<p style="text-align:center">2014 ACC Invited Session Proposal</p>

Session Title: Controls Education

Sponsoring Committee: IEEE Control Systems Society Technical Committee on Education
    Chair: Ljubo Vlacic; Deputy Chairs: Bonnie Ferri and Bozzena Pasik-Duncan

Session Organizer: Bonnie Ferri, Deputy Chair of the CSS TC on Education

Session Overview:

The CSS Technical Committee on Education plans to organize sessions for future ACCs on the topic of controls education. There are normally very few controls education papers at the ACC, but the topic is of great interest to the attendees. This committee organized a series of sessions like this 10-15 years ago, and the attendance at the sessions was typically 50-60 people. We intend to build interest in such a series of invited sessions by giving out Call for Paper flyers during the ACC Controls Education Invited Session inviting people to submit controls education papers to the 2015 IEEE Conference on Decision and Control and to the 2015 ACC in order to raise awareness of this session and increase submissions.

The papers included in the 2014 ACC Invited Session on Controls Education show cutting edge pedagogies applied to courses in systems and controls. The pedagogies include experiential education and problem-based learning. Some of these papers arose out of work performed for NSF grants on engineering education. Five of the papers exploit experiential learning, where hands-on activities allow students to experience a new perspective on the topic being taught. The sixth paper shows how a standard senior-level controls course can be taught using a problem-based learning approach.

The first three papers address learning enhancement through the addition of hands-on experiences in lecture-based courses. The third paper further addresses the use of a MOOC platform to flip the course in order to facilitate the in-class hands-on activities. The fourth paper has similar goals as the first three papers: it offers the potential to teach controls in a more wide-spread and distributed manner using a low-cost experimental platform. The fifth paper is a lab course that combines embedded computing and controls systems, topics normally taught in two distinct courses and shows how they can be combined to be taught together. The final paper of the session employs a Problem-Based Learning pedagogy to teach a dynamics and controls course.

Paper 1 Title: "Simple Guitar String System for Teaching Fundamental Concepts in a Variety of ECE and ME Courses"

Authors: Al Ferri and Bonnie Ferri

Brief Abstract: This paper presents an inexpensive, mobile experimental platform suitable for courses in circuits and electronics, signals and systems, dynamical systems, acoustics, and vibrations. While being a simple platform, the list of fundamental concepts that can be explored with the platform is very rich, including the relationship between time domain and frequency domain signal characteristics, harmonic content of signals, impulse response, initial condition response, transfer functions, frequency response, resonance, low damping, controllability, observability, filtering, and modes of vibration in strings.

Paper 2 Title: "Integration of Theory and Ubiquitous Experiments in a Signals and Systems Course"

Authors: Aaron Lanterman, Michael Giardino, Jennifer Michaels, Bonnie Ferri, William Hunt, Al Ferri

This paper explores the inclusion of low cost experiments into a lecture-based introductory Systems and Systems course. The experiments are ubiquitous in space and in a curricular sense. Most of the experiments can be completed in a regular lecture room during a lecture period by students working at their desks, and one is completed in any large room by students using only their computers. The experiments are also embedded into a traditionally very theoretical course, thereby giving students an integration of theory and experiments without the use of high cost, centralized laboratory facilities.

Paper 3 Title: "Flipping a Controls Classroom Around a MOOC"

Author: Jean-Pierre de la Croix and Magnus Egerstedt

Abstract: Bridging the theory-practice gap in controls education is a well-known challenge. In this talk, I will discuss how one can approach this divide using a flipped classroom. Based on my recent MOOC (Massive Open Online Course), Control of Mobile Robots, I have flipped the classroom in a senior robotics and controls class at the Georgia Institute of Technology. The students take the MOOC and come to class prepared to program robots. Key to this is not only that the theoretical content is being delivered via the MOOC, but also a hardware/software platform that provides a learning environment where exploratory, practical tinkering is grounded in solid theory. The paper also discusses why the flipped classroom format is ideal for engineering courses in general, as well as report on my flipped classroom findings.

Paper 4 Title: "A Low Cost Experiment to Test Control and Decision Making Strategies."

Authors: Julián Barreiro-Gómez and Nicanor Quijano.

Abstract: Currently, there are few experiments capable of illustrating new control and decision making strategies. Some of the experiments that we might find are extremely expensive, and they cannot be acquired by third-world countries. In order to overcome these issues, we have developed a balls-in-tubes experiment, which is a low-cost platform for research and educational purposes. In this paper, first, we show how the plant has been designed based on a co-simulation idea, in order to determine the main characteristics of the system (e.g., dimensions, materials, actuator, power supply, etc). Then, in order to illustrate the usefulness of the process, we have done several experiments to show how system identification and other control and decision-making techniques (i.e., classical PD, optimal control, fuzzy logic, and population dynamics) can be implemented and analyzed.

Paper 5 Title: "Teaching Feedback Control and Embedded Design in a Single Course with Lab Projects"

Authors: David G. Taylor and Daniel D. Murdock

Abstract: This paper describes an undergraduate course that has been developed to enable the teaching of feedback control theory and embedded microcontroller implementation in combination, using lab projects to convey the material through exposure to power electronics, electric machines and motion control applications. By incorporating this wide range of topics into a single course, students are better able to grasp connections between concepts more typically taught in separate courses by separate instructors, and they acquire a more comprehensive perspective on the practice of control engineering.

Paper 6 Title: "Applying Problem-Based Learning to Instruction of System Dynamics and Controls"

Authors: Nuno Filipe and Amy Pritchett

Abstract: Problem-Based Learning is a style of active learning where the students learn about a subject through solving authentic, difficult problems in teams. This paper describes the implementation of Problem-Based Learning to the teaching of system dynamics and controls to a third-year undergraduate class of aerospace engineering at the Georgia Institute of Technology. The pros and cons of Problem-Based Learning applied to the teaching of controls are analyzed. The course design and implementation are described. The grade results and student opinions are examined. The paper concludes with a discussion of lessons learned and recommendations for the application of problem-based learning.

Session Organizer Background:

Dr. Ferri is the Associate Chair for Undergraduate Affairs at Georgia Tech, which is one of the largest producers of engineering graduates in the United States. She has won numerous campus-wide teaching awards for her outstanding teaching and for her innovation in the classroom. She is a recipient of the IEEE Harriet B. Rigas Award from the IEEE Education Society. She is a past Chair of the IEEE CSS Technical Committee on Education and was the Program Chair for the 1998 ACC. She currently serves as the Deputy Chair for Invited Sessions for the IEEE CSS Technical Committee on Education.