Machine Learning for Multi-Parameter Optimisation for a Zero-Field Optically Pumped Magnetometer

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The measurement of magnetic fields in the human body is already having a significant impact in a wide range of healthcare applications, from magnetoencephalography (MEG) to foetal-magnetocardiography [1; 2]. Optically pumped magnetometers (OPMs) have been demonstrated as a promising technology for these types of applications, achieving suitable signal resolution with a low size, weight and power [3]. Machine learning is an effective tool to interrogate systems with complex dynamics to find optimal parameters more efficiently than through human selection [4]. This is particularly important for systems with multiple parameters and a subsequent high number of parameter configurations, where an exhaustive search would be infeasible. Here we present a single beam caesium zero-field OPM. There are several key operating parameters which significantly impact the sensitivity of the OPM, namely; (1) temperature, (2) laser power and (3) laser detuning. Here, we implement a number of automated machine learning strategies to find the optimal parameters to optimise the amplitude to width (mV/nT) ratio of the zero-field resonance line shape, and sensitivity (T/$\sqrt{\text{Hz}}$). This machine learning approach increased the optimal sensitivity from 500 fT/$\sqrt{\text{Hz}}$ found manually to $<$ 300 fT/$\sqrt{\text{Hz}}$.

References

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