

2006 American Control Conference
Minneapolis, Minnesota, June 2006

Workshop ***

REAL TIME OPTIMIZATION BY EXTREMUM SEEKING CONTROL

8:00-17:00, Tuesday, June 13

Organizers:

Miroslav Krstic, University of California, San Diego

Kartik Ariyur, Honeywell Aerospace Electronic Systems

Andrzej Banaszuk, United Technologies Research Center

Mario Rotea, Purdue University

Eugenio Schuster, Lehigh University

Proposal

Extremum seeking control, a popular tool in control applications in the 1940-50's, has seen a resurgence in popularity as a *real time optimization* tool in aerospace and automotive engineering. This workshop will present the theoretical foundations and selected applications of extremum seeking.

In addition to being an optimization method, extremum seeking is a method of adaptive control, usable both for tuning set points in regulation/optimization problems and for tuning parameters of control laws. It is a *non-model based* method of adaptive control, and, as such, it solves, in a rigorous and practical way, some of the same problems as neural network and other intelligent control techniques.

The first half of the workshop will teach the attendees the extremum seeking algorithms, the basics of their stability analysis, the design guidelines. Both single-parameter and multivariable problems will be covered, as well as both the continuous and discrete time implementations. A novel "slope seeking" extension applicable to some unstable plants will be introduced. An application of extremum seeking to minimizing limit cycles caused by actuator limitation will be presented.

In the second half of the workshop, applications to aerospace and propulsion problems (formation flight, combustion instabilities, flow control, compressor rotating stall), automotive problems (anti-lock braking, engine mapping), bioreactors, and charged particle accelerators will be presented.

Presented by researchers who spearheaded the revival of extremum seeking, the workshop will be one well integrated mini-course, designed as such by organizers who have been working jointly on these problems since 1996, rather than patched up from distinct pieces of research by an ad hoc team.

The workshop will be of interest to a broad audience of ACC attendees interested in nonlinear and adaptive control (from IEEE CSS), in optimization (from SIAM and INFORMS), as well as to industrial control engineers working on applications in electrical, mechanical (ASME), aerospace (AIAA), chemical (AIChE), and biomedical engineering.

Schedule

8:00-9:00	History of extremum seeking, introductory algorithm for a static map, elements of stability analysis (Krstic)
9:00-9:50	ES in the presence of plant dynamics, ES compensators for performance improvement, ES with internal model principle for tracking parameter changes (Ariyur)
9:50-10:20	COFFEE
10:20-11:10	Multiparameter ES and slope seeking (Ariyur)
11:20-12:00	Limit cycle minimization via ES, discrete time ES (Krstic and Ariyur)
12:00-13:30	LUNCH
13:30-13:45	Application to anti-lock braking (Ariyur)
13:45-14:05	Control of combustion instabilities (Banaszuk)
14:05-14:35	Control of flow separation in diffusers (Banaszuk)
14:35-15:00	Formation flight optimization via ES (Ariyur)
15:00-15:30	COFFEE
15:30-16:00	Compressor rotating stall control (Krstic and Ariyur)
16:00-16:30	Automotive engine mapping (Banaszuk or Krstic)
16:30-16:45	Bioreactor optimization (Krstic and Ariyur)
16:45-17:00	Beam matching in particle accelerators (Schuster)