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Behavior Classification using Multi-site LFP and ECoG Signals

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***Abstract*-**Deep Brain Stimulation (DBS) is an effective therapy that alleviates the motor signs of Parkinson's disease (PD). Existing DBS is open loop, providing a time invariant stimulation pulse train that may generate cognitive, speech, and balance side effects. A closed-loop DBS system that utilizes appropriate physiological control variables may improve therapeutic results, reduce stimulation side effects, and extend battery life of pulse generators. Furthermore, by customizing DBS to a patient's behavioral goal, side effects of stimulation may arise only when they are non-detrimental to the patient's current goals. Therefore, classification of human behavior using physiological signals is an important step in the design of the next generation of closed-loop DBS systems. Ten subjects who were undergoing DBS implantation were recruited for the study. DBS leads were used to record bilateral STN-LFP activity and an electrocorticography (ECoG) strip was used to record field potentials over left prefrontal cortex. Subjects were cued to perform voluntary behaviors including left and right hand movement, left and right arm movement, mouth movement, and speech. Two types of algorithms were used to classify the subjects' behavior, support vector machine (SVM) using linear, polynomial, and RBF kernels as well as *lp*-norm multiple kernel learning (MKL). Behavioral classification was performed using only LFP channels, only ECoG channels, and both LFP and ECoG channels. Features were extracted from the time-frequency representation of the signals. Phase locking values (PLV) between ECoG and LFP channels were calculated to determine connectivity between sites and aid in feature selection. Classification performance improved when multi-site signals were used with either SVM or MKL algorithms. Our experiments further show that the *lp*-norm MKL outperforms single kernel SVM-based classifiers in classifying behavioral tasks.