Real-Time Robust Fault Detection and Isolation

For Safety and Recovery in High Performance Systems

Technology Need

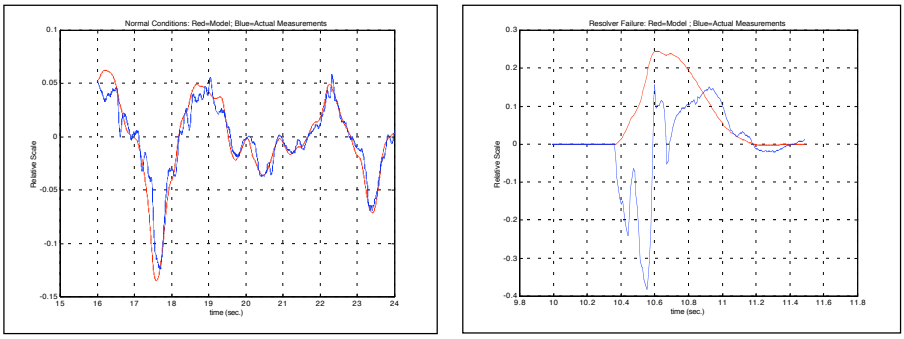
Fault detection is a prime concern in the deployment of many systems. For certain types of systems, there is a significant potential for an accident, including severe injury or property damage, without adequate fault detection and response capability. Oak Ridge National Laboratory (ORNL) has been addressing this need as a part of the development of high performance systems.

General Approach

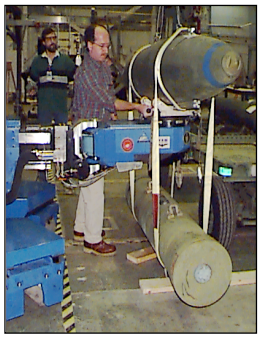
The general approach to error detection is through model-based anticipatory and trend-forecasting schemes (such as Kalman predictive filtering), which can detect a system error during system transients. Unfortunately, it is difficult to distinguish between a fault and system disturbance with conventional methods due to the short decision times available when a failure occurs and the unpredictable nature of disturbances acting on a plant (such as thermal drift, mechanical vibrations, impact forces, etc.). This explains why such systems are not readily commercially available for real-time control processes.

ORNL's Approach

ORNL's approach has been to separate the disturbance forces acting on the system from the overall nonlinear system response caused by a fault. Preliminary work at ORNL indicates that this approach of partitioning of these forces can reduce response times to a fraction of a second. ORNL has successfully demonstrated this approach on a high capacity human amplifying material handling system. For this system, a human being is in close contact with a hydraulically powered robotic manipulator that is moving materials of over 2000 lbs. Safety through fault detection is critical for both the operator and the hardware.



Fault detection data.
(Normal operation on the left and failure on the right. Note deviation of measured and modeled values)



Material handling system.
(Relies on fault detection system for safe operation.)

Application Areas

This approach could also be applied to other systems, such as power plants. Rapid detection of faults and rapid isolation of safety critical components could impact overall power plant availability, thereby reducing unanticipated costly shutdowns.

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