General Research Interest

Design of Real Time controllers for a wide range of industrial drives, Energy Systems, Electric Glass Melters and aerospace vehicles with focus on Adaptive and Intelligent Control Systems, System Identification, Large Scale Systems, Real Time Computer Control, Microprocessor Relays, Power system planning, Energy Conversion, and Electric Glass Melter modeling.

The Motivation for our current Research Activities In Intelligent Control Systems

Focus:

- Development of Intelligent Control Schemes for Fighter Aero Planes (Ongoing Activity)

- Development of different designs of multiple model adaptive controllers using fuzzy logic switching (Recently Completed Activity) :
  - Multiple Model MRAC System.
  - Multiple Model STR System.
    - Parallel Controller.
    - Controller with Multiple Identification Models.

Acknowledgement:

Graduated: (Ph.D. # 10) Dr. K. Al-Olimat, ECE Dept, Ohio Northern University
"Adaptive Control Systems with Multiple Models and Fuzzy Logic"

Current Group: 2 Ph.D. and 1 MS

PH.D.
- Development of Multiple Models Adaptive Control Algorithms for Jet Engine Control", Tim Wright
- "Next Generation Intelligent Adaptive Control Schemes, S. Kamalasadan, with application to Fighter Aero plane Control

MS:
"Adaptive Control of Fighter Aero planes", Jason Reed.

Specific Subtasks:

- Three different designs of multiple model adaptive controller Schemes are developed:
  - Multiple Model MRAC System.
  - Multiple Model STR System.

- Parallel Controller.
- Controller with Multiple Identification Models.

Why "Adaptive" Control ?

Fixed Parameter Controllers May Not Be Adequate to maintain System Performance Due To:

- Modeling Uncertainties and/or Inaccuracies
- Practical systems operate in changing environment:
  - Changes in operating points…… (Systems are Mostly Nonlinear)
  - System Reconfigurations
  - Disturbances
  - Changes in Command Signals or Trajectories

Typical Stationary Digital Controller System

Adaptive Control systems:

- Monitor System Input/Output Performance And changing environment
- Provide CONTROLLER that "Adapts" to System changes
- Satisfactory Performance is Maintained

The Two "Conventional" Adaptive Schemes: The **MRAC** and the **STR** have Structural Provisions for Such "Adaptation"

However, a Potentially Serious Problem (Model Choice) with both MRAC and STR Exists:

- The Model Choice problem in the MRAC
  A Reference model is specified by the designer to be used as performance specification
- The Model Choice problem in the STR
  A model is specified by the designer to be used in the Identification task

Limitations of Conventional Adaptive Systems In Terms of "Model Choice"

- In the MRAC
  - Single reference model may not have acceptable dynamic performance over the entire range of system operation.

- In the STR
  - Single identification model may not represent the plant properly over the entire range of system operation.

Therefore: Incorporation of more "Intelligence" into the Control Scheme is required in order to:

Substitute for the Designer's "Model Choice" On Line Incorporated in :

- Supervisory Loops
- Self Organizing Loops

Using:

- Expert Systems Techniques
- Neural Network Techniques
- Fuzzy System Techniques

The " M R M Concept " Solution

- Multiple Reference Model Choices will provide An Acceptable model for each environment
- Provided that A Proper Model Switching Strategy is implemented
- Design a corresponding controller

Current State of Development

3 effective Schemes of MM Adaptive Controllers with fuzzy logic switching have been developed and investigated:

- Multiple Model MRAC System.
- Multiple Model STR System.
  - Scheme I: Parallel Controller.
  - Scheme II: Controller with Multiple Identification Models.

Applications

- Robotics Manipulators
- AC Drives
- Power Generating Unit Stabilization
- Aircraft Control
- Jet Engine Control
- Fuel Ratio Control for Spark Ignition Engine
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