25th Mediterranean Conference

on

Control and Automation (MED)

BOOK OF ABSTRACTS

July 3 – 6, 2017

University of Malta, Valletta Campus

Malta

University of Malta

WEBT2	Meeting Room 2
Adaptive Control (Regular Session)	
Chair: Lemos, Joao M.	INESC-ID
Co-Chair: Ilioudis, Vasilios	Aristotle Univ. of Thessaloniki

13:30-13:50 WEBT2.1

Adaptive State Feedback Stabilization of N + 1 Coupled Linear Hyperbolic PDEs

Anfinsen, Henrik (NTNU), Aamo, Ole Morten (NTNU)

We design an adaptive control law for a set of n + 1 linear partial differential equations (PDEs) of the hyperbolic type. The control law is based on swapping design, where filters are used to express the system states as linear, static combinations of the filters and the unknown parameters, facilitating for estimating the parameters using any standard adaptive law. The estimates generated by the adaptive law combined with the filters can then be used to generate estimates of system states for which an adaptive controller is designed. Boundedness and square integrability in L_2 for all signals in the closed loop is proved, and the theory is demonstrated in a simulation.

13:50-14:10 WEBT2.2

Robust Adaptive Controller for Linear Plants with Variable Step Quantizer

Margun, Alexey (ITMO Univ), Furtat, Igor (Russian Acad. of Sciences), Bazylev, Dmitry (ITMO Univ)

The paper is extension of previous authors results and aimed to the adaptive control of uncertain linear plants under conditions of only quantized output measurement and bounded external disturbances. Quantizer with dynamical changing step is considered. Control law synthesis is based on consecutive compensator method. Kharitonov polynomials based tuning algorithm for controller parameters and quantization step is designed. Proposed control system provides convergence of quantizer output to the reference signal with prespecified accuracy.

14:10-14:30 WEBT2.3

Automatically Fine-Tuned Speed Control System for Fuel and Travel-Time Efficiency: A Microscopic Simulation Case Study

Michailidis, Iakovos (Center for Res. and Tech. Hellas), Michailidis, Panagiotis (Centre for Res. and Tech. Hellas), Rizos, Athanasios (Consiglio Nazionale Delle Ricerche), Korkas, Christos (Democritus Univ. of Thrace), Kosmatopoulos, Elias (Democritus Univ. of Thrace and CERTH, Greece)

Within the current document a model independent, cognitive and adaptive optimization mechanism, namely CAO, is adopted for providing efficient speed/torque control actions. However since real-life tests were not feasible, a simulation model of a 1.4lt displacement gasoline car, playing the role of the actual car, was adopted while the potential maximum cruising speed levels are chosen so as to emulate a usual suburban route and the vehicle speed control is replicated by a common PID scheme. The control decisions are applied directly to the car throttle/torque pedal itself. The goal of the optimization application was to minimize the vehicle velocity error, while minimizing the total fuel consumption for a certain 10km trip with varying road angles/slopes. It should be noted that CAO module could be applied directly to a car system in a straightforward manner without any preparatory investigations. Initially PID gain values were selected arbitrary while a PID gain – tuning module from Matlab/Simulink was used in order to fine-tune them under certain road conditions. Finally the tuned values were used as initial ones for all CAO's application cases (A, B, C and D). CAO presented substantial improvements in the specified performance index, with respect to the base case speed strategy, as well as to the PID tuning in all simulation scenarios considered.

14:30-14:50 WEBT2.4

A Model Based Sliding Mode Observer Applied in PMSM Sensorless Control for Speed and Position

Ilioudis, Vasilios (Aristotle Univ. of Thessaloniki)

This paper presents a novel algorithm for speed and position estimation of Permanent Magnet Synchronous Machine (PMSM). The developed sensorless control scheme is based on a simple implementation of sliding mode observer (SMO) employing the modified PMSM mathematical model. All PMSM variables are expressed in an arbitrary rotating frame. Initially the modified rotor flux is calculated through measuring the stator voltages and currents. Then the required rotor speed and angle are estimated via a connected in series SMO using the modified rotor flux as input. Simulation results demonstrate and the effectiveness of the proposed sensorless method and the convergence performance of rotor speed/angle observer.

14:50-15:10 WEBT2.5

Recursive Sparse Identification for Adaptive Control

Bras, Rui (INESC-ID), Lemos, Joao M. (INESC-ID)

Motivated by applications in adaptive control, this article compares two recursive estimation algorithms for sparse estimation of linear dynamical (ARX) models. In most practical situations an accurate mathematical model estimation of a real system using the least number of parameters is highly desirable. The expectation of sparsity is imposed through minimization of an objective function that includes a quadratic error term combined with a sparsity-inducing regularization term. The Least Absolute Shrinkage and Selection Operator (LASSO) is a well-known example of this approach. The increasing complexity and memory requirements of LASSO inspire the development of recursive algorithms that use the l1-norm and the l1-weighted norm. The two algorithms considered consist of a modification of recursive LASSO by the addition of a l1-weighted regularization term. In one case subgradient minimizers are used, while the proximal gradient is used in the other. Simulation results show that the use of the proximal gradient is advantageous.

15:10-15:30 WEBT2.6

Simple Adaptive Control of Quadrotor Attitude. Algorithms and Experimental Results

Tomashevich, Stanislav (IPME RAS, ITMO Univ), Fradkov, Alexander L. (Acad. of Sciences of Russia), Andrievsky, Boris R. (Inst. for Problems of Mechanical Engin), Belyavskyi, Andrew (ITMO Univ), Amelin, Konstantin (SPBSU)

In the paper the simple adaptive control approach is employed to designing the adaptive controllers of quadrotor angular motion. The adaptive controllers are synthesized based on the Implicit Reference Model (IRM) design technique. The “shunting method” (parallel feedforward compensation) is used to cope with the unmodelled plant dynamics. Analytical justification of system stability is made by employing the Passification method. Quality of the closed-loop IRM adaptive control system is studied and compared with that of the proportional-derivative (PD) non-adaptive control system experimentally on two degrees of freedom (2DOF) quadrotor testbed and in-flight tests of the QuadRoy quadrotor for nominal and parametrically perturbed cases. Advantage of the simple adaptive control for the cases of the plant model parametric uncertainty and the external disturbances is demonstrated.

WEBT3	Meeting Room 3
Robotics and Control Engineering Education (Invited Session)	
Chair: Gonçalves, José A.	IPB
Co-Chair: Moura Oliveira, Paulo	Univ. De Tras Os Montes E Alto Douro
Organizer: Gonçalves, José A.	IPB
Organizer: Moura Oliveira, Paulo	Univ. De Tras Os Montes E Alto Douro
Organizer: Soares, Filomena	Univ. of Minho

13:30-13:50 WEBT3.1

Application of 2DOF Quadrotor-Based Laboratory Testbed for Engineering Education (I)

Belyavskyi, Andrew (ITMO Univ), Tomashevich, Stanislav

(IPME RAS, ITMO Univ), Andrievsky, Boris R. (Inst. for Problems of Mechanical Engin)

The paper is devoted to application of the novel 2DOF Quadrotor-based Laboratory Testbed for engineering education in the such the disciplines as Automatic Control, Adaptation and Identification, Real-time Control Systems, Data and Signal Processing, Telecommunications, Information Theory, Flight Dynamics, high- and low-level Programming Languages. The testbed is based on a quadrotor, mounted in the gimbals. Testbed is aimed for debugging and pre-flight testing the quadrotor control algorithms, for scientific research and education. In the paper, construction of the Testbed is briefly described and the experience of its usage for engineering education in the ITMO University is outlined.

13:50-14:10 WEBT3.2

Differential Mobile Robot Controller Study: A Low Cost Experiment Based on a Small Arduino Based Prototype (I)

Gonçalves, José A. (IPB), Costa, Paulo (Univ. of Porto)

In this paper it is presented a low cost experiment based on a small Arduino based prototype. The chosen educational challenge is a classical introductory experiment, that consists in following a line with a mobile robot. The presented experiment has as goal to introduce students to mobile robotics, having as base a challenge and a kinematics that are commonly applied in Junior competitions. A group of students participated in a workshop that consisted, initially, in a lecture where tutors explained the differential robot kinematics and how to develop a controller for the proposed challenge. Then the students, after the theoretical introduction, implemented the proposed robot controller.

14:10-14:30 WEBT3.3

An Experience of Implementing Robotics Education in Secondary and High Schools (I)

Filippov, Sergey (Presidential Lyceum of Physics and Mathematics), Fradkov, Alexander L. (Acad. of Sciences of Russia), Ten, Natalia (ITMO Univ), Nikitin, Denis (Saint Petersburg State Univ)

Robotics and control theory education at schools has shown to be an effective start for children to become a successful engineer. It is a complex task to make the education complex and to build a system that will help hundreds of schoolchildren succeed. It includes many steps. First, it is important to find ways to explain robotic principles and to teach children how to use control theory in a simple way. Second, to provide high quality techniques for both students and teachers. Third, to organize activities to fill robotic life with events that will face children with new challenges. Fourth, to help children continue their way in universities and get good jobs. And last but not least is to make the whole system work nonstop, be effective and provide good results. The Robotics Center described below is an example of a place, where such steps were made. The paper is about an unique experience of making such a complex robotic education system for children of middle and high schools, its description and results. Courses of the leading robotic education branches (UAV, computer vision and navigation) are described. Robotic activities are shown: competitions, robotic games and robotic camps are described. The paper shows the outcomes of the robotic education and its influence on student lives.

14:30-14:50 WEBT3.4

Classroom Partial Flip for Feedback Control Systems: A Biomedical Engineering Experience (I)

Moura Oliveira, Paulo (Univ. De Tras Os Montes E Alto Douro), Cunha, José Boaventura (Univ. De Trás-Os-Montes E Alto Douro)

New times demand new teaching and learning methodologies. A partial flipped classroom methodology was tested in a modelling and feedback control course for undergraduate biomedical engineering. A semester course was divided in two parts: the first half using a flipped approach and the second one using a classical approach. The experience results are reported, presenting the methodology ups and downs. The use of videos as student's primer study supporting element to prepare classes in advance was explored. Using part of the class time to perform quiz group activities proved to be a major enabler to actively involve students in the learning process. The results achieved in the flipped part strongly confirm a much higher engagement and participation level from students in theoretical classes. Moreover, the flipping approach promotes students to continuously study along the semester.

14:50-15:10 WEBT3.5

Teaching/Learning PBL Activity: Gantry Crane Control System Implementation (I)

Correia, Ana (Univ. of Minho), Amaro, Bruno (Univ. of Minho), Junior, Emanuel (Univ. of Minho), Barbosa, Joao (Univ. of Minho), Pinto, Tiago (Univ. of Minho), Bicho, Estela (Univ. of Minho), Soares, Filomena (Univ. of Minho), Moura Oliveira, Paulo (Univ. De Tras Os Montes E Alto Douro)

This paper presents a teaching/learning experiment running in the laboratorial curricular unit Project I of the 4th year of the Integrated Master in Industrial Electronics and Computers Engineering at the University of Minho. Project specifications were defined by the three teachers involved in the experience and students were encouraged to look on different solutions for a real-word problem. In a concurrent way, students designed, developed and implemented didactic rigs to control a gantry crane system. The control was performed in open-loop, based on the Posicast feedforward technique, and in closed-loop, using a two-degrees of freedom configuration. The experiment procedure and the project outcomes of two solutions proposed by the students are presented.

15:10-15:30 WEBT3.6

Software Tool for MoReRT Design of 2DoF PI/PID Controllers (I)

Vilanova, Ramon (Univ. Autonoma De Barcelona), Alfaro, Victor M. (Univ. of Costa Rica), Visioli, Antonio (Univ. of Brescia)

The goal of this paper is to present a software tool intended to aid at the design of 2DoF PI/PID controllers by using the MoReRT approach. This tool is suitable for those who need to design the PID controller for the simple closedloop feedback in an effective and user-friendly way. The tool has been implemented in MATLAB^R /SIMULINK^R and has been designed on the basis of a simple but effective menu/dialog interaction system. That users may benefit from the simple utilization without the need of complex software optimization requirements. The features of this tool determine its usability especially for educational purposes. The software includes system analysis and robustness features, design of 2DoF PI and PID controllers, closed loop simulations and evaluation of control quality. As a tool for education, it also provides appropriate theoretical background to specific control design tasks, therefore the user is able to understand all performed tasks without an exhaustive effort.

WEBT4 Meeting Room 4

Networked Systems (Regular Session)

Chair: Manesis, Stamatis Univ. of Patras

Co-Chair: Stankovic, Srdjan Univ. of Belgrade, Serbia

13:30-13:50 WEBT4.1

Multi Operating Mode for Energy Adaptability in Wireless Sensor Network

AYADI, Hayfa (ENIG), Zouinkhi, Ahmed (National School of Engineering of Gabes), Val, Thierry (Univ. De Toulouse CNRS IRIT UMR 5505), Boussaid, Boumedyen (National School of Enginering of Gabes), Abdelkrim, Mohamed Naceur (ENIG)

Wireless communication presents the most attractive sign of development in this decades. It contributes to the appearance of Wireless Sensor Network (WSN) which is invented in order to increase the supervision capacity for such phenomenon. It gets more regard from both the customers and the research society. (WSNs) is composed from numerous wireless sensor nodes which suffer from a very serious energy constraint. For this raison we are interested to the standard of IEEE 802.15.4 with beacon enabled mode. This work suggests a multi mode approach to the technology of IEEE 802.15.4 as a new technique to extend the