論 文 の 内 容 の 要 旨

論文題目　Detection of Changes in Dynamical Systems by Nonlinear Time Series Analysis
（非線形時系列解析による動的システムのパラメータの変更同定）

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The problem of detecting changes, or damage, in the dynamics of a large nonlinear system is examined. The system is partitioned into several interacting subsystems, and changes in the dynamics of each subsystem are detected. Each subsystem is an input-output system. The case in which all inputs cannot be measured is considered; therefore, the dynamics of the subsystem under consideration must be modeled using only the observed outputs. On the basis of ideas derived from existing embedding theorems, functional relations between delayed multivariate observations are proposed and justified. The multivariate observations are divided into primary and secondary observations; the secondary observations are used for obtaining information about the input, while delays of the primary observations are used for obtaining information about the state of the system. Local linear models based on the proposed functional relations are then estimated from time series data; changes in the dynamics of the subsystem are detected by monitoring the normalized root mean square error of the models. The functional relations and the proposed change detection method are examined by several numerical examples, including discrete maps and continuous-time systems. Finally, the method is applied to detect changes in the parameters of a nonlinear hysteretic model of a five-story building under earthquake loading; it is shown that changes in the nonlinear parameters, as well as the stiffness, can be identified from only velocity measurements. The approach is applicable to the analysis of coupled systems and complex networks as well. The two proposed functional relations are non-predictive relations; thus, they cannot be used to predict the future behavior of the system. However, since they model the dynamics of the system, they can be applied to change detection. Another possible application is noise reduction.