Object surveillance with radio-frequency atomic magnetometers

R. Gartman[1], P. Bevington[1,2], W. Chalupczak[1],

[1] National Physical Laboratory, Hampton Road, Teddington TW11 0LW, United Kingdom
[2] Department of Physics, University of Strathclyde, Glasgow G4 0NG, United Kingdom

Instruments based on radio-frequency (rf) technologies create an interesting alternative to standard surveillance methods such as ultrasound, infra-red or visible imaging. Our focus is on inductive tomographic imaging, an active measurement, where the object signature is created by an external drive, in the form of an oscillating magnetic field (primary field). Through the inductive coupling of the primary field with the electrically conductive or magnetically permeable object, the target will generate a signature in the form of an oscillating magnetic field (secondary field), which can be detected by the magnetic field sensor. In the context of inductive tomographic imaging, atomic magnetometers proved to be versatile magnetic field sensors with a sensitivity reaching $fT/Hz^{1/2}$ in an open, unshielded environment [1,2,3].

We will demonstrate and discuss two possible object detection schemes involving magnetive couplings. One realization includes monitoring the inductive coupling between an object and a primary magnetic field oscillating at a variable frequency by an atomic magnetometer. The rf resonance frequency of the atomic magnetometer is synchronously tuned with that of the primary field frequency. The second option uses a fixed operational frequency and a primary field with a non-monochromatic spectral distribution. Our realization uses a 'white noise' source for the primary field.

Recently, enhanced-sensitivity magnetic induction communication schemes implementing dc atomic magnetometers were demonstrated [4]. The detection scheme discussed in this abstract is also relevant to magnetic field communication, where information is encoded in the source of the rf signal (primary field) rather than through inductive coupling with an object (secondary field). Therefore, the results of our measurements will also be explored in terms of magnetic field communication.

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