博士論文を要約したもの

博士論文題目

Real-Time Neuroprosthetic Control: Invasive and Non-Invasive Brain-Machine Interfaces for Paralyzed Patients

（神経義手の実時間制御―麻痺患者を対象とした侵襲および非侵襲ブレイン- マシン・インターフェース―）

氏　　名　福間 良平

Advancements in invasive brain machine interface (BMI) research have enabled patients with motor dysfunction to control external devices. However, to bring BMIs out of the laboratory and into the real world to improve the quality of life for patients, the invasiveness and clinical risks associated with contemporary BMIs need to be improved. Electrocorticogram (ECoG) is a technology that measures the activity of populations of neurons via electrodes placed on the cortical surface, providing a promising way to measure brain activity with relatively low invasiveness. To study preserved motor representation and motor information in paralyzed patients, which is essential to realize ECoG-based BMIs for clinical application, ECoG signals were recorded during a hand movement task of patients with differing severities of motor dysfunction. The results of spatiotemporal and decoding analyses showed that motor representation and motor information were deteriorated due to paralysis, although one of the paralyzed patients could still control a real-time ECoG-based neuroprosthetic arm and keep it under control after several days, without re-tuning the BMI parameters (chapter 2). To further examine the relationship between neurological symptoms and the preservation of motor information among patients with severe motor dysfunction, magnetoencephalogram (MEG) signals from severely paralyzed patients during a hand movement task were analyzed. The results of cortical current estimation and decoding analysis revealed that the subjective movability of phantom limbs was correlated with the amount of preserved motor information, and that paralysis altered the distribution of motor information in the bilateral sensorimotor cortices, depending on the properties of motor information (chapter 3). In addition, some of the patients could control a real-time MEG-based BMI successfully, and online performance was shown to correlate with the amount of preserved motor information in the contralateral sensorimotor cortex (chapter 4). These findings suggest the efficacy of ECoG-based BMI to reconstruct the motor function of paralyzed patients, as well as the importance of non-invasive BMI for multiple purposes, such as a training method for invasive BMI and an evaluation tool to test the potential of individual patients to control invasive BMI, before implantation surgeries.