TRI-AXIAL SQUARE HELMHOLTZ COIL FOR TESTING SATELLITE STABILIZATION WITH MAGNETORQUERS

Ion BOSTAN, Viorel BOSTAN, Nicolae SECRIERU, Vladimir MELNIC, Valentin ILCO, Alexei MARTÎNIUC, Vladimir VĂRZARI

Technical University of Moldova, 168, Ștefan cel Mare Blvd., Chișinău, Republic of Moldova

*Corresponding author: vladimir.melnic@mate.utm.md

The paper describes the design, construction and initial testing of a magnetic field simulator consisting of Helmholtz coils, for testing under laboratory conditions the system for determining and controlling the attitude of microsatellites. In addition to numerical modeling, it is necessary to validate the results in real experiments which leads to a higher level of confidence in orbit performance and lower risks.

One of the methods of satellite stabilization is by magnetorquers: coils that create magnetic field. The momentum created by the magnetorquer interacts with the geomagnetic field in orbit and rotates the satellite. For the proper work of the attitude determination system as well as the attitude control system, it is necessary the ability to detect the magnetometer, the ability to act in pairs as well as the interface between these two. For this purpose at the Center for Space Technologies of Technical University of Moldova was created three-axis Helmholtz cage, consisting of 3 pairs of square coils. This simulator allows the magnetic field to be generated from the orbit of the satellite. Initial tests confirmed the purpose of creating the desired magnetic field, by programmed change of the current intensity in the Helmholtz coils.

The described system will be used in the Center for Space Technologies for further research of the attitude determination and control systems of satellites designed within this center, including for other research that requires the creation of a uniform and programmable magnetic field.

Keywords: *Helmholtz coil, magnetic field, satellite, magnetometer, magnetorquer.*

References

1. RESTREPO, A., FRANCO, E., CADAVID, H., PINEDO, C. Analysis of the Magnetic Field Homogeneity for an Equilateral Triangular Helmholtz Coil. *Progress In Electromagnetics Research M*, 2016, 50, pp. 75–83.
2. MAHAVARKAR, P., JOHN, J., DHAPRE, V., DONGRE, V., LABDE, S. Tri-axial square Helmholtz coil system at the Alibag Magnetic Observatory: upgraded to a magnetic sensor calibration facility. *Geoscientific Instrumentation, Methods and Data Systems*, 2018, 7 , pp 143-149.
3. BALTAG, O., MARIN-ROȘU, G., COSTANDACHE, D., RĂU, C. Instalaţie magnetometrică vectorială pentru studiul modelelor fizice navale, *Buletinul AGIR*, 2014, 4, pp 26-32.
4. KLESH, A., SEAGRAVES, S., BENNETT, M., BOONE, D., CUTLER, J., AND BAHCIVANK, H. Dynamically Driven Helmholtz Cage for Experimental Magnetic Attitude Determination. *Advances in the Astronautical Sciences*, 2010, pp 147–160.
5. HERCEG, D., JUHAS, A., AND MILUTINOV, M. A Design of a Four Square Coil System for a Biomagnetic Experiment. *Facta Univer-sitatis, Series: Electronics and Energetics*, 2009, 22, pp 285–292.
6. MARTINO, C. F., PORTELLI, L., MCCABE, K., HERNANDEZ, M., BARNES, F. Reduction of the Earths magnetic field inhibits growth rates of model cancer cell lines. *Bioelectromagnetics*, 2010, 31(8), pp 649–655.
7. FARINA, M., MARIGGIO, M. A., PIETRANGELO, T., STUPAK, J. J., MORINI, A., FANO. G., ELF-EMFs induced effects on cell lines: Controlling ELF generation in laboratory. *Progress In Electromagnetics Research B*, 2010, 24, pp 131–153.

8. Prinkey M., Miller† D., Bauer P., (2013) CubeSat Attitude Control Testbed Design: Merritt 4-Coil per axis Helmholtz Cage and Spherical Air Bearing, Guidance, Navigation, and Control and Co-located Conferences, Boston, doi:10.2514/6.2013-4942.
9. PRINKEY M., MILLER† D., BAUER P., *CubeSat Attitude Control Testbed Design: Merritt 4-Coil per axis Helmholtz Cage and Spherical Air Bearing* [online]. 2013. Available: https://arc.aiaa.org/doi/abs/10.2514/6.2013-4942.
10. SAUNDERSON, E., GOUWS, D. *Evaluation of the effect of ambient temperature variation on the calibration of a Large Helmholtz Coils System, employed for the calibration of space qualified magnetometers* [online]. SpaceOps Conferences, Marseille, 2018, Available: https://arc.aiaa.org/doi/abs/10.2514/6.2018-2374.