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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;