The Center for Control, Dynamical Systems, and Computation
Spring Seminars
Presents

Plasma Control in Tokamak Machine

by

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Abstract:

Tokamaks are the most promising devices to obtain nuclear fusion energy from a high temperature, ionized gas (plasma). The main advantages are that fuel sources are essentially inexhaustible, the fusion process is inherently safe, and no harmful greenhouse gases are produced.
In a tokamak, the plasma, having the rough form of a torus, is magnetically confined through electromagnetic fields generated by a set of ''poloidal field'' coils distributed around the vacuum vessel. Voltages are applied to these coils which drive coil currents inducing the magnetic fields. This field interacts with the plasma to change its shape and position and to induce plasma current.
The uncertainty of the mathematical model of the plasma dynamics, which is correctly described by a set of non-linear partial differential equations, the vertical position instability typical of the most common plasmas, and the occurrence of unpredictable disturbances during the ''plasma shots'', make the use of a feedback control action mandatory. Moreover, the high number of input coil voltages and controlled outputs (typically the plasma current and some position and shape geometrical parameters), the strong coupling between the various input-output channels, and the demanding control requirements, make the feedback control problem difficult and challenging.
In the recent years a large amount of work has been devoted to obtain better plasma control performance using advanced control methodology. This research has been predominantly of methodological type, although some of the emerging new concepts have been successfully experimented.Presently in all large devices (such as JET and DIII-D tokamaks) there are programs aimed at implementing new shape controllers based on the concept developed in the previous years.
The aim of this seminar is, on one hand, to report results obtained in recent years, and, on the other hand, to outline some open problems which appear to be promising line of research for the control community.

About the Speaker:

Alfredo Pironti received the Laurea degree cum Laude in electronic engineering, and the PhD in electronic and computing engineering from the University of Naples Federico II in 1991 and 1995, respectively. Since 1991 he has been with the Dipartimento di Informatica e Sistemistica at the University of Naples, where he is currently an associate professor of system theory. He has been a visiting researcher at the Max Planck Institute for Plasma Physics in Garching (Germany), the Center for Control Engineering and Computation (University of California at Santa Barbara), and at the ITER Joint Work Site of Naka (Japan). His research interests include robust control of uncertain systems and the application of feedback control to nuclear fusion problems.