Machine-Learning robust control of magnetic disturbances

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Optical atomic magnetometers may easily detect magnetic signals as weak 100 billion times weaker than the Earth field, and one million times weaker than the environmental field variations. This commonly requires that these sensors are operated in shielded volumes, which poses practical constraints and sets limitations to the application areas. Instead of using expensive and delicate shields we have developed an active cancellation system using a closed-loop control implemented in a Field Programmable Gate Array (FPGA). The magnetometer output is used as an error signal of the closed-loop. Perfect cancellation of the environmental magnetic field fluctuations is obtained by finely tuning the feedback loop by means of a machine learning technique, which designs accurately its parameters. The ML approach is a powerful tool for designing and optimizing the loop parameters when dealing with poorly known system. This approach may find application in other areas where common mode disturbances are to be cancelled for improving the signal to noise ratio in the detection of weak difference-mode signals. The originality of our work lies in the application of the ML method for achieving better noise rejection in magnetometric unshielded operation. The FPGA usage and ML approach can be adapted to any differential device suffering from limited common-mode-rejection ratio.

[1] G. Bevilacqua, V. Biancalana, Y. Dancheva, A. Vigilante; "Machine-Learning robust control of magnetic disturbances"; Submitted (2018); Preprint available at arXiv:1803.03212.