A Model Assisted Probability of Detection Study for Eddy Current Testing of Multi-layer Structures

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Eddy current (EC) excitation with GMR (Giant MagnetoResistive) sensors \cite{1} for measuring induced fields has been used successfully in many industrial applications for detecting flaws in materials and components. This article focuses on the detection of cracks at fastener sites in multi-layered structures, which are commonly seen on aircraft skin, and develops a model assisted method of assessing the probability of detection (POD). In an EC-GMR system the conductive specimen under investigation is excited with a time-varying magnetic field. The perturbations in induced magnetic field introduced by flaws are picked up by GMR sensors which provide high sensitivity even under very low frequency fields. Despite limitations of skin depth and sensitivity to lift-off, a well-designed EC-GMR system can potentially detect buried defects in a multi-layered structure \cite{2}. Further, it is shown that using rotating current excitation, EC-GMR system is sensitive to defects with arbitrary orientations \cite{1}.

In practice, the GMR signal of a defect is not only a function of the defect size but also of geometrical features in the vicinity such as edges, adjacent rivets and properties of the layered structure. As it is expensive and time consuming to manufacture a variety of samples including these factors, numerical models can be used to provide fast and accurate estimates of defect signals. In order to take advantage of this, we adopt the concept of model assisted probability of detection (MAPOD) and consider it in a multi parameter framework \cite{3-5}. We use a meta-model to reduce the computational effort and Monte Carlo simulations to propagate the uncertainties essential for calculating POD. The multi parameter approach estimates POD not only w.r.t. the flaw size but also w.r.t. critical parameter combinations during inspection.

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References: