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SIMULTANEOUS ESTIMATION OF SET MODEL PARAMETERS WITH INTENSIVE MEASUREMENT NOISE

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ABSTRACT

The goal is an investigation of a noise measurement influence on the identification of a set of unknowns. It is assumed that any kind of functional dependency of sought functions and a wide class of mathematical models can be used to identify the process studied. The new regularization schemes of inverse problems are analyzed to increase the estimation accuracy even with intensive noise level.

The main inverse problem peculiarity is that small input errors drive to a large variety of numerical solutions. To avoid this, the problem in question should be regularized, i.e., the domain of admissible solutions needs to be restricted. The restrictions are preset either ad hoc or based on preliminary information about the quantities estimated. In this case the numerical stability is ensured and the solution obtained tends asymptotically to its exact value if the noise level approaches zero. In practice, however, restricting the domain of admissible solutions we obtain a necessary condition of satisfactory estimation accuracy. The proof of the solution to be asymptotically convergent with the noise level tending to zero is of theoretical interest. The practical experiment processing needs the solution to be found not in the neighborhood of zero noise level. An asymptotic convergence is not a substantiation of satisfactory inverse problem solution for non-zero noise. Therefore noisy data processing can be regularized, but no satisfactory solution is obtained. So, the point is to find a satisfactory numerical solution with the observations of fixed non-zero noise level.

Our view rests on the analysis of the solution behavior under increasing, and not decreasing, measurement noise. In this way we investigate the optimum regularization scheme and the increasing noise effects. The following questions are raised and studied:

• What method can identify a set of various unknowns under intensive observation noise?
• How does the stabilization degree of the domain of admissible solutions affect the accuracy of the inverse problem solution?
• What conditions are optimums to match the inverse problem solution with measurement noise?

The investigation has the following outline. The abstract inverse problem is formulated. The regularization under separate matching with a sampling is considered. Main functional behavior of a similar regularization is discussed. Based upon the proposed approach the optimal identification coefficients and boundary conditions of PDE simultaneously are considered. By virtue of a similar viewpoint the inverse problem is studied not from the subject of sought quantity but from the sought solution behavior with all conditions of problem formulation. In other words we consider an inverse problem not as boundary, coefficient, source or any other type but as a problem which solution should be studied when the mapping operator is known in implicit form. As a result maximum unknown quantities estimation with minimum input information is possible. The one cannot be realized with the standard Tikhonov regularization scheme.