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NEURAL NETWORKS BASED SYSTEM IDENTIFICATION TECHNIQUES FOR MODEL BASED FAULT DETECTION OF NONLINEAR SYSTEMS

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Abstract. *Residual generation is an essential part of model-based fault detection schemes. For nonlinear systems, the task of residual generation is sometimes complicated by the size of the problem, or by the lack of a suitable model from where the residual can be generated. This paper develops and implements neural-networks based system identification techniques for nonlinear systems with the specific goal of residual generation for fault detection purposes. Two NN structures were investigated in this paper: a new structure of partially connected neural networks (PCNN), and a conventional, fully connected neural network (FCNN). The two approaches are tested on a Boeing 747 aircraft model. Results of computer experiments are reported. Performance comparisons of the two neural networks are presented.*

Keywords: Neural networks, Partially connected neural networks, Fully connected neural networks, Identification, Fault detection, Aircraft

1. **Introduction.** Fault detection and identification (FDI) are critical issues in the operation of high performance airplanes, space vehicles, and structures where safety, mission satisfaction, and significant material value are important [1,2]. Real-time FDI would insure high performance of the aircraft even with impairments to the actuators, sensors or control surface, and thus increase the aircraft's survivability, and probability of mission success [3].

In model based fault detection, a model (mathematical or heuristic) is employed to describe the nominal behavior of the monitored system. Fault detection is accomplished by using a quality index (residual) to compare the output predicted by the nominal identification map (signals obtained from the model) with the actual measurements (real-time output signals). The residuals are expected to be close to zero in fault-free cases, but are distinguishably different from zero when a component of the system fails [4,5]. The success of the model-based method is heavily dependent on the quality of the model;