Bachelor assignments in the NIM group

Magnetic detection - B. Ten Haken

See also: http://www.utwente.nl/tnw/nim/

Sensitivity measurements - taking magnetic detection to the limit.

Sebastiaan Waanders & . B. Ten Haken

The NIM group has developed a way to detect minuscule amounts of superparamagnetic iron oxide in very noise environments like the human body. This measurement technique will eventually be able to replace the costly and risk-prone gamma-probe based sentinel lymph node procedure with a magnetically oriented one, bringing down costs and reducing associated risks. However, there is still a significant amount of development and data analysis necessary before we reach this stage. That's where you come in!

You will take the next steps towards nanogram-range detection of superparamagnetic iron oxide (SPIO) nanoparticles, by improving the measurement setup and careful analysis of the resultant datasets to improve the sensitivity of the measurements whilst significantly decreasing measurement time in a multidisciplinary team consisting of biomedical engineers, technicians and physicists.

neuronal dynamics during ischemia/hypoxia

When neurons and their supporting glial cells do not receive enough sugar and oxygen, the neuronal unit is not able to maintain the ionic gradients over the cell membrane that are necessary to enable spiking. When the ion concentrations change, the functioning of the neuron is altered. This changes its excitability for example.
This typically happens in patients that have suffered from a heart attack or stroke. Or, less common, lack of oxygen due to drowning (or an avalanche).
We are working on a computer model that calculates the neural activity in brain tissue and the corresponding EEG signal of a patient. With such a model we hope to gain insight in what causes the variety of signals that are measured from these patients.
An important step for developing this model is getting insight into and quantifying the changes in single cell behavior when ionic concentrations change in the surrounding tissue.
You are asked to investigate this with a single cell model that is already available.

Interested

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Bachelor assignments BMT Neuroimaging group

Joost Pouw & Bennie Ten Haken

In treatment of patient suffering from breast cancer it is very important to determine whether metastatic tumor cells have spread to the lymph nodes. Surgical resection of the sentinel lymph nodes followed by histopathological analysis of the resected nodes is currently the most reliable method to diagnose metastatic spread to the lymph nodes. The sentinel nodes are the first nodes to receive lymphatic drainage from the tumor area, and thus the first nodes reached by metastatic cells.

To be able to detect the sentinel nodes during surgery a tracer is injected near the tumor. The tracer is then transported via the lymphatic system, the sentinel nodes are reached first and the tracer accumulates here. In current practice a radioactive tracer and/or a blue dye are used. A handheld gamma probe, able to detect the radioactive tracer, is used by the surgeon to localize the sentinel nodes during resection.

In our group we are working on the design and clinical implementation of a radiation-free alternative method. In this alternative method, a magnetic tracer is injected. This tracer can be detected with a sensitive magnetometer. We are currently using a commercially available magnetometer in a clinical study in the MST hospital, and we are developing a more sensitive device in our group.

ENDOMAGNETICS
SYSTEMS FOR BETTER HEALTHCARE

Impression of the sentinel node procedure and anatomy of the lymphatic system

Assignment 1 Development of a phantom

As mentioned before, we are working with a commercially available device in a clinical trial, and we are developing a more sensitive system. To be able to assess the clinical performance of these devices we are in need of a phantom that mimics the surgical situation. This allows to perform initial test without burdening patients. The phantom will be used to quantitatively and reproducibly test the performance of these devices.
Goal: Development of a phantom that can be used to assess the clinical performance of handheld magnetometers for intraoperative sentinel lymph node localization in breast cancer treatment.

Assignment 2 Influence of Lymph node characteristics on quantitative measurements

To optimize the sentinel node procedure with a magnetic tracer, we are interested in the distribution of the tracer to the lymph nodes. One of the methods to analyze the distribution is to quantify the amount of magnetic contrast agent in the resected lymph nodes. This is possible by performing Vibrating Sample Magnetometry, in which the response of the magnetic tracer in the lymph node to an applied magnetic field is measured. Size, shape and tracer distribution vary with every different lymph node. We are interested to know if and how much these characteristics influence the signal obtained from the VSM measurement.

Goal: To develop different phantoms, representative of lymph nodes containing magnetic tracer. The phantoms are used to determine if for instance size, shape or tracer distribution influence the signal of the VSM measurement.

BACHELOR ASSIGNMENT BIOMEDICAL ENGINEERING - NEURO-IMAGING GROUP - MARTIJN VISSCHER & BENNIE TEN HAKEN

CHARACTERIZATION AND OPTIMIZATION OF A MAGNETOMETER FOR BIOLOGICAL SAMPLES

Magnetic nanoparticles are increasingly important for biomedical applications. For these applications new techniques for detection and analysis of those particles are needed. In our group a magnetometer was developed to characterize samples with magnetic nanoparticles, aimed to detect very tiny amounts in the order of nanograms. The system is designed to analyze small intact biological samples at room temperature. Samples containing superparamagnetic nanoparticles, harvested in for example sentinel lymph node procedures, can be quantified to make a selection for additional microscopic analysis. The system is designed with two excitation coils to enable mixing of magnetic fields of different frequency and amplitude. Using this, the typical nonlinear magnetization of the particles is exploited to distinguish the particles from a linear magnetic background, like tissue. To facilitate introduction into a clinical environment, the system needs some improvements and several technical questions have to be answered. The optimal excitation parameters and detection conditions are not completely known yet. Therefore several technical experiments are needed to obtain a more stable and highly sensitive system with a fast procedure that enables characterization of magnetic nanoparticles in biomedical samples.