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14. ABSTRACT
The main goal of this research is to develop novel methodologies in the design and modeling of sensitivity testing and related experiments, which are commonly encountered in military applications. The research has progressed well with four papers accepted and scheduled to appear, one tentatively accepted and one under review. Paper 1 proposes a new sequential procedure for root finding in highly nonlinear situations. Paper 2 addresses the modeling and data combination from experiments with varying degrees of accuracy (e.g., in explosive testing, a finite

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Statement of the problem and summary of the most important results

Adaptive designs for stochastic root-finding are very useful for sensitivity testing. Paper 1 proposes a new adaptive design procedure using Bayesian methods. Different from Wu's MLE procedure (which was funded by ARO to the U of Wisconsin in mid-80's), this new procedure gives more importance to observations closer to the root, making it more robust to the model misspecifications. The convergence of the new procedure is proved analytically and its superiority over the existing procedures is demonstrated using simulations. With the advances in computing and sophisticated physical models, use of computer modeling has become popular as an alternative to physical experiments or field tests. For example, to understand the conditions (e.g., temperature, storage density, age) under which a stockpile of ammunition can explode, there is a limit on how many actual field tests can be performed. This explosive mechanism can be described by a physical model and implemented in a finite element analysis code. How to efficiently integrate data from two sources, one with more accuracy (i.e., field test data) and another with less accuracy but much faster (i.e., computer model)? Paper 2 proposes a novel Bayesian approach to model and integrate such data sources. Because the relationship between the response and the input variables in computer models is highly nonlinear, traditional experimental design technique like fractional factorials cannot be used. Paper 3 proposes a new class of Latin Hypercube designs with orthogonal and maximin properties. Feedback control is a technique commonly used in military applications. Paper 4 gives the first systematic attempt to connect feedback control with robust parameter design which has proven very powerful in improving industrial quality but less used in the military arena. In most sensitivity testing experiments, the response is binary (e.g., penetrate or not). In a 2004 paper by Joseph and Wu (co-PI and PI) which won the Jack Youden Prize, a new method for binary response called FAMe was proposed. Paper 5 studies the modeling and analysis strategies of this method more generally and in depth. Paper 6 proposes a new sequential design method for detecting money laundering. This topic is very important to the security of the nation because, money laundering often involves criminal activities including terrorism. These papers collectively can lead to a better understanding of several related problems and provide novel and more efficient methodologies with immediate or potential military applications.

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