WOMEN IN CONTROL II

IEEE Control Seminar Day
G12, Hicks Building, The University of Sheffield
Wednesday 9th November 2005

1100
Resonantly damped coronal loop oscillations
Maria Dymova (University of Sheffield)

1130
Exponential Stability of Dynamic Systems on Time Scales
Ewa Piotrowska (The University of Sheffield)

1200

Some novel applications of sliding mode controller and observer theory
Professor Sarah Spurgeon (University of Leicester)

1240 **LUNCH**

1400
Some Results on the Fault Detection of Mass-Spring-Damper System
Tabassom Sedighi (Coventry University)

1430
Nonlinear discrete-time models: state-space vs.I/O representations
Ulle Kotta

1515
Stabilisation of nonlinear systems using associated angular representations
Zahra Sangelaji (The University of Sheffield)

1545
Control of a Transmission Line Inspection Robot Based on Expert System Design Methods
Jihong Wang and Jessie Ke (University of Liverpool)

Please contact Professor Alan Zinober (a.zinober@shef.ac.uk) if you wish to join the speakers for a two course lunch at a nearby pizza restaurant at a cost of £7.50.

Resonantly damped coronal loop oscillations

Maria Dymova (University of Sheffield)

Soon after coronal loop oscillations were observed by TRACE spacecraft for the first time in 1999, various theoretical models have been put forward to explain the rapid damping of the oscillations of these intriguing objects. In our study we interpret coronal loop oscillations as fast kink modes of a straight cylindrical magnetic flux tube with immovable edges modelling dense photospheric plasma at the ends of the loop. To simplify the problem we use the cold plasma approximation and consider the tube to be thin. In its equilibrium state the tube is permeated by a homogeneous magnetic field directed along the tube. We include an effect of stratification in our model supposing that plasma density varies along the tube. There is also density inhomogeneity in the radial direction confined to a layer with thickness much smaller than the radius of the tube. Considering the system of linearized ideal MHD equations we study the dependence of the spectrum of tube oscillations and its damping due to resonant absorption on the parameters of the unperturbed state.

Exponential Stability of Dynamic Systems on Time Scales

Ewa Piotrowska (The University of Sheffield)

The problem of exponential stability of linear dynamics systems is studied. The theory of time scales allows to unify the seemingly disparate fields of discrete and continuous dynamical systems. Many results concerning differential equations carry over quite easily to corresponding results for difference equations, while other results seem to be completely different in nature from their continuous couterparts.The study of dynamic equations on time scales reveals such discrepancies, and helps avoid proving results twice, once for differential equations and once for difference equations. Control systems on time scales include continuous-time and discrete-time systems. The concept of stability is extremely important, because almost every workable system is designed to be stable. If a system is not stable it is practically of no use. The basic idea of a stable system is that the response should decay to zero when the input is removed and that a bounded input should produce a bounded output response. The stability characteristics of an autonomous linear system of differential or difference equations can be characterized completely by the placement of the eigenvalues of the system matrix. The sufficient condition is that the eigenvalues of the system matrix should be contained in the set of exponential stability, which may change for each time scale on which the system is studied. In general, the placement of eigenvalues of the system does not guarantee the stability of any time varying systems. Generalization of the Lyapunov criteria for uniform exponential stability of discrete and continuous linear systems results in the sufficient condition for uniform exponential stability for regressive time varying linear dynamic systems.

Some novel applications of sliding mode controller and observer theory

Professor Sarah Spurgeon (University of Leicester)

Sliding mode control systems are characterised by a discontinuous injection signal that seeks to render particular surfaces in the state space attractive. The dynamic performance when in the so called sliding mode is characterised by the choice of discontinuity surface and the control is designed to ensure the state of the system is constrained to the surface in finite time, which in turn ensures robust performance. In terms of the application of sliding mode theory to the observer situation, the discontinuous injection is used to enforce a zero error, or sliding mode, on the difference between the plant and observer output. Analysis of the applied injection signal can be used in both the observer and controller situations to infer information about the system of interest. This talk will show how the methods can be used to monitor system parameters, and hence perform condition monitoring, in high speeed rotating machinery and also to construct internal signals within the human neuromusculoskeletal control system.

Some Results on the Fault Detection of Mass-Spring-Damper System

Tabassom Sedighi (Coventry University)

In this talk, we present a model for a general mass-spring-damper system (as an example). We then control this system and some results on the fault detection of this system is given. To aid the establishment of equilibrium points and the design of controllers, observers and residual of fault detection, a set of non-linear differential equations, several transformations and smooth approximate input-output maps will be simply presented. We will also introduce detailed conditions to analysis residual effectiveness by the methods such as selection of operating points, control inputs, sensor faults,, component faults, fault positions and observer eigenvalues. We will derive and compare the defined fault positions, the observer-based residual performance for the system above for the different number of mass (n = 2, 3, 4, 5, 6). We conclude that the effectiveness of observer-based residual changes as n (number of mass) varies, and system complexity increases. The methodology, the transformations and mappings used for this system are applicable to the systems with the similar non-linear structures.

Nonlinear discrete-time models: state-space vs. I/O representations

Ü. Kotta

The presentation compares state-space and input/output representations for nonlinear discrete-time systems. For linear models, these two representations are essentially equivalent and their structures are closely related, but these statements do not hold for nonlinear models. we illustrate this point with simple, realistic examples for which only one of the two representations exists or for which both exist but their structures are profoundly different. Overall, the main point of this talk is the importance of the choice of representation in the development of nonlinear dynamic models.

Stabilisation of nonlinear systems using associated angular representations

Zahra Sangelaji (The University of Sheffield)

The stabilisation of a general class of nonlinear systems is studied by using the angular form of a differential equation to reduce the problem to the control of the radial component of the state. In this method, the system is converted into two subsystems. One is a nonlinear equation on a sphere and the other is a radial differential equation. In various cases, a simple stabilising control law can be written based on the one-dimensional radial system dynamics. This control is able to stabilise the original system by driving the radial state to the origin. Therefore, the stabilisation problem of the nonlinear system can be considered as a one-dimensional stabilisation problem.

Control of a Transmission Line Inspection Robot Based on Expert System Design Methods

Jihong Wang and Jessie Ke (University of Liverpool)

A power transmission line inspection robot is developed through the project. An expert system design method is adopted for controlling the robot to crawling along the transmission line and crossing the obstacles encountered. The expert system is organised into three layers and an algorithm is proposed to coordinate the operations between distributed expert systems, in which the principle of the goodness to fit to the rules and facts is employed for the decision making and reasoning mechanism. To implement the control strategy, a combination of computer languages including C, VC++ and CLIPS are adopted that provide a convenient and effective software platform. On-line experiment results show that the control strategy can guide the inspection robot to patrol along the transmission lines and cross various typical obstacles efficiently. At the locations of corners and bends of a transmission line, the obstacles are more complicated to negotiate, so two sub-expert systems work together and guide the robot passing through those locations smoothly at the relatively lower speed.