Proceedings of the 17th World Congress
The International Federation of Automatic Control
Seoul, Korea, July 6-11, 2008

Multi-Model Based Fault Detection and Diagnosis of a Hydraulic Servo Axis

Marco Muenchhof *

* *Technische Universitaet Darmstadt, Institute of Automatic Control,Laboratory for Control Systems and Process Automation, Darmstadt, Germany (Tel: +49-6151-16-3114; e-mail: MMuenchhof@iat.tu-darmstadt.de).*

Abstract: This contribution describes the design and implementation of a multi-model based fault detection and diagnosis system for a hydraulic servo axis. Multiple models are operated in parallel to the plant - similar to a bank of observers. Beside one model mimicking the fault free process, there are additional models describing the process behavior in the presence of both actuator and process faults. For each model the squared error between the model output and the plant output is determined. The model which (over a period of time) shows the best match with the process is assumed to currently best describe the process behavior. The fault injected into the model with the best match is thus at the same time the diagnosis, i.e. the fault which is assumed to be present in the real system. This system has been tested exhaustively at a testbed. The result of the tests is shown in the accompanying video.

Keywords: Hydraulic Actuators, Fault Diagnosis, Physical Models, Video Demonstration

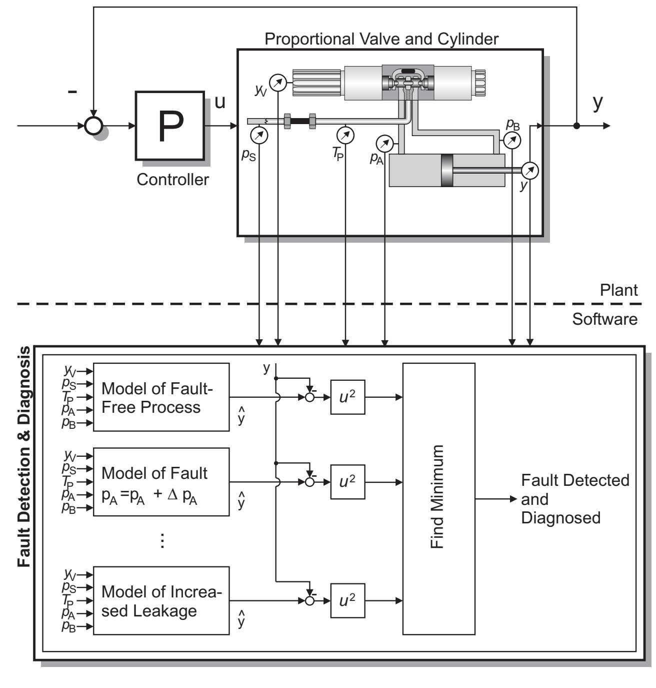

Fig. 1. View of Multi-Model Based Fault Detection and Diagnosis

1. MULTI-MODEL BASED FAULT DETECTION AND DIAGNOSIS

The fault detection and diagnosis system is based on the parallel evaluation of a bank of models. Each model describes the behavior of the plant in the presence of a certain fault. If any of the evaluated models performs better than the model designed for the fault-free case, one can infer on the presence of a fault. The diagnosis can as easily be carried out by searching for the model with the best fidelity, i.e. the smallest squared error between the model output and the process output. The setup is shown in Fig. 1. It is somewhat similar to the dedicated observer scheme (DOS) described by R.N. Clark in Chapter 2 of Patton et al. [2000]. However, in the paper at hand, nonlinear models are employed without any feedback of the output error. The development of the hydraulic model is covered in detail in Muenchhof [2006], where also parity equation and parameter estimation based fault-detection and diagnosis approaches can be found. A good overview of these and other fault detection and diagnosis methods can be found e.g. in Isermann [2006].

2. EVALUATION AT TESTBED

At the testbed, the approach has been tested for both sensor fault and process fault detection. For sensor faults, the system was able to detect faults in the area of a few percent of the maximum sensor reading. Pressure sensor offset faults could already be detected for an offset of around 2 bar. The video shows the reaction to a process fault, i.e. increased leakage flow between chamber A and B.

REFERENCES

Rolf Isermann. *Fault Diagnosis Systems.* Springer-Verlag, Berlin, 2006.

Marco Muenchhof. *Model-Based Fault Detection for a Hydraulic Servo Axis, Nummer 1105 in Fortschritt-Berichte VDI Reihe 8.* VDI-Verlag, Dsseldorf, 2006. ISBN 3-18-510508-7.

R. J. Patton, P. M. Frank, and R. N. Clark. *Issues of Fault Diagnosis for Dynamic Systems.* Springer-Verlag, Berlin, 2000.