Control of Nonlinear Physical Systems
2015 American Control Conference Workshop
In Celebration of the 60th Birthday of Anthony M. Bloch
June 30, 2015

Schedule, Titles, and Abstracts of Lectures

8:20–8:35 Welcome and Opening Remarks

8:35–9:15 Topological Aspects of Optimal Fusion of Multispectral Sensor Data
John Baillieul
The talk will describe techniques for simultaneously exploring image segments concentrated in
different parts of the optical spectrum (IR, visible spectrum, UV, etc.). The problem to be addressed is
that of representing multispectral sensory information in a way is optimally aligned with human perceptual abilities.

9:20–10:00 Control of Quantum Systems
Roger Brockett
Spin systems, and their optimization through effective design of interrogatory RF pulses play a
significant role in modern studies of quantum systems. The geometry and optimal control of
nonholonomic systems provide essential foundations in this area.

10:05–10:35 Coffee Break

10:35–11:15 Bipedal Locomotion on Small Feet
Jessy Grizzle
Differential geometry in combination with numerical optimization is proving to be a powerful tool for
designing gaits for bipedal robots that do not rely on flat-footed walking. We discuss recent progress
with our bipedal robot MARLO.

11:20–12:00 Global Nonlinear Control for Multi-Body Dynamics
Harris McClamroch
The talk will address the key role of geometry in global models, both analytical and numerical, of
control of multi-body systems. The results will be illustrated with examples of nonlinear control
problems that arise in robotics and spacecraft control.

12:05–13:35 Lunch Break

13:35–14:15 Hamiltonian Structures and Variational Principles
Tudor Ratiu
Recent work on higher order variational principles has proved to be useful in application areas such as
image processing, and in understanding the physics of materials (fluids, liquid crystals, ferromagnets
etc.) with internal degrees of freedom. This talk will discuss the underlying mathematical principles
and connections to control theory.

14:20–15:00 Paralleloimeters: Mechanical Devices that Measure Curvature
Alberto Rojo
I will discuss mechanical devices that measure parallel transport and curvatures, in particular, the
“paralleloimeter” and the “torsiometer”, different from devices previously presented in the literature.
The torsiometer measures the torsion of a curve, in the same way as does the rotation of the
polarization axis for light traveling on a coiled optical fiber. The paralleloimeter provides an analogy to
the gravity probe B measurement. Finally I will discuss the non-holonomy of a rolling sphere and its
connection to spin $\frac{1}{2}$ and the Landau–Zener formula.
15:05–15:35 Coffee Break

15:35–16:15 Topologically Protected Edge States in Continuous Honeycomb Structures
Michael Weinstein

Edge states are a type of energy-localization along a line-defect, the interface between different media. Topologically protected edge states are a class of edge states which are stable to strong local distortions of the edge. They are therefore potential vehicles for robust energy-transfer in the presence of imperfections. In this talk I will explain their occurrence in two-dimensional honeycomb structures, such as graphene.

16:20–17:00 Energy Shaping and Variational Integrators
Dmitry Zenkov

Long-term simulation algorithms and computation with physical models should preserve essential structures in the models, such as conservation laws, dissipation inequalities, etc. Feedback control laws, and in particular, digital feedback stabilizers, that are compatible with underlying Lagrangian and Hamiltonian structures, will be considered.

17:05–17:45 Dynamics of Collective Decision Making
Naomi Leonard

I will discuss a realization theory for bio-inspired collective decision-making using the singularity theory approach to bifurcations. The theory is used to study mechanisms that explain the remarkable decision-making of animal groups and to leverage these mechanisms in distributed feedback control design for autonomous decision-making networks.

17:50–18:00 Discussions and Felicitations