基本波型直交フラックスゲートの広帯域化と多チャンネル駆動法の研究

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論 文 名　：Band widening and multichannel operation methods for the fundamental mode orthogonal fluxgate magnetometer

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論 文 内 容 の 要 旨

Thesis Summary

In this thesis, two issues regarding the fundamental mode orthogonal fluxgate (FM-OFG) magnetometer are investigated; The one is to widen the cutoff frequency of the magnetometer and the other is to remove the interference that occurs when two or more magnetometers are placed closely.

A wide-band magnetic sensor with high resolution is a key element for the construction of an active magnetic shield. A new compact hybrid magnetometer design is proposed by combining a pT-level fundamental mode orthogonal fluxgate (FM-OFG) for low frequency range and a search coil magnetometer (SCM) with a thin cylindrical magnetic core for high frequency range. By inserting 20 % of the sensor head of FM-OFG inside the cylindrical magnetic core of SCM, the sensitivity for the FM-OFG part can be made double due to the flux collection effect of the cylindrical core. By setting a cross over frequency at 637 Hz, the resolution 4 pT/√Hz above 10 Hz is obtained. The cutoff frequency is increased to 33 kHz from 6 kHz which is for the case of FM-OFG alone.

In order to measure magneto-cardiogram with the FM-OFG, magnetometers are placed in a dense array to measure magnetic field distribution above the torso. Due to the high sensitivity of FM-OFG and the use of the ac excitation to drive sensor heads, tiny but still substantial (several hundreds pT) sinusoidal interferences are visible in the output when two FM-OFGs are placed closely. From precise experiments, frequencies of such interferences are found exactly the difference between frequencies of ac excitation currents to each sensor heads and higher harmonics of the frequency difference. The interference has been attributed to the beat of excitation magnetic fields. After this finding we simply propose to use the same excitation frequency for all the sensor heads. The beat interferences at dc are harmless for the biomagnetic field measurement, because they are time-varying.

We fulfill two objectives. We made the sensor bandwidth widening by useing a FM-OFG and search coil to build hybrid magnetometer. Noise of hybrid sensor operating without switching is very low as FM-OFG in low frequency domain, and as search coil in high frequency domain. We found the interference reasons of fluxgate array, and a method to avoid main interference to achieve fluxgate array operational.

We have developed a method to widen the frequency band and a method to remove the interference between FM-OFG magnetometers placed closely as in an array.