15th APCA International Conference on Automatic Control and Soft Computing

CONTROLO 2022 CAPARICA-PT

Program Overview

Day	Time	Room A: UNINOVA Auditorium	Room B: CENIMAT Auditorium
Wednesday, 6th July	8:30 – 9:00	Badge collection and on-site registration	
	9:00 – 9:20	**Opening Ceremony**	
	9:20 – 10:20	**Keynote 1:** Advances in Motion Control of Aerial Vehicles, Rita Cunha, IST / Universidade de Lisboa, Portugal	
	10:20 – 10:40	Coffee break	
	10:40 – 12:20	**WeA1:** Planning for autonomous vehicles	**WeB1.SS:** Control applications in robotics I
	12:20 – 14:00	Lunch	
	14:00 – 15:40	**Panel 1:** Interaction between industry and academia	
	15:40 – 16:00	Coffee break	
	16:00 – 17:40	**WeA2:** Automation and industry applications	**WeB2:** Nonlinear control
	19:00 – 20:00	**Welcome Reception:** Frigate “Dom Fernando II e Glória” (Bus at 18:00 from conference site)	
Thursday, 7th July	9:00 – 10:40	**ThA1:** Softcomputing, fuzzy control and digital twins	**ThB1:** Control applications in medical sciences
	10:40 – 11:10	Coffee break	
	11:10 – 12:10	**Keynote 2:** Intelligent humanoids: From labs to real world, Carlos Balaguer, University Carlos III, Spain	
	12:10 – 14:00	Lunch	
	14:00 – 15:40	**ThA2-SS:** Geometric and analytic methods for nonlinear data	**ThB2:** Control in infrastructures
	15:40 – 16:00	Coffee break	
	16:00 – 17:20	**ThA3:** Networked and multi-agent control systems	**ThB3:** Fault detection and PID control
	17:30 – 18:30	**APCA General Assembly**	
	20:00	**Conference Dinner:** Restaurant “Casa do Alentejo”	
Friday, 8th July	9:00 – 10:40	**FrA1:** Learning-based and intelligent control	**FrB1-SS:** Control applications in robotics II
	10:40 – 11:10	Coffee break	
	11:10 – 12:10	**Keynote 3:** Learning to fly agilely, Davide Scaramuzza, University of Zurich, Switzerland	
	12:10 – 14:00	Lunch	
	14:00 – 15:40	**Panel 2:** New perspectives in engineering education	
	15:40 – 16:00	Coffee break	
	16:00 – 17:00	**FrA2:** Modeling and control applications	**FrB2:** Optimal control
	17:00 – 17:10	Short break	
	17:10 – 17:30	**Closing Ceremony**	

Wednesday, 6th July

Time	Reference	Description	Room
8:30 – 9:00		Badge collection and on-site registration	
9:00 – 10:20		**Opening Ceremony**	Room A
9:20 – 10:20	**Keynote 1**	**"Advances in Motion Control of Aerial Vehicles"** Rita Cunha, IST / Universidade de Lisboa, Portugal *Chair: Bruno Guerreiro*	Room A
10:20 – 10:40		Coffee break	
10:40 – 12:20	**WeA1**	**Planning for autonomous vehicles** *Chairs: Miguel Ayala Botto and Pedro Lourenço*	Room A
10:40 – 11:00	51	A Trajectory Optimization Strategy for Merging Maneuvers of Autonomous Vehicles Authors: Francesco Laneve, Alessandro Rucco and Massimo Bertozzi Abstract: In this paper we address the merging problem for Autonomous Vehicles (AVs) in presence of moving obstacles. The AV is required to follow a given desired path with a nominal (path-dependent) velocity profile, while keeping a desired safe distance with respect to moving obstacles. By using a new set of coordinates and a Virtual Target Vehicle (VTV) perspective, we propose a trajectory generation strategy to compute the (local) optimal collision-free trajectory that best approximates the desired one. In the proposed strategy, we exploit the extra degree of freedom of the VTV in order to generate a time parametrized reference, which helps to find the right space-time gap to perform a safe merging maneuver. We show the efficacy of the proposed strategy through a set of numerical computations and highlighting the main features of the generated trajectories.	
11:00 – 11:20	35	Nonlinear MPC for Attitude Guidance & Control of Autonomous Spacecraft Authors: Marina Relvas, Pedro Lourenço and Pedro Batista Abstract: This paper presents the design of attitude control systems for autonomous spacecraft subject to noisy measurements from sensors, external and internal disturbances. The objective is to perform slew manoevres and maintain pointing stability while guaranteeing fast convergence and high performance. For slew manoevres, a Nonlinear Model Predictive Controller (NMPC) is designed to achieve improved convergence while imposing constraints on the actuators. For pointing stability, however, Linear Quadratic Regulators (LQRs) are proposed based on the linearization about the null error. The pair of controllers is coupled to perform, in sequence, a slew manoevre towards the desired pointing (nadir or inertial) followed by high performance pointing stability. The success of the proposed solutions is measured by analyzing, resorting to realistic numerical simulations, the capacity of the NMPC to achieve the stopping criterion in minimal time and effort and of the LQR to drive and maintain the attitude error to a maximum of 36 arcsec, both of which are achieved.	
11:20 – 11:40	26	Authors: Solange D. R. Santos, José Raul Azinheira, Miguel Ayala Botto and Duarte Valério Title: Path Planning and Guidance Laws of a Formula Student Driverless Car Abstract: Autonomous driving has been a topic of great interest in several areas, from which motor racing is no exception. Aiming to autonomously control the future Formula Student Lisboa vehicle, this work is developed with the objective of implementing different strategies for control and path planning, with the purpose of minimising race lap times. These strategies are tested in simulation, using a realistic model of the prototype. The approach followed involves the decoupling of the lateral and longitudinal subsystems, where the reference path is obtained using artificial potential fields and then combined with a two passes algorithm developed to generate a speed profile. This allows to obtain a sub-optimal solution that adequately portrays the expected behaviour of a human driver while respecting traction conditions.	

11:40 – 12:00	75	Robust Path-Following Control of Underactuated Marine Vehicles Using Gradient Descent Fuzzy Estimation Authors: Gholamreza Nazmara and António Pedro Aguiar Abstract: This paper presents a robust path-following control strategy for underactuated autonomous underwater vehicles (AUVs) utilizing gradient descent fuzzy estimating in its structure. The proposed control scheme has two interior loops: the inner loop control that is responsible to track the velocity command signals, and the outer loop that controls the vehicle's path-following errors. Thanks to fuzzy estimators, uncertainties, including un-modelled dynamics, water current, and lateral velocities are explicitly addressed to make the control strategy robust to them. Using gradient descent fuzzy estimation with a simple implementation structure provides a satisfactory and robust performance for the marine vehicle in different practical situations. In the stability analysis section, Lyapunov based theory has been used in order to show exponential convergence of both velocity and tracking error's signals to a neighborhood of the origin, and also boundedness of all related signals. The efficiency of the proposed control approach is confirmed through computer simulation.
12:00 – 12:20	66	Quasi-anytime algorithm for resolution of aircraft trajectory conflict using mixed-integer programming Authors: Thiago Rodrigues da Costa, Rubens Junqueira Magalhães Afonso and Fernando Jose de Oliveira Moreira Abstract: Inspired by the move blocking concept present in model predictive control applications where the computing time is critical, we propose a reduction in the number of decision variables in the MILP by holding them constant during each block of time samples. Simulation scenarios were used to validate the proposal and confirm the expected time decrease. In turn, the success of this approach enabled us to propose a quasi-anytime algorithm for deconfliction, starting with larger blocks to obtain a coarse but conflict-free trajectory in short time, and then progressively decreasing the block size to refine the solutions, up until the minimal block size is reached or we run out of time to output a solution. Simulations were used to illustrate the application of the algorithm.

10:40 – 12:20	**WeB1.SS**	**Control applications in robotics I** *Chairs: José Gonçalves and Januz Jakubiak*	Room B
10:40 – 11:00	50	Hybrid Legged-Wheeled Robot Path Following: A Realistic Simulation Approach Authors: Vítor Hugo Pinto, Inês Soares, Francisco Ribeiro, Jose Lima, José Gonçalves and Paulo Costa Abstract: Legged-wheeled locomotion systems are particular cases used for robots, increasing their degrees of freedom. To increase safety and robustness in the performance of industrial robots, by decreasing the chance to easily break their joints or hurt someone, the use of non-rigid joints is being increasingly found in the literature and in the industry. Realistic simulators are tools capable of detecting rigid bodies interactions through physics engines. This paper present the simulation model of a hybrid legged-wheeled robot, built in the SimTwo simulator. Later, the proposed algorithms for path following control were detailed. Several tests were performed to the implemented path following algorithms. These showed that the errors in linear paths are at most 1 cm. For circle paths, the maximum error is 3 cm.	
11:00 – 11:20	13	Trajectory pace energy optimisation Authors: Paulo Cardoso Salgado and Teresa Paula Azevedo Perdicoúlis Abstract: The minimisation of energy consumption is paramount in the industry. Therefore, for industrial robot arms, tracking a pre-defined end-effector trajectory in due time, with the lowest energy loss, is of utmost importance. Very crucial to this problem is the pace to undergo the trajectory, since this can keep energy consumption levels to a minimum. To contribute to the answer to this problem, in this paper, the robot trajectory is parameterised by an independent function, which represents the undergoing pace. Thence, the proposed strategy consists in optimising this parameter in view of energy efficiency. This approach has been tested in a case study and, after the parameter curve is optimised, the energy loss was reduced to 10% of its initial value, i.e., when using a constant pace.	
11:20 – 11:40	87	Model predictive control for assistive robotics manipulation Authors: Fábio Luz, Bruno J. N. Guerreiro and Manuel Marques Abstract: This paper addresses the use of Model Predictive Control (MPC) method for robotic manipulation, more specifically for a six-degrees of freedom robotic manipulator that is used for assistive purposes. MPC does not require any user’s control input, allows the handle of nonlinear constraints, and opens the door to integrate machine learning and artificial intelligence techniques, contributing towards more autonomous assistance. The results show the ability to reach the reference position, even if it is variable through time, and to react immediately to perturbations, adapting the trajectory of the end-effector.	

11:40 – 12:00	89	Analytical solution for the fixed-path coordination of two mobile robots Authors: Janusz Jakubiak Abstract: The paper studies the coordination task for two mobile robots moving along linear paths to obtain minimal motion time without collisions. The problem is solved using maximum velocity based parameterization and coordination diagram approach. The properties of the parameterization and analytical formula for the collision zone are used to obtain the form of the optimal paths and the formulas for the switching points between path segments.
12:00 – 12:20	80	Control of a robot cane for locomotion assistance Authors: Pedro Bollinger, Gonçalo Neves and João Sequeira Abstract: With the increase in the elderly population throughout the world, there is a growing number of people in need of locomotion assistance. With current technology, it is possible to enhance standard walking aids and improve their effectiveness. This paper proposes an adaptive control system for a robotic cane based on an existing prototype. The control design is derived from the model of an inverted pendulum. The controller is based on a linear–quadratic regulator and uses gain scheduling techniques to adapt to the individual locomotion characteristics of the user, namely the walking speed and the angle of the cane. Control system performance is assessed through computer simulations. The results demonstrate the system's adaptability to operating conditions and resilience when faced with rapid input variations, confirming the viability of the approach.
12:20 – 14:00		Lunch
14:00 – 15:40	**Panel 1**	**Interaction between industry and academia** Room A *Moderator: Luís Brito Palma, NOVA University Lisbon, Portugal*
		Speakers: Fernando Correia, Nokia, Portugal Iven Mareels, Center for Applied Research for IBM, Australia Victor Venâncio Dias, Ihm/Stefanini, Brazil Abstract: Interaction between industry and research/development (R&D) institutions can be conceptualized as having three main stages: agents of interaction, channels of interaction, and the potential benefits from collaboration. This panel intends to discuss relevant topics in this theme, namely methodologies to improve relations between industry and academia, so that R&D projects have greater relevance from the point of view of impact on society, the formation of human resources with more or less scientific/technological profile, the interaction between humans and machines, the transfer of knowledge between entities, among others.
15:40 – 16:00		Coffee break
16:00 – 17:40	**WeA2**	**Automation and Industry applications** Room A *Chairs: José Gonçalves and João Miguel Santos*
16:00 – 16:20	39	IoT Lysimeter System with Enhanced Data Security Authors: Geraldo Oliveira, Carlos Almeida, João Miguel Santos, João C. Martins and José Jasnau Caeiro Abstract: Diverse sources of data related to precision agriculture may be acquired with IoT architecture based devices. Lysimeters are used to measure the amount of actual evapotranspiration released by plants, an important parameter for agriculture. Newer proposals of lysimeters extend the capabilities of these devices taking advantage of modern electronics, sensors, Internet, and computing devices. The paper presents an IoT based experimental lysimeter system implementation with enhanced data acquisition features. Some data is stored using a blockchain technology approach. The blocks are generated using an edge computing device. The special Linux operating system version for this device implements a trusted execution environment (OP-TEE). The paper describes the architecture of the system, the hardware implementation, the data acquisition and blockchain software for the critical data generated by the smart lysimeter system, at the edge computing level.
16:20 – 16:40	103	Industrial Automation Home-Lab (IAH-Lab) for Teaching/Learning during Covid-19 Pandemic Authors: Luis Brito Palma, Rui Azevedo Antunes and Paulo Gil Abstract: Worldwide the Covid-19 pandemic has led to temporary disruptions to face-to-face teaching/learning at universities and other institutions, and a general shift to online teaching/learning and training. In this paper the authors propose a new pedagogic methodology for teaching and learning based on a remote industrial automation laboratory located in the teacher’s house, to which it was given the acronym IAH-Lab. The main contributions are the proposed remote teaching/learning methodology and architectures, and also the new hardware/software setup (IAHLab) mounted for this purpose. Simulations and experimental results elucidate the potential and performance of the proposed remote laboratory.

16:40 – 17:00	77	Providing the Key Ingredients of an Edge PaaS for Supporting and Facilitating the development of Smart Energy Applications Authors: Giovanni Di Orio and Pedro Maló Abstract: The monitoring and control of Critical Energy Infrastructure (CEI) is nowa-days entrusted to Smart Grids (SGs). SGs rely on massive data and services to provide “awareness” about the status of the system. To do that distribut-ed computing schemes have been applied based on decentralized communi-cations, data collection, extractions, loading and analysis. These schemas are totally aligned with the Edge Computing (EC) paradigm. EC is an emerg-ing paradigm that provides capabilities for processing and analyzing data away from the cloud, at the edge of the network closer to the source of the data. It offers multiple benefits including improved application perfor-mance, network latency reduction, and data locality. These characteristics reinforce EC is expected to have great impact on SG. A crucial aspect in EC is how to design and develop architectures suitable for SGs. The authors strongly believe that the foundation for the successful implementation of edge-based solutions strictly depends on employing modern advanced cloud-native solutions, i.e., patterns, tools, techniques, and tech technolo-gies derived from cloud-based design. As a result of this statement an Edge Platform-as-a-Service (PaaS) has been designed, developed, and deployed and used as the foundation of a data platform at the Edge made up of open source and free-to-use PaaS services.
17:00 – 17:20	47	Authors: Filipa Gouveia, Rogério Campos-Rebelo and Filipe Moutinho Title: Reconfigurable sensor node applied to LoRa networks Abstract: In the last few years, there has been a growth in smart devices, which has allowed the emergence of intelligent networks and Smart Cities. These have based their success on the use of technologies such as LPWAN. Despite this, existing devices are usually developed for a specific use, limiting their application. This paper proposes a reconfigurable sensor node, adaptable to different network technologies and applications and easily handled by a common user. In this way, the reconfigurable sensor node becomes suited, not only for prototyping, but also for temporary and specific applications, such as acquiring and transmitting information about works on the public road. To validate the proposed reconfigurable node, a prototype was created and tested using an Arduino as the implementation platform, a LoRa RYLR896 antenna, and a set of sensors.
17:20 – 17:40	19	Prototyping and Control of an Automatic Ceramic Tableware Finishing Device Authors: Mariano Alvarez, Laiany Brancalião, Diogo Gomes, Vítor Pinto, Jorge Carneiro, José Santos, João Paulo Coelho and José Gonçalves Abstract: This paper presents a first prototype of an automated system that will be applied in stoneware tableware ceramics finishing, being developed in the scope of STC 4.0 HP project. The main objective of this prototype is to test different alternatives to obtain a precise finish on ceramic pieces produced by GRESTEL, improving the production of irregular pieces that until now are finished using manual labor. This is why the implementation of a closed-loop control of the rotation speed of a finishing sponge and its applied force control is proposed. Once the prototype has been designed and implemented, it can be concluded that the proposed approach is adequate to meet the requirements.
16:00 – 17:40	**WeB2**	**Nonlinear control** Room B *Chairs: Bruno Guerreiro and Matheus Reis*
16:00 – 16:20	86	Cooperative Path Following with Collision Avoidance Guarantees using Control Lyapunov and Barrier Functions Authors: Matheus Reis, Pallov Anand and A. Pedro Aguiar Abstract: In this paper, we address the problem of safety-critical, cooperative path following (CPF) control for a swarm of heterogeneous robotic vehicles following possibly intersecting paths. Control Lyapunov functions (CLFs) and control Barrier functions (CBFs) are utilized on a quadratic program (QP) based controller to achieve the desired task, while also giving explicit collision avoidance guarantees. We propose a modified CLF-CBF based QP controller to overcome deadlock-like configurations by assigning specific priorities for each of the agents. Numerical simulation results for three agents shows the efficacy of the proposed methodology.
16:20 – 16:40	25	Nonlinear Control of Hybrid Drones via Optimised Control Allocation Authors: Gil Serrano, Bruno Guerreiro and Rita Cunha Abstract: This work addresses the development of a unified control strategy, based on nonlinear control techniques, for hybrid tri-tiltrotor UAVs, so that a simple trajectory is followed. A model of a tri-tiltrotor UAV is derived, detailing the forces and moments that act on the system, followed by a unified control approach that considers the system dynamics as a whole. Backstepping control and nonlinear optimisation are used for position and attitude control to calculate force and moment references and a control allocation strategy based on nonlinear optimisation is proposed. Two trajectories are defined; in the first trajectory, the UAV is expected to fully transition from rotary-wing to fixed-wing configuration, while in the second, it is expected to fly in an intermediate configuration. To validate the approach, simulations for these trajectories are performed and the results are analysed.

16:40 – 17:00	36	Identification of low-dimensional nonlinear dynamics from high-dimensional simulated and real-world data Authors: Chiara Paglia, Annika Stiehl and Christian Uhl Abstract: In this paper, the methods principal component analysis (PCA), dynamical component analysis (DyCA) and sparse identification of nonlinear dynamics (SINDy) are investigated on high-dimensional simulated and real-world data. Since SINDy requires low-dimensional data, high-dimensional data has to be reduced in a preprocessing step. This can be done using dimension reduction methods such as PCA or DyCA. SINDy is applied to these low-dimensional signals and the performance is examined with respect to these methods. Investigated datasets consist of the Rössler attractor and measured EEG data of epileptic seizures. The results demonstrate the advantage of DyCA as a preprocessing step to eliminate component noise in data governed by a certain type of differential equations.
17:00 – 17:20	11	Regional Input-To-State Stabilization of Discrete-Time Systems under Saturating Actuators Authors: Lucas A. L. Oliveira, Valter Leite and Luís F. P. Silva Abstract: We introduce a new controller design condition formulated in terms of linear matrix inequalities, ensuring the local input-to-state stabilization of discrete-time systems under magnitude and rate saturating actuators. Such a contribution plays a relevant role in practical applications by relaxing design conditions to couple with input-to-state stability and, thus, allowing the Lyapunov function to increase whenever the process is affected by energy-bounded exogenous signals. Moreover, such a controller design requires a local stability approach due to the nonlinear effects of magnitude and rate saturating actuators. An example illustrates the application of the proposed techniques and suggest exploring the convexity of the formulation to handle more general systems such as uncertain and time-varying ones.
17:20 – 17:40	38	Dynamic Matrix Control of a 3DOF Helicopter with Stabilizing Inner Loop Authors: Andreyna Sárila Ramos Ferreira, Angelo Caregnato Neto, Rubens Junqueira Magalhães Afonso and Roberto Kawakami Harrop Galvão Abstract: This paper investigates the use of a dual-loop control system for a laboratory helicopter with three degrees of freedom, namely pitch, elevation and travel. The goal consists of following a travel reference at constant elevation while limiting pitch excursion. A first-principles model of the helicopter was initially employed to design the inner loop through a Discrete Linear Quadratic Regulator (DLQR) formulation. With this stabilizing controller in place, the step response to a travel command was acquired for the design of a Dynamic Matrix Control (DMC) scheme with pitch constraints. The dual-loop architecture was implemented in a multirate manner, with DMC acting as a command governor for the DLQR controller. Experimental results are presented to show the efficacy of the overall control system.
19:00		**Welcome Reception (Bus will leave at 18:00 from conference site)**

Thursday, 7th July

Time	Reference	Description	Room
9:00 – 10:40	**ThA1**	**Soft-computing, fuzzy control, and digital twins** *Chairs: João Rosas and Diego Carneiro*	Room A
9:00 – 9:20	21	Promoting Olive Groves's Soil Quality by a Digital Twin's Predictive Based Control: the sensor's network Authors: Joao Paulo Coelho, Letícia Silva, Romina Giugge, Francisco J. Rodríguez-Sedano and Paula C. Baptista Abstract: In Portugal, the olive groves soil has been subject to severe degradation due to harsh farming techniques combined with uncontrollable conditions such as climate changes and steep terrain orography. In this framework, this tendency must be reverted by adopting different farm management policies. The MAN4HEALTH project address this subject in two-folds: one, at an agronomic level, where the soil will be protected by growing a layer of indigenous plants and other, that resort to the soil's digitization in order to improve the deployment of fertilizers. This paper addresses the latter and aims to provide an overall description of the architecture of a predictive control system based on the soil's digital twin. In this control paradigm, an artificial intelligence layer will follow the entire cultivation process through the development of a soil's digital twin. This model will be able to describe the spatial and temporal dynamics of fertilization policies and be included within a model predictive control strategy in order to both decrease the concentration of chemicals released into the soil and promote the economic income of the farmer. In particular, this paper tackles one of the phases of this project where soil digitization must be carried out in order to feed the data to the digital twin. In particular, the description of the sensor network and the data management architecture.	
9:20 – 9:40	14	Less conservative state feedback design with switched controllers for TS fuzzy systems Authors: Flavio Faria, Leandro Elias, Rafael Magossi, Diego Carneiro and Vilma Oliveira Abstract: In this work, relaxed conditions for parallel distributed compensation fuzzy controllers via state feedback are proposed. The LMI conditions are obtained exploring the properties induced by the sector nonlinearity approach and by partitioning the space generated by the first-order time derivative of the membership functions. A chattering free state-dependent switching law to ensure the asymptotic stabilization of the feedback system is obtained and the efficiency of the proposed results is supported by a numerical example.	
9:40 – 10:00	44	Communication library to implement digital twins based on Matlab and IEC61131 Authors: Isabel Tajadura, Jesus Enrique Sierra Garcia and Matilde Santos Abstract: The rise of Industry 4.0 and digitalization has led to an increase in interest in simulation tools and virtual models, such as Digital Twins (DT). In addition to the application of the DTs in operation and maintenance, the DT can also help in the control field making easy the design and tuning of control algo-rithms, without putting in risk the integrity of the system to be controlled. In a control scheme, three main components can be identified: the controller, the system to be controlled, and the communication system that connects them. In this work, a set of communication libraries has been created to link the controller and the plant, as well as an aid in the implementation of DTs for control applications. Specifically, a library for Simulink and a library for IEC61131-compatible systems have been developed. Both libraries share da-ta. This way virtual and real controllers and plants can be interconnected. The libraries have been tested experimentally linking two different computers	
10:00 – 10:20	49	An intelligent fuzzy-GPC control for agricultural sprayers: comparison between GPC and PID fuzzy controllers Authors: Deniver Schutz, Heitor Mercaldi, Elmer Penaloza, Vilma Oliveira and Paulo Cruvinel Abstract: The application of pesticides is an important stage in food production in the agroindustry. In this process, adequate regulation and control of flow and pressure via automatic control technologies plays a fundamental role in reducing costs and biological risks. The dynamics of spraying systems have nonlinearities due to variation of the sprayer fluidic resistance and the presence of dead zone in the electrohydraulic actuators. Therefore, it is necessary to develop adaptive control solutions to deal with parametric uncertainties and nonlinearities in this type of systems. In this research work, an adaptive fuzzy-GPC controller is proposed to regulate the flow and pressure of a boom spraying system. Hence, a basic modeling of the sprayer system and a development methodology for the application of the fuzzy-GPC controller are presented. Additionally, a comparative analysis with a conventional GPC and a fuzzy-PID controllers is carried out. The results obtained show the reduction in the control action oscillations with the proposed controller which can reduce the wear of the actuators, as well as an increase in the stability robustness in the presence of variations in the parameters of the sprayer.	

10:20 – 10:40	102	Specification and Development of Dynamic Systems and Controllers based on Game Engines Authors: Guilherme Gil, João Rosas and Luis Brito Palma Abstract: This research work presents an approach for developing a platform for simulating industrial processes and virtual PLCs. This approach is based on a Structured Text IEC like Language Interpreter, systems simulation, and Unity 3D game engine. The developed platform can recognize structured text (ST) and validate its syntax through a lexical and syntactical analyzer using the Flex and Bison tools. As an illustration, a client application has been developed in Java. Users can enter their Structured Text code, execute it on a virtual PLC, declare input/output addresses, analog or digital, and observe their state. The integration of game engines has allowed obtaining a simulation system that meets more demanding requirements in modeling automation and control systems using open-source tools.
9:00 – 10:40	**ThB1**	**Control applications in medical sciences** Room B *Chairs: João M. Lemos and Paula Rocha*
9:00 – 9:20	70	Observer/LQR Adaptive Control of the Neuromuscular Blockade Authors: David Lima, Daniel Salgueiro and José Soares Augusto Abstract: In this paper is presented the development of an adaptive controller of the neuromuscular blockade (NMB). The controller uses pole placement with full state variables feedback (SVF) with observer, uses the linear quadratic controller (LQR) methodology for positioning the closed loop poles and calculating of the feedback vector of gains, and the adaptation mechanism is based on online batch system identification (SYSID) with an ARX (auto-regressive with exogenous input) model. To force input tracking, a PID controller is designed and inserted in the loop. Pseudo-random binary sequences (PRBS) are used in the generation of noisy signals added to the deterministic input signals to help in system identification. Simulations are performed with the linearized NMB model, around the 8% level of blockade, since linear blocks are easily simulated with vectorized operations in Octave.
9:20 – 9:40	52	A new control scheme for neuromuscular blockade with optimal initialization time Authors: Débora Nogueira, Teresa Mendonça and Paula Rocha Abstract: A new strategy is proposed for the automatic control of the neuromuscular blockade during general anaesthesia by means of the continuous infusion of rocuronium. This consists in the design of a controller based on steady-state model inversion with pole placement to be put into action at an optimal initialisation time.
9:40 – 10:00	68	Reduced Order Modelling of Neuromuscular Blockade Authors: Daniel Salgueiro, David Lima and José Soares Augusto Abstract: In this paper, model order reduction (MOR) is investigated in a widely used compartmental model of neuromuscular blockade (NMB). MOR is a very useful and important aspect of system identification, since its difficulty increases steeply with the number of parameters being estimated. The proposed reduced order models (ROMs) are tested with a database of 100 synthetic parameters already used in several research studies on NMB control. A ROM (named M3) with 4 parameters, which reduces to half the 8 parameters of the nominal base model (named N-NMB), was evaluated with the 100 patients database and revealed to be very promising: frequency and time domains results of M3 are quite similar to N-NMB results. The ROMs are intended to be used in the development of adaptive LQR controllers, with observers, which use online system identification, focused on the delivery of anaesthesia to patients. The development was done with Octave.
10:00 – 10:20	3	Control of a S-I-R Epidemiological Model Authors: Bertinho A. Costa and João M. Lemos Abstract: This paper addresses the control of a S-I-R epidemiological model. Two objectives are considered, the control of the level of infection, and the maximization of the number of susceptible individuals counted at the end of the pandemic. The properties and structure of the S-I-R model are explored. A nonlinear control strategy is proposed that solves the problem considered.
10:20 – 10:40	43	Human-machine interaction for monitoring COVID-19 Internet data in Russia and the world Authors: Sergei Levashkin, Oksana Zakharova and Konstantin Ivanov Abstract: We develop a human-machine interaction via dashboard for COVID-19 data vis-ualization in the regions of Russia and the world. In particular, it includes an adaptive-compartmental multi-parametric model of the epidemic spread, which is a generalization of the classical SEIR models; and a module for visualizing and setting the parameters of this model according to epidemiological data, imple-mented in a dashboard. Data for testing have been collected since March 2020 on a daily basis from open Internet sources and placed on a "data farm" (an automat-ed system for collecting, storing and pre-processing data from heterogeneous sources) hosted on a remote server. The combination of the proposed approach and its implementation in the form of a dashboard with the ability to conduct vis-ual numerical experiments and compare them with real data allows most accurate-ly tune the model parameters thus turning it into an intelligent system to support a decision-making. That is a small step towards Industry 5.0.
10:40 – 11:10		Coffee break

11:10 – 12:10	**Keynote 2**	**"Intelligent humanoids: From labs to real world"** Carlos Balaguer, University Carlos III, Spain *Chair: Luís Palma*	Room A
12:10 – 14:00		Lunch	
14:00 – 15:40	**ThA2.SS**	**Geometric and analytic methods for nonlinear data** *Chairs: Fátima Silva Leite and Maria Barbero-Liñán*	Room A
14:00 – 14:20	88	A 4th-order variational problem on SO(3) Authors: Margarida Camarinha Abstract: In this paper we consider a fourth-order variational problem on SO(3) and study its stationary points. This gives rise to a higher-order interpolation method that is one step ahead of the cubic interpolation method for rigid body orientation.	
14:20 – 14:40	30	Optimization on Stiefel Manifolds Authors: Markus Schlarb and Knut Hüper Abstract: Explicit matrix-type formulas for gradient and Hessians of smooth functions on the compact real Stiefel manifold with respect to a whole class of (pseudo-)Riemannian metrics are presented. This includes explicit formulas for corresponding normal spaces and associated orthogonal projections. It turns out that some well-known formulas are reproduced, moreover, it is shown that they are even valid in a much bigger context. All proofs are included, some of them for the first time. A numerical experiment is added as well.	
14:40 – 15:00	18	Variational problems on Riemannian manifolds with constrained accelerations Authors: Alexandre Anahory Simoes and Leonardo Colombo Abstract: We introduce variational problems on Riemannian manifolds with constrained acceleration and derive necessary conditions for normal extremals in the constrained variational problem. The problem consists on minimizing a higher-order energy functional, among a set of admissible curves defined by a constraint on the covariant acceleration. In addition, we use this framework to address the elastic splines problem with obstacle avoidance in the presence of this type of constraints.	
15:00 – 15:20	63	Best fitting geodesic going through the Riemannian mean Authors: Luís Machado and Fátima Silva Leite Abstract: Our main objective here is to derive alternative normal equations for the geodesic fitting problem on compact Lie groups and Grassmann manifolds. This is achieved by constaining the solution to pass through the Riemannian mean of the data, a property which is shared by their Euclidean counterparts and also by using variations of geodesics by geodesics to solve the corresponding optimization problem.	
15:20 – 15:40	31	Dynamical Component Analysis: Matrix Case and Differential Geometric Point of View Authors: Philipp Romberger, Monika Warmuth, Christian Uhl and Knut Hüper Abstract: Dynamical component analysis, a data-driven dimensionality reduction and subspace detection method for multivariate time series is mathematically analyzed. The matrix based formulation is put in perspective to a recently published vector based approach. Moreover, a differential geometric point of view is taken as well. A numerical experiment with the Rössler attractor is added.	
14:00 – 15:40	**ThB2**	**Control in infrastructures** *Chairs: Rui Barros and Fares M'Zoughi*	Room B
14:00 – 14:20	85	Control action of a Tuned Mass Damper in mitigating earthquake-induced structural pounding between building floors Authors: Pedro Folhento, Rui Carneiro de Barros and Manuel Braz-César Abstract: Passive control devices are widely used in the reduction of lateral vibrations of building structures. Controlling these lateral vibrations is vital in preventing collisions between adjacent building structures during a seismic event. These collisions modify the dynamic behavior of the intervenient structures and cause substantial local damage. In this way, the implementation of a Tuned Mass Damper (TMD) can be a solution in mitigating the earthquake-induced building pounding. However, there are concerns regarding the effectiveness and practical applicability of solutions for this purpose. In fact non-linear inelastic behavior of building structures, expected during earthquakes, is one of these concerns that should be considered in the assessment of the TMD effectiveness. Hence, this study addresses the investigation of the control action effectiveness of a TMD in reducing the lateral displacements of one of two building structures modelled with elastic and inelastic behavior that are prone to earthquake-induced structural pounding. Results show that TMD is effective in reducing displacements, pounding forces, and number of impacts, under elastic building behavior. However, when inelastic behavior is considered the TMD becomes less effective.	

14:20 – 14:40	59	Optimization of the cyclic in-plane response of reinforced concrete frames with infill masonry walls using a genetic algorithm Authors: Pedro Folhento, Rui Carneiro de Barros and Manuel Braz-César Abstract: A typical option in building construction is the use of reinforced concrete frame structures with infill masonry walls. The presence of infill walls in frame structures greatly influences the dynamic behavior of frame structures during seismic events. This wall usually does not have a structural role, being neglected in the design phase of building structures. Innumerous negative effects may arise from the neglection of this non-structural element in frame structures, namely, increased shear, energy, and ductility demands in the structure's elements, torsional effects due to irregular height or plan distributions of the infill panels in buildings, out-of-plane failure of the walls projecting debris to the inside or outside of the buildings, etc. Hence, this work intends to study the in-plane cyclic behavior of reinforced concrete portal frame structures with infill walls. A numerical model is developed to replicate the quasi-static experimental response of reinforced concrete frames with infill walls specimens. To obtain an optimal response, the corresponding model's parameters are calibrated through the use of a genetic algorithm. Results show that these algorithms can be a good option in calibrating the in-plane cyclic response of masonry infilled reinforced concrete frame structures.
14:40 – 15:00	101	Dual Airflow Control Strategy for Floating Offshore Wind Turbine Stabilization using Oscillating Water Columns Authors: Fares M'Zoughi, Payam Aboutalebi, Irfan Ahmad, Izaskun Garrido and Aitor J. Garrido Abstract: This paper presents an airflow control strategy developed for Oscillating Water Columns (OWC) integrated in the barge platform of a Floating Offshore Wind Turbine (FOWT). The concept of the investigated platform combines a barge-based FOWT with OWCs to help reduce the undesired vibrations induced from waves and wind. Moreover, the OWCs are governed by a dual airflow control strategy design to reduce the platform pitch and tower top fore-aft displacement in order to help stabilize the FOWT platform. This objective is achieved by controlling the valves within the OWCs. The comparative study between the standard FOWT and the proposed OWC-based FOWT, based on the analysis of the free decay responses, shows an improvement in the platform's stability by reducing both the platform pitch and tower fore-aft displacement.
15:00 – 15:20	65	Vortex shedding effects due to wind action on the design of steel tubular towers Authors: Samuel Bastos and Rui Barros Abstract: This work addresses the effect of vortex shedding due to wind action applied to steel tubular towers of constant circular section and its consequence on the design verifications, namely top deflection and fatigue. The effect of vortex shedding and fatigue were studied according with different methods available in the bibliography, in particular the Eurocode and CICIND model code methods [1]. Additionally, a simplified method based on a dynamic analysis and a physical interpretation of the phenomenon was developed and pro-posed. The methods studied were then applied to real structures, whose structural performance had been monitored over time. The estimates of the methods were compared with the measurements of the monitoring with the objective to evaluate the reasonableness of their application.
15:20 – 15:40	8	Distributed Predictive Policies for Local Residential Energy Communities Authors: Joaquim Palma Silva, José Manuel Igreja and João Miranda Lemos Abstract: The main goal of this work is to design Battery Storage Management solutions for Smart Grids with multiple interconnected microgrids, or local power generation units, using a distributed model predictive control approach. In order to know how much energy should be stored, sold or bought, a model predictive control policy computes the minimum of a cost function that minimizes the net revenue. The solution also encourage some level of storage. The alternating direction method of multipliers computes the proposed distributed model predictive control solution, considering that each system is directly interconnected with its neighbors. The distributed predictive control algorithm is described and tested in simulations.
15:40 – 16:00		Coffee break
16:00 – 17:20	**ThA3**	**Networked and multi-agent control systems** *Chairs: Anikó Costa and Cristina Nuevo-Gallardo* Room A

16:00 – 16:20	27	Input Event Modeling for Discrete-Event Controllers: a Petri Net Approach Authors: Luis Gomes, Rogerio Campos-Rebelo, Anikó Costa and João-Paulo Barros Abstract: The modeling of controllers for discrete-event systems commonly uses state-based formalisms, such as state diagrams and Petri nets. These modeling formalisms heavily relies on the concept of events, which from an automation system perspective could be characterized as a change on a signal or other variable. Several types of events could be defined, considering different types of signals, including Boolean and multi-valued signals, as well as different types of dependencies in terms of the evolution of the signals. For the presented work, the model of the controller is produced using IOPT nets, a non-autonomous Petri nets class. In this paper a set of translation rules for several types of events is proposed allowing the generation of behaviorally equivalent IOPT Petri net models, which will be executed concurrently with the main model constrained by the translated events. An example is presented to illustrate the benefits associated with the usage of the proposed translation rules. We conclude identifying some future work, namely their integration with the IOPT-Tools framework, which is freely available to use.
16:20 – 16:40	83	Path Following for Purcell's Swimmers: An Event-based Control Approach Authors: Cristina Nuevo-Gallardo, José Emilio Traver, Inés Tejado and Blas M. Vinagre Abstract: Path following for Purcell's swimmers, consisting of three-link robots connected by one-degree-of-freedom joints, is a difficult task because motion primitives do not allow displacement in a unique direction. This paper proposes a framework to overcome this problem on the basis of event-based control in order to carry out the robot control in closed-loop. Specifically, the controller is an asynchronous strategy in which the event triggering is performed by threshold. Simulation results for different kinds of paths, i.e., rectilinear and curved roads, are given to demonstrate the effectiveness of the proposed control strategy.
16:40 – 17:00	10	Autonomous Vehicle Platoon Packet-based Control Problem UnderDenial-of-Service Attacks Authors: Roberto M. Fuentes, Pedro M. Oliveira, Leonardo Carvalho, Márcio Júnior Lacerda and Jonathan M. Palma Abstract: The present work tackles the $\mathcal{H}_{\infty}$ Packet-based control design in the autonomous vehicle platoon (AVP) problem based on digital re-design of a linear parameter-varying system under the assumption of the presence of Denial of Service (DoS) attacks. The main novelty in this paper is the parameter-dependent modeling and the added assumption of DoS attacks during the control design process. This assumption is particularly relevant in the AVP problem since all the vehicles exchange data using an autonomous vehicle network (AVN), and those networks can be susceptible to attack from malicious agents. To illustrate the viability of the proposed approach some simulations are provided considering the time-invariant model of the AVP, and the parameter-varying model with and without the presence of DoS attacks.
17:00 – 17:20	12	A General Optimization Approach to Maximize the Region of Attraction of Saturating Discrete-Time Delayed Systems Authors: Romulo J. Silva Jr., Valter Leite and Luís F. P. Silva Abstract: A key challenging feature of controller design for saturating systems is estimating the attraction region. Such a feature is even more involved in the case of state delayed systems because the region of attraction must be associated with state values in a range of time-interval. This work introduces a new optimization procedure that explores a lifted state-space representation of discrete-time state delayed systems under saturating actuators. A remarkable aspect of our approach is that the procedure can be applied even for controller design methods that do not use the lifted state-space representation, leading to much bigger region estimates.

16:00 – 17:20	**ThB3**	**Fault detection and PID control** *Chairs: Ramon Vilanova and G. Lloyds Raja*	Room B
16:00 – 16:20	58	Design of a closed-control loop based on simple tuning rules for fractional PID controllers for integrating systems with robustness considerations Authors: Helber Meneses Navarro, Michael Alfaro, Orlando Arrieta and Ramon Vilanova Abstract: In this paper, we prove the advantages of using fractional-order PID controllers over integer-order PID controllers when a good performance in both set-point tracking and load disturbance rejection tasks, with a constraint on the maximum sensitivity is required for the control of integrating processes. Moreover, simple rules are devised to tune this kind of controllers and they allow to achieve suitable control effort which is sought in real applications. The comparison with other recent tuning rules which also deal with these trade-offs shows the effectiveness of the implemented tuning rules.	

16:20 – 16:40	40	Optimal iIMC-PD double-loop control strategy for integrating processes with dead-time Authors: Pulakraj Aryan, G Lloyds Raja and Ramon Vilanova Abstract: In this work, indirect internal model control – proportional derivative (iIMC-PD) double-loop controller is suggested to control the dynamics of integrating processes with dead-time. The inner loop consists of a PD controller which is responsible for the disturbance rejection. Its operational settings are determined using Routh-Hurwitz (RH) stability criteria. The outer loop comprises of the indirect IMC controller which is responsible for the set point tracking. The optimal value of both inner loop as well as outer loop tunables are obtained using a metaheuristic technique called the Equilibrium Optimizer (EO) with the objective of minimizing the Integrated Squared Error (ISE). Simulation results establish the satisfactory enhancement of the suggested control strategy over some of the re-cent works.
16:40 – 17:00	84	A novel proposal for estimating PID parameters based on centroids Authors: Álvaro Michelena Grandío, Francisco Zayas-Gato, Esteban Jove, José Luis Casteleiro-Roca, Héctor Quintián, Óscar Fontenla Romero and Jose Luis Calvo-Rolle Abstract: Currently, self-tuning Proportional-Integral-Derivative (PID) controllers are widely used in industrial control loops since they are adaptive controllers. However, this type of controllers often causes high settling times due to the identification process. Therefore, in the present research paper, a method to reduce settling times in self-tuning PID algorithms is presented. The proposed method is based on the use of centroids to adapt the controller to the system dynamics and to improve the control loop performance.
17:00 – 17:20	34	Circuit Breaker condition based maintenance using Advanced Fault Detection and Analysis on COMTRADE Event Data Authors: Francisco Silva and Nuno Amaro Abstract: A systematic and systemic analysis of historical data in power systems can contribute to the creation of condition based monitoring solutions for critical assets as circuit breakers. This work presents a methodology that automatic processes event-based data in COMTRADE format to obtain relevant metrics used in asset management. It considers the data processing, fault detection, classification and analysis stages at both, device and system level to aggregate and provide relevant metrics to end users. The methodology is validated using a sub-set of real life COMTRADE files from faults that occurred in the Portuguese Transmission System, between the years 2011 and 2021. The outcomes of this validation step are herein presented as well.
17:20 – 17:40	5	A new analytical design approach of fractional phase advance operator Authors: Tahar Bensouici, Imen Assadi and Abdelfatah Charef Abstract: Fractional forward filters modeling non-integer advances are digital filters, which ideally have flat group delays. This paper proposes a new, simple and efficient FIR filter design method to approximate the fractional phase advance operator zv. The design technique is based on the MacLaurin series expansion formula, which is applied to a discrete fractional system to obtain a closed form FIR digital filter approximation the digital ideal fractional phase advance operator zv . Some numerical examples have been presented to illustrate the performance and the effectiveness of this new design method and its use in performing a low order digital differentiator. Some comparisons results show that the proposed design yields better performances compared to the existing techniques.

17:30 – 18:30	**APCA General Assembly**	Room A
20:00	**Conference Dinner**	

Friday, 8th July

Time	Reference	Description	Room
9:00 – 10:40	**FrA1**	**Learning-based and intelligent control** *Chairs: Miguel Ayala Botto and Alberto Cardoso*	Room A
9:00 – 9:20	55	A Deep Learning Approach for Data-Driven Predictive Maintenance of Rolling Bearings Authors: Domicio Neto, Jorge Henriques, Paulo Gil, César Teixeira and Alberto Cardoso Abstract: Predictive maintenance, i.e., maintenance scheduled and implemented accordingly to the ma-chine's estimated condition and degradation, is considered a promising approach, as it can extend machines' availability, productivity, overall product quality, and reduce the waste of material and human resources related to maintenance, among other benefits. It is, for this reason, a key object of Circular Manufacturing, which is an emerging discipline that aims at creating more clean and sustainable manufacturing environments. Deep Learning in this area has been increasingly researched, showing promising results and the ability to extract hidden and abstract information that can improve the performance of health status prediction. In this work, a predictive maintenance approach using Deep Learning is developed for the PRONOSTIA-FEMTO benchmark, regarding the prediction of the current health status of rolling bearing components. The dataset contains vibration data from several run-to-failure simulations. The preprocessing stage is carried out using local mean decomposition, enabling better feature extraction. The approach is then compared to another non-Deep Learning approach for performance assessment.	
9:20 – 9:40	46	Intelligent Hybrid Control of Individual Blade Pitch for Load Mitigation Authors: Carlos Serrano, Matilde Santos and Jesus Enrique Sierra Abstract: Floating offshore wind turbines are energy devices that are subjected to strong loads, mainly wind and waves. Besides, they are complex and nonlinear systems, which make the task of control them more difficult. In this work, the control of the angle of the blades of a floating wind turbine is addressed, with the final goal of reducing the vibrations in the structure without compromising the extracted power. For this purpose, an intelligent hybrid control strategy is implemented. It consists of an incremental PD fuzzy controller combined with a linear quadratic regulator (LQR), which is optimized with genetic algorithms (GA). To test the control scheme, simulations are performed with the FAST software in the Matlab/Simulink environment on a realistic model of a FOWT. Results are com-pared with those obtained by the gain scheduling PI controller (GSPI) embedded in FAST, in terms of tower vibrations and turbine power output.	
9:40 – 10:00	9	Variable sampling period adaptive control based on reinforcement learning Authors: Joao M. Lemos, Francisco Parente and Rita Cunha Abstract: This article addresses the design of an adaptive control algorithm, based on reinforcement learning, for a class of bilinear systems with an accessible disturbance. The main contribution consists of using a variable sampling period, indexed to the control variable, to implement a warped time scale, in which the plant appears as a linear system to the controller. As a result, it is possible to perform aggressive manoeuvres, that consist of sudden reference changes defined by high amplitude step functions. Simulations show that the algorithm proposed is able to outperform the direct use of reinforcement learning adaptive control with a constant sampling period.	
10:00 – 10:20	33	Transmission Tower Classification Using Point Cloud Similarity Authors: Francisco Silva and Nuno Amaro Abstract: Right-of-Way managers have increasingly used LiDAR inspections as an input to monitoring and maintenance activities of their infrastructures, making up a large percentage of the volume of data stored. Much of the short-comings of this use revolve around the ability to accurately process data, classify elements and apply fitting monitoring strategies. This issue is raised by TSOs, when linking overhead line transmission tower scans to their respective models. In this sense, this work proposes a similarity based classification methodology to perform this task, supported by traditional point cloud distance metrics, using a set of Base Reference Models (BRM) built on alignment algorithms applied to pre-existent point clouds. This work tests this methodology for different sets of BRMs and point cloud distance metrics. We find that the effectiveness of this approach is highly related to the BRM resolution and to the distance metrics employed. For the use case at hand, the Chamfer distance similarity approached reached an accuracy as high as 89%.	

10:20 – 10:40	61	Control of a Wave Energy Converter using Reinforcement Learning Authors: José Trigueiro, Miguel Ayala Botto, Susana Vieira and João Henriques Abstract: In this work, a control scheme based on Deep Reinforcement Learning (DRL) is presented, using a simulation model of the Mutriku power plant. The controller acts on the generator torque and relief valve aperture simultaneously, and exclusively uses data measured in the plant as an observation signal, without requiring external measurements of the sea state. The DRL algorithm that implements this controller is the Twin Delayed Deep Deterministic Policy Gradient (TD3). This controller is further evaluated against a classical power control law, using the average power generation for a set of representative sea states as a performance metric. The black box behaviour of the controller is also analysed, in order to gain insight into the type of learned control law it implemented and resulting dynamics.

9:00 – 10:40	**FrB1.SS**	**Control applications in robotics II** *Chairs: José Lima and José Gonçalves*	Room B
9:00 – 9:20	37	Stochastic Modeling of a time of flight sensor to be applied in a mobile robotics application Authors: Laiany Suganuma Brancalião, Miguel Ángel Conde, Paulo Costa and José Gonçalves Abstract: In this paper it is presented the stochastic modeling of a time of flight sensor, to be applied in a mobile robotics application. The sensor was configured to provide data at a frequency of 30 Hz, obtaining a tradeoff between reactiveness and accuracy. The sensor data was acquired using a microcontroller development board, being the sensor moved with a manipulator, in order to assure repeatability and accuracy in the data acquisition process. The sensor was modeled having in mind the targets color, ranging from black to white for the working range, its variance, standard deviation, offset, means and errors measures were estimated.	
9:20 – 9:40	45	SmartHealth: A Robotic Control Software for Upper Limb Rehabilitation Authors: Arezki Abderrahim Chellal, Jose Lima, José Gonçalves, Florbela Fernandes, Maria F Pacheco, Fernando Monteiro and Antonio Valente Abstract: The proposed work was developed under the Smart Health project, which aims to advance the upper body rehabilitation by offering a robotic alternative to reduce the limitations of physical therapy, providing more intensive and personalized therapy sessions for patients. The use of robots allows on the one hand to relieve therapists from laborious and repetitive tasks, and on the other hand to relieve rehabilitation centers with more affordable sessions. The proposed strategy is to develop a new python-based software that controls the robot, collects the patient's forces and muscle activity in real time and store them for future analysis, while providing visual feedback, thus allowing to optimize the sessions. These features allow the physiotherapist to have an objective perception of the patient's performance during the exercise. This solution is implemented in robots already commercialized in the industrial field, which are generally mass-produced in production lines at a relatively low cost and with great flexibility.	
9:40 – 10:00	69	Task Allocation Algorithms for Drone Parcel Delivery Systems Authors: Tomás Bastos, Bruno J. N. Guerreiro and Rita Cunha Abstract: This paper addresses optimization strategies for task allocation in a fleet of drones with the goal of parcel delivery. With this goal, several algorithms are discussed, focusing on the study and implementation of Task Sequential Greedy Algorithm. The proposed strategies build on this algorithm, modified to include drone battery limitations and recharge possibilities with a configurable objective function giving the user the possibility of combining and tuning both time and energy consumed. It was also modified to include relays, where parcels can change carrier during an in-flight maneuver. A binary optimization algorithm is also implemented to decide where and when the relay maneuvers are beneficial to the system. A preliminary validation of the proposed algorithms is given based on simple case studies.	
10:00 – 10:20	78	Design of an Underactuated USV Catamaran Authors: Mário Assunção, Pedro Teodoro, Rosa Marat-Mendes and Victor Franco Abstract: The Sea2Future program was developed at ENIDH, since 2018, and it has in-volved the construction of an unmanned surface vehicle (USV) with the partici-pation of students and teachers of this educational institution. This first USV, with two hulls, referred to as USV-enautica1, included a control system which al-lows it to carry out several functions autonomously and it was used to study the composite construction, the propulsion command and control architectures, the navigation algorithms, and the control systems. The challenge of designing a lightweight hull suitable for coastal and open ocean navigation is described and the implemented solution for the microcontroller and software operation, the sen-sors, the navigation, and the control systems are explained. The USV has suc-cessfully demonstrated its ability to be operated remotely, which is necessary to validate the hydrodynamic parameters, and afterwards the aim of autonomous operation.	

10:20 – 10:40	57	Tracking a moving target in 2D using a particle filter based on innovative adaptive estimation Authors: Cirano Pinheiro, Marcela Ranno and Francisco Souza Abstract: In this work, a particle filter based on innovative adaptive estimation for tracking a moving target in 2D is proposed. Aiming to mitigate the uncertainty or lack of knowledge of the process and measurement noise covariance matrices, the particle filter is allied to an innovative adaptive estimation. For such, the difference between the theoretical and measured innovation covariances is defined as an approximation that uses the average of a moving estimation window for the innovation sequence calculus. This difference is computed continuously, using innovative adaptive estimation based on the maximum likelihood theory to dynamically adjust the covariances of the particle filter. To illustrate the efficiency and applicability of the proposed filter, simulations are carried out for estimating the state of a moving target considering different scenarios. The simulation results show that the proposed filter performs well in terms of robustness compared to extended Kalman filter and classic particle filter.
10:40 – 11:10		Coffee break
11:10 – 12:10	**Keynote 3**	**"Learning to fly agilely"** Davide Scaramuzza, University of Zurich, Switzerland *Chair: Tarek Hamel* Room A
12:10 – 14:00		Lunch
14:00 – 15:40	**Panel 2**	**New perspectives in engineering education** *Moderator: Luís Gomes, NOVA University Lisbon, Portugal* Room A
		Speakers: Teresa Restivo, University of Porto, Portugal André Silva, Universidade da Beira Interior, Portugal António Teixeira, Universidade Aberta, Portugal João Correia de Freitas, NOVA University Lisbon, Portugal Paulo Moura Oliveira, University of Trás-os-Montes e Alto Douro, Portugal Abstract: This panel is planned to discuss new challenges on engineering education covering new curricula requirements and structure as well as on lifelong training to assist employees and entrepreneurs in keeping up with current technologies. The discussions also address recent challenges and adopted strategies to mitigate the impact of COVID-19 pandemic, namely in terms of support for experimentation, which is of paramount importance within engineering courses curricula.
15:40 – 16:00		Coffee break
16:00 – 17:00	**FrA2**	**Modeling and control applications** *Chairs: Paula Rocha and Ricardo Pereira* Room A
16:00 – 16:20	7	A new insight on state-trimness and minimal state-space realizations of input-output behaviors Authors: Ricardo Pereira and Paula Rocha Abstract: In this paper we study the property of state-trimness, which, together with observability, is a necessary and sufficient condition for the minimality of the state-space realizations of a given input-output behavior. More concretely, we show how to compute the trim subspace T of a non state-trim state-space system S and prove that the restriction of S to T is a state-space system with the same input-output behavior as S. Combined with Kalman's observability decomposition, this allows obtaining minimal state-space realizations from non minimal ones.
16:20 – 16:40	48	State control of linear systems with potentially Metzler dynamics Authors: Dusan Krokavec and Anna Filasova Abstract: In this paper are solved problems concerning the control of ostensible positive linear systems. The desired control goal is achieved by designing a composed system matrix representation, where the constructive procedure is given to its formation. The method is flexible and allows to obtain the state control with the gain matrix being strictly positive. The design is computationally simple, since it reduces to the solution of a feasibility LMI problem. Numerical simulation is presented to illustrate the validity of the proposed method.

16:40 – 17:00	81	Optimized operation of an electric vehicle charging station with photovoltaic support and vehicle-to-grid implementation Authors: Carlos Vivas, Francisco R. Rubio, Antonia Lopez and Francisco Ramos Abstract: This paper tackles the problem of modelling a smart charging station for electric vehicles (EVCS) that is suitable for DC fast and ultra-fast charging while providing a minimum stress on the power grid. Operation of the charging station is managed in such a way that it is either supplied by photovoltaic (PV) power or the power grid, with the additional support of a battery-based storage sytem that provides an additional energy pool for efficient management of power flows. Vehicle-to-grid (V2G) is also implemented for improving the stability of the grid during peak load hours providing support in the Demand Response and Regulation Services demanded from the system operator. A receding horizon optimization schedule for intra-day market (24h ahead) is explored and simulations illustrate the feasibility of V2G as a tool to provide ancillary services to the grid as well as providing improved economical exploitation of the EVCS.

16:00 – 17:00	**FrB2**	**Optimal control** *Chairs: Maria Barbero-Liñán and Sílvio Gama*	Room B
16:00 – 16:20	76	Finite-time inverse optimal control for a general class of chaotic systems Authors: Pallov Anand and A. Pedro Aguiar Abstract: This paper addresses the finite-time stability control design problem for a general class of nonlinear systems, including the particular case of chaotic systems. Combining the results of finite-time stability using control Lyapunov functions with inverse optimality tools, we propose an explicit controller that is optimal with respect to a suitable cost functional and solves the finite-time stability problem. The proposed procedure is applied to obtain the finite-time synchronizing control signals for the Lorenz chaotic system dynamics in master-slave configuration. Numerical simulations illustrates the behavior of the derived controllers.	
16:20 – 16:40	32	A numerical algorithm for optimal control problems with a viscous point vortex Authors: Carlos Balsa and Sílvio Gama Abstract: Vortex dynamics and passive tracers in vortex-dominated flows form a vast area of research that continues to attract the attention of numerous studies. Among these studies, there has emerged in recent times a special interest in the use of control theory applied to vortex dynamics. Viscous point vortices are singular solutions of the two-dimensional incompressible Euler equations. These solutions correspond to the limiting case where the vorticity is completely concentrated on a finite number of spatial points each with a prescribed strength/circulation. By definition, a passive tracer is a point vortex with zero circulation. This work reports numerical explorations of the advection of one passive tracer by viscous point vortices living in the unbounded plane. The main objective is to find the energy-optimal displacement of one passive particle (point vortex with zero circulation) surrounded by N point vortices. The numerical results show the existence of nearly/quasi-optimal controls.	
16:40 – 17:00	24	Presymplectic integrators for optimal control problems via retraction maps Authors: Maria Barbero-Liñán and David Martín de Diego Abstract: Retractions maps are used to define a discretization of the tangent bundle of the configuration manifold as two copies of the configuration manifold where the dynamics take place. Such discretization maps can be conveniently lifted to the cotangent bundle so that symplectic integrators are constructed for Hamilton's equations. Optimal control problems are provided with a Hamiltonian framework by Pontryagin's Maximum Principle. That is why we use discretization maps and the integrability algorithm to obtain presymplectic integrators for optimal control problems.	

17:00 – 17:10		Short break	
17:10 – 17:30		**Closing Ceremony**	Room A