Design of a Helm Holtz Cage with Automatic Environment Compensation

A Helm Holtz cage is a device that creates a magnetic field with the cage that can be controlled in body 3 dimensional orientation and overall field strength. This has particular use in measuring the effects of magnetic fields on systems, and to allow the test and calibration of (magnetic) compass systems and sensors.

Within most engineering labs and on the manufacturing floor, power supplies, wiring within the building, machinery being used, and movement of metal objects creates a dynamically changing magnetic field. This causes the field within the Helm Holtz cage to vary from the desired magnetic vector, resulting in unknown and unmeasured errors.

The objective of this Capstone Design Project is to design a system that can measure the changes in the magnetic field near a Helm Holtz cage and modify the control signals of the Helm Holtz cage to compensate for the changes so that the combined field inside the Helm Holtz cage is constant.

This will require the design of a 3 axis magnetometer, the control of a 3 axis Helm Holtz cage, and the design and implementation of algorithms to correct the field generated by the Helm Holtz cage coils so that the field seen by systems within the Helm Holtz cage is constant.

Functional Specifications:

1. A 3 axis magnetometer design must have enough range to measure the magnetic fields inside a factory floor, the additional field generated by the Helm Holtz cage, and an accuracy and precision at least 4 times better than the Helm Holtz cage.
2. A control system consisting of 3 programmable power supplies and a controller that will allow the creation of a magnetic field within the Helm Holtz cage.
3. A control algorithm implemented in Labview to control 3 power supplies so that a magnetic vector of arbitrary strength and (3-D) orientation can be created within the Helm Holtz cage. The range of the field should be at a minimum ±150,000 nanoTesla, and preferably ±250,000 nT (5 times the Earths' magnetic field)
4. A control Algorithm implemented in Labview or Matlab to use the real time measurements of the magnetic field near the Helm Holtz cage (via the external Magnetometer) to compensate for changes such that the magnetic field within the Helm Holtz cage is maintained at the desired magnitude and orientation.
5. The deviation from the desired orientation should be less than 0.1º degree in any axis, and the deviation from the desired magnitude should be less than 100 nT.

Required Skills:

This project will require a team of 3 students: a computer engineering student to implement the software, and two electrical engineers, who have:

experience in control systems;

experience in electronics and interfacing measurement systems to PCs;

handle the calibration algorithms of the Helm Holtz cage

1.Knowledge of National Instruments Labview programming language/environment to control the power supplies that control the Helm Holtz cage.

2.Knowledge of feedback control theory and digital implementations

3.Knowledge of Matlab for modeling and simulation may be useful.

4.Knowledge of electronics, interfacing embedded systems, and selection/programming of embedded development boards

5. Some mechanical experience to mount sensors rigidly to the Helm Holtz cage would be helpful.

For further information, please contact:

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