Electromagnetic Induction Landmine Detection using Bayesian Model Comparison

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Electromagnetic induction (EMI) landmine detection can be cast as a Bayesian model comparison problem. The models used for low metallic-content mine detection are based on the equivalent electrical circuit representation of the EMI detection system. The EMI detection system is characterized and modeled by the impulse response of its equivalent circuit. The analytically derived transfer function between the transmitter coil and receiver coil demonstrates that the EMI detection system is a third order system in the absence of a mine and that the presence of a mine adds an additional pole that makes the detection system fourth order. The value of the additional pole is determined by the equivalent inductance and resistance of the mine and is unique for each mine. This change in system order suggests that measured system impulse responses can be used in conjunction with impulse response models to infer the presence or absence of a landmine. The difficulty of this techniques is that the amplitude of the term added to the the system impulse response by the landmine is small compared to the impulse response of the system alone. To test the feasibility of Bayesian inference based EMI landmine detection, an EMI detection system experiment was designed and built. In the experiment the EMI detection system was driven by a broadband maximal-length sequence (MLS) in order to obtain sufficient dynamic range in the measured impulse responses. This paper discusses the development of parameterized impulse response models for the detections system with and without a landmine present and the assignment of appropriate priors for the parameters of these models. This paper also presents the ratios of computed posterior probabilities for the mine and no mine models based on data obtained from the experimental EMI landmine detection system. These odds ratios demonstrate the potential of Bayesian EMI landmine detection.