Aalto University

Dissertation press release 21.12.2020

Moving towards next-generation imaging of brain activity

Title of the dissertation	Development of an on-scalp MEG system using optically-pumped magnetometers Swedish: Utveckling av ett magnetoenkefalografi-system som använder optiskt pumpade magnetometrar
Contents of the dissertation	Magnetoencephalography (MEG) is a noninvasive functional neuroimaging method in which the magnetic field caused by brain activity is measured using sensors outside the head. These neuromagnetic measurements are used to examine brain function both within neuroscientific research and clinical medicine. Current state-of-the-art MEG systems utilize so-called SQUID sensors that require cryogenic cooling and thermal insulation between the sensors and the subject's head. The thermal insulation necessitates a relatively large brain–sensor separation, leading to loss of signal as well as spatial resolution. Recent developments to another type of sensor, called *optically-pumped magnetometer* (OPM), has resulted in sensors with sufficient performance for MEG use. OPMs do not require cryogenic cooling and can thus be placed much closer to, or even directly in contact with the subject's scalp. Such *on-scalp* MEG systems will significantly improve signal quality as well as increase spatial resolution, and may thus enable the detection of phenomena so far only detectable in invasive measurements that require surgery. In addition, the improved adaptability of OPMs will enable new types of MEG systems, including wearable MEG devices allowing for subject movement and smaller, low-cost systems. This Thesis contributes to the development of an on-scalp MEG system based on OPMs and explores what such a system can or should consist of. Further, methods and software which can be utilized in the development of the next generation of on-scalp MEG systems are developed. Through these works, this Thesis provides a stepping stone for the continued development of on-scalp MEG as an imaging method and demonstrates its future prospects.
Field of the dissertation	Biomedical Engineering, Neuroimaging
Doctoral candidate	Rasmus Zetter, M.Sc.(Tech.)
Time of the defence	15.1.2021 at noon
Place of the defence	https://aalto.zoom.us/j/69971504989
Opponent	Professor Matthew Brookes., University of Nottingham, United Kingdom
Custos	Professor Lauri Parkkonen., Aalto University School of Science, Department of Neuroscience and Biomedical Engineering
Electronic dissertation	http://urn.fi/URN:ISBN:978-952-64-0214-7
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