BOOTSTRAP IDENTIFICATION OF LINEAR AND NONLINEAR SYSTEMS WITH APPLICATIONS TO PREDICTION AND CONTROL PROBLEMS

by

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submitted

in fulfilment of the requirements of
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CERTIFICATE

This is to certify that the thesis entitled ''Bootstrap Identification of Linear and Nonlinear Systems with Applications to Prediction and Control Problems'' being submitted by Rai Mukteshwar Prasad for the award of Doctor of Philosophy to the Indian Institute of Technology, Delhi is a record of bonafide research work he has done during August'74 to September'77 under our supervision. The results obtained in this thesis have not been submitted to any other university or institute for award of any degree or diploma.

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To Lili, my wife

and

Gunjan and Bhawana, my children

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R.M. Prasad

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ABSTRACT

The thesis presents two-stage bootstrap identification algorithms for discrete-time linear and nonlinear stochastic systems represented by state variable models. The utility of these algorithms in the problems of prediction, closed-loop system identification and controller design have also been demonstrated. The method proposed is a powerful alternative to the usual extended Kalman filtering method which suffers from two major defects : (1) the computations increase due to state augmentation and (2) the filter often diverges due to approximate pointwise linearization. In deriving the algorithms of this thesis, the main aim of the author has been to overcome the above two difficulties. This is achieved by splitting the parameter and state estimation problems into two stages, thus avoiding higher dimensionality, and then employing filters which check divergence in the estimators. The two stages of estimation are mutually coupled in bootstrap manner such that the estimates flow from one into another. To check divergence, four alternative methods have been proposed which are: (1) modeling error compensation, (2) minimum divergence criterion, (3) stochastic approximation method and (4) Pandya's adaptive filter. These are used in the state estimators of the two-stage procedure.

Validity of above algorithms has been tested using both simulated and real life data. A linear model using weather data of Delhi has been obtained for predicting daily maximum temperature and humidity. Two nonlinear models, again using real data, have

been obtained for making prediction of river flow and unemployment rate.

Besides the above, two more problems, one of closed-loop identification and another of controller design for deterministic and stochastic systems have been considered. These problems have also been solved using the proposed two-stage estimation algorithms.

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