Fast Subject Independent Magnetoencephalographic (MEG) Source Localization using an Artificial Neural Network

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Source localization from MEG data in real time requires algorithms which are robust, fully automatic and very fast. We present a system which is able to localize a single dipole to reasonable accuracy within a fraction of a millisecond, even when the signals are contaminated by considerable noise. The network is a multilayer perceptron (MLP) trained on random dipoles and random head positions. The MLP takes the coordinates of the center of a fitted sphere and the sensor measurements as inputs, uses two hidden layers, and generates source location coordinates as outputs. Adding head position as an extra input overcomes the primary limitation of previous MLP-based MEG localization systems, namely the need to retrain the network for each session. We use an analytic model of quasistatic electromagnetic propagation through a spherical head model to map randomly chosen dipoles and head positions to sensor activities according to the sensor geometry of a 4D Neuroimaging Neuromag-122 MEG system. After training with random dipolar sources contaminated with real noise, localization of a single dipole could be performed within 0.3 milliseconds on an 800 Mhz Athlon workstation, with an average localization error of 1.09 cm. To improve the accuracy to 0.54 cm, one can apply a few iterations of Levenberg-Marquardt (LM) minimization using the MLP's output as the initial guess. The hybrid method performs localization of a single dipole within about 65 milliseconds. We apply the MLP and the MLP-start-LM hybrid method to localize a single dipole source from actual BSS-separated MEG signals and compare with standard commercial software. Support by: NSF CAREER award 97-02-311, the NFFBI, and the NEC Research Institute.