

FAULT DIAGNOSIS IN CONTROL SYSTEMS FINAL PRESENTATIONS
Idris Yamanturk (1304)

Morning session: 9:15-12:15, May, 15, 2002

1. The General Theory of Observers by Onur Karasakal and Ahmet Doganci

Abstract: In this study, the topics which are given below is discussed.

1. The concept of observer and the state estimator
2. The theory of observers for an arbitrary linear time-invariant system and observer matrix equation
3. Design of Observer
 - a) By pole location (Dynamic assignment)
 - b) By using Ackermann's formula
 - c) By solving observer matrix equation (explaining by an example)
4. Parameter insensitive observer
5. The robust observer
 - a) Minimal order robust observer
 - b) Doyle-Stein observer
 - c) Failure insensitive Luenberger Observer

** Parts 1-4-5c will be presented by Onur KARASAKAL

** Parts 2-3-5a-b will be presented by Ahmet DOGANCI

2.

An Introduction to the Linear Kalman Filtering by Okan TÜR

Abstract: In 1960, R.E. Kalman published his famous paper describing a recursive solution to the discrete-data linear filtering problem. Since that time, due in large part to advances in digital computing, the Kalman filter has been the subject of extensive research and application, particularly in the area of navigation, space guidance and orbit determination. The purpose of this presentation is to provide a practical introduction to the Linear Discrete Kalman filter. This introduction includes a description and some discussion of the basic discrete Kalman filter.

3. Nonlinear Estimation by Evren Aydin

Abstract: Kalman filtering (Kalman, 1960; Kalman and Bucy, 1961) originally started as a solution to the state estimation problem in linear time-invariant state space model structures, in which a linear, stochastic dynamic system is represented by a set of differential equations, describing the evolution of the states in time, and a set of algebraic equations which map the states to measured outputs. Since then Kalman filtering has also been applied to input and parameter estimation problems, new derivations with their interpretations of the filter have been given, and extensions to non-linear and time-varying systems have been proposed. Some of these extensions became known as the Linearized Kalman Filter and the Extended Kalman Filter, which both have been derived to solve nonlinear estimation problems. Nowadays Kalman filtering is widely used and is one of the

key tools in data assimilation. In this study, concluding studies of estimation theory will be presented by giving explicit consideration to problems in nonlinear estimation. Many modulation methods, such as frequency and phase modulation, have inherently nonlinear observation models, and the dynamic message models for the majority of realistic vehicle-guidance and control problems are inherently nonlinear. In this study, we also studied on some extensions of nonlinear estimation as linearized Kalman filter, extended Kalman filter and decentralized Kalman filter.

Keywords: Kalman filter, linearized Kalman filter, extended Kalman filter, adaptive system identification, decentralized Kalman filter.

4. An Overview Of Algorithms For Failure Detection, Isolation And Identification

INTRODUCTION (In this part, various algorithms for failure detection and diagnosis are given. The detection and diagnosis of the failures are considered and appropriately classified)

ACTUATOR AND CONTROL SURFACE LEVEL FAILURES by **Hasan Hilmi Cakmak**

FAILURE DETECTION TECHNIQUES SENSOR LEVEL FAILURES by **Murat**

Aydemir

Abstract: In aircraft, control surfaces such as elevators and rudder take important role during taking off, landing and trim motion. When an actuator or a control surface effectiveness failure occurs the dynamics of the aircraft changes. This control surface failure (or actuator failure) has to be detected as fast as possible. In the presentation, some of the actuator and control surface failure detection techniques encountered in the literature are given. Some of them can also be used for sensor failure detection.

5. Algorithms for Reconfiguration of the Flight Control Laws and the Simulation of the Algorithms by Hakan Develi and Dogan Kasa

HAKAN DEVELY:

- 1.Introduction
- 2.An automatic redesign approach for restructurable control systems
 - 2.1. Introduction
 - 2.2. The automatic redesign approach
 - 2.3.Development of the automatic redesign procedure
 - 2.4.Solution of the optimization problem

DODAN KASA:

- 3.Control systems insensitivity to variations in dynamic system parameters
- 4.Reconfiguration based on min-max type criteria
 - 4.1.The min-max principle
 - 4.2.Parameter insensitive, disturbance attenuating redesign

4.3.The simulation of the reconfiguration algorithm

5. Summary of contributions

Afternoon session: 14:00-16:30, May, 15, 2002

6. Introduction to Monitors, Detectors, and Diagnosticians by Zeki Guzen

7. Innovation approach to Fault Detection by Duhan Sonmez

8. Robust Kalman Filters for FDI by Orkun Sarper Geren and Birkan Akbiyik

Abstract (Orkun Sarper Geren): Kalman filters are widely used in navigation measurement operation problems. This filter enables the diagnosis and reduction of the measurement faults and determination of the exact value of the measured parameter. Starting from an arbitrarily chosen initial condition, Kalman filter operates an iteration algorithm that converges to the actual value of the measured parameter step-by-step. This algorithm makes an iteration by finding an extrapolation value for the next state, measuring the parameter at that state, finding the difference of the extrapolation and measured value and reducing the difference by multiplying it with a gain coefficient.

Abstract (Birkan Akbiyik): Robust Kalman filters are used to identify the failures in a system. In this work, a robust Kalman filter robust to measurement failure is designed to determine that the failure is whether in the actuator itself or in the control surface sensor. Here, measurement failure does not affect the robust Kalman filter while actuator failure does. Hence, the part which failed (surface sensor or actuator itself) is determined.

9. Title: Fault Diagnosis Via Artificial Neural Networks by Erkan Karakus

Abstract: This study is a compilation of studies conducted on Fault Diagnosis via Artificial Neural Networks. An overview of the problem is given and then some Neural Observer schemes to detection and isolation of instrument/component faults problem are explained. After obtaining the symptoms from the neural observers a Fault Isolation structure is given in order to identify the faulty behaviour if exists. An experimental study is given with results obtained from a three-tank fault diagnosis system.

10. Fuzzy applications in Fault Diagnosis by Engin Yesil