Title:	Effect of Local In-Homogeneities in the Subcutaneous Tissue on Muscle Fiber Conduction Velocity Estimates Assessed with a Novel Analytical Surface EMG Model
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Abstract: (Your abstract must use Normal style and must fit in the space on the right)	**Introduction:** most surface EMG models considered space invariant systems. Space invariance in the direction of propagation of the source (action potential) implies that the volume conductor is both homogeneous and geometrically invariant along this direction. For infinite fibers, signal detection from any location along the space invariant direction provides the same potential shape with a delay, which is far from practical cases. The aims of this study were 1) to develop an analytical model of surface EMG generation in a volume conductor with local spherical in-homogeneities (non-space invariant system), and 2) to apply this model for the analysis of sensitivity of CV estimates to local in-homogeneities. **Method:** we considered a planar volume conductor made of muscle tissue (anisotropic) and a fat layer (isotropic). The impulse response of this system without in-homogeneities in the layers will be termed “in-homogeneity free solution” of the problem and was provided previously [1]. The effect of a local spherical in-homogeneity in the isotropic layer is described adding a perturbation term to the in-homogeneity free solution. This term is a series of harmonic functions decaying at infinity [2]. We considered the first two terms of this series, thus obtaining an approximate solution. Moreover, in the case of more than one in-homogeneity, we neglected the mutual effects between the perturbation terms of the in-homogeneities. The approximations introduced can all be evaluated analytically and imply constraints in the selection of the geometrical relations between the source and the in-homogeneities. This selection was performed so that the worst case approximation error was smaller than 5% of the perturbation term. The model was applied to simulate single fiber action potentials detected by double differential filters. CV of the simulated potentials was estimated with a multi-channel approach [3]. The interelectrode distance (IED) was 5 or 10 mm, and the number of EMG channels 2, 3, or 4. In each simulated condition, three spherical in-homogeneities (1 mm radius; conductivity 10 times that of the fat) were located in 25 random positions within a 4 mm thick fat layer. **Results:** the CV estimates depended on the location of the in-homogeneities with respect to the fiber and detection electrodes. The variability of the CV estimate in the 25 conditions with random location of the in-homogeneities was significantly affected by the number of channels and IED used for the estimates. The maximum percent variation of CV estimates over the 25 conditions decreased with the number of channels and IED: 19.6% (2-channel), 12.1% (3-channel), 6.4% (4-channel), for 5 mm IED, and 12.0% (2-channel), 5.2% (3-channel), 2.4% (4-channel), for 10 mm IED. **Conclusion:** the novel model developed allowed the analysis of the sensitivity of multi-channel CV estimation methods to local tissue in-homogeneities. The degree of variability of CV estimates as well as the effect of increasing the number of channels and IED obtained by the simulations were in agreement and explained previous experimental findings [4]. It is concluded that multi-channel methods for CV estimation significantly reduce the sensitivity of CV estimates to small electrode displacements in the presence of tissue in-homogeneities. This reduces the variability of the measure when performed on the same subject on different occasions, and thus improves reproducibility of the results [4]. **References:** [1] Farina D., Merletti R. IEEE Trans. Biomed. Eng. 2001;48:637-646. [2] Sneddon, I. Mixed Boundary Value Problems in Potential Theory. The Netherlands: North-Holland, 1966. [3] Farina D, Muhammad W, Fortunato E, et al. Med Biol Eng Comput. 2001;39:225-36. [4] Farina D, Zagari D, Gazzoni M, Merletti R. Muscle Nerve. 2004;29:282-91.