissy P, Crco U, Roy S. Changes in the Surface EMG Signal and the Biomechanics of Motion During a Repetitive Lifting Task. (2010) IEEE Transaction on Neural Systems and Rehabilitation Engineering, 10 (1): 38-47.
Analysis of surface EMG during isometric constant-force contractions for assessing lower back pain. Recent time-frequency analysis procedure computes instantaneous median frequency (IMDF) for nonstationary EMG signals. Acqusition from surface EMG data of 6 electrodes on thoraco-lumbar region. Surface EMG from 3 bilateral back muscles using single differential electrodes, with detection geometry of parallel silver bars separated 10mm interelectrode distance, with custom-mad double-sided interface and positioned at T10, L1, and L5.
Signals were conditioned by a custom-made isolated amplifier (gain 3000, bandwidth 20-450Hz) and digital sample rate of 1024 Hz, acquired in 30sec interval during repetitive lifting task. Nonstationary EMG signal, the frequency content of the signal derivd using a time-frequency transformation (Cohen Class) with further imporvements by Cohen-Posch representations for more stable estimate of time-frequency parameter. Cohen-Posch distributions derived from Choi-Williams time-frequency representation using iterative alogirthm that adjusts distributions to satisfy time and frequency marginal.

Jesinger R, Stonick V. Processing signals from surface electrode arrays for noninvasive 3D Mapping of muscle activity. (1994) IEEE 6th Digital Signal Processing Workship 57-60

Technique for reconstruction and imaging of volumetric neuromuscular activity using digital signal processing of multichannel surface potential recording. Use MRI model anatomical structures, time-frequency distributions of multichannel EMG array data decompose broadband source localization problem to narrowband and signal processing estimation for imaging tool with ability to diagnose neuromuscular disorders and better understanding of biomechanics Multichannel surface potentials of subject upper muscles acquired with array of 4mm disc electrodes during contraction at varying force levels, chose bandpass filter acquired EMG 0.3-300 Hz, amplified gain 1000, samples at 1kHZ, time-frequency distribution estimated with Welch Method (256-point overlap) and 512-poing Hamming window, using time-frequency distribution for boundary electrodes allows choose frequency component for localization, such that source localization problem solved for desired frequency so that solutions superimposed to provide an understanding of intensity and location of muscle activity.

Alverti A, Frigo C, Anderoni G, Baroni G, Bonarini A, Cerveri P, Crivellini M, Dellaca R, Ferrigno G, Galli M, Pedrocchi A, Rodano R, Santambrogio G, Tognola G, Pedotti A. Functional Evaluation and Rehabilitation Engineering. (2011) IEEE Engineering in Medicine and Biology Society, 3: 24-34

Movement carried out by sensory nervous system summarized as a multiple-input multiple-output non-linear dynamic time-varying control system, for research on analyzing complex sensory motor performance and ultimate goal to enhance execution of different tasks for rehabilitation and disabilities. Recording EMG signals with anomalous gait patterns provides opportunity for direct analysis of locomotors common issued to individual muscles responsible for progress and dynamic stability. Consideration required of recording system and signal acquisition procedures, as well as data processing algorithms specific. Possible future prospects of rehabilitation engineering for functional electrical stimulation (FES) along with orthotics and prosthetics for motor control and sensory neural prostheses. Where challenge to overcome is develop devices by identification of signals that can b used as control signals for FES by sEMG signal detected from voluntary muscle activation.