CLAWAR

September 11-13, 2017 PORTO, PT

Technical Program

CLAWAR ASSOCIATION

isep Instituto Superior de Engenharia do Porto

INESCTEC TECHNOLOGY & SCIENCE | ASSOCIATE LABORATORY | PORTUGAL

University of Minho
School of Engineering

U.PORTO
FEUP FACULDADE DE ENGENHARIA
UNIVERSIDADE DO PORTO

U C
UNIVERSIDADE DE COIMBRA

universidade de aveiro
theoria poiesis praxis

ISR INSTITUTO DE SISTEMAS E ROBÓTICA
UNIVERSIDADE DE COIMBRA

InnoTecUK

Welcome to CLAWAR'17

It is our pleasure to welcome you all to the CLAWAR'17 conference, held in Porto, Portugal during 11 – 13 September 2017. CLAWAR'17 is the 20th issue of the International Conference series on Climbing and Walking Robots and the Support Technologies for Mobile Machines. The technical conference includes five keynote presentations, given by well-known scientists in their fields of research, and 84 original articles with cutting-edge scientific findings in a wide range of topics related to the rapidly evolving areas of robotics. We hope that CLAWAR'17 will enable delegates to exchange research ideas and to establish collaborative networks for advancement of science and knowledge discovery in the field of robotics and associated technologies.

Following the example of last year's CLAWAR'16, we are offering to use a "Conference App" during CLAWAR'17, to allow delegates access the conference material and programme via their mobile devices. However, a hard copy of the technical programme will also be available to delegates for use. Moreover, as is the tradition in CLAWAR conferences, delegates will also receive soft copy and hard copy conference proceedings published by World Scientific Publishing Company.

The social programme of the conference, in the evening of Tuesday 12th September, includes a guided visit to the Porto Wine Cellars and a tour to some of the main spots of Porto, followed by the conference banquet where the participants will be able to have a taste of traditional Portuguese cuisine. We hope that this will meet the delegates' expectation of CLAWAR'17 and of the Porto hospitality.

There will also be tours arranged to visit robot research laboratories in the School of Engineering at Porto Polytechnic and in the Faculty of Engineering at the University of Porto during the evening of Monday 11th September and afternoon of Tuesday 12th September, respectively. These laboratories will highlight the state of the art research being carried out in autonomous and industrial robots.

Finally, if you have queries or require any assistance please do not hesitate to approach the conference helpers or members of the conference organising team. We wish you all a successful and fruitful CLAWAR'17 conference and hope you enjoy the event from both technical and social aspects.

Manuel F. Silva & Gurvinder S. Virk
General Co-Chairs, CLAWAR'17

CLAWAR 2017 Technical Programme

Monday 11 September 2017

Time: 08:00 - 09:20		
08:00-09:00	Conference Registration	(Secretariado)
09:00-09:20	Opening of Conference	(Auditório E)

Keynote Address – 1
Session Chair: Giovanni Muscato

Time: 09:20 - 10:20			**Venue: Auditório E**
Time	Paper ID	Proc Page	Presentation
09:20-10:20	PL2	4	High-Level Learning, Interaction and Cooperation for Humanoid Robots *Luís Paulo Reis*

Session – Mm1: Locomotion-1
Session Chair: Paulo Ferreira

Time: 10:40 – 12:40			**Venue: Auditório E**
Time	Paper ID	Proc Page	Presentation
10:40-11:00	3	337	Accelerate the Disturbance Recovery for a Passive-Based Biped Walker Based on Model Predictive Control *Ka Deng, Mingguo Zhao and Wenli Xu*
11:00-11:20	15	349	Bio-Inspired Bipedal Speed Control in the B4LC System *Qi Liu, Kartikeya Karnatak and Karsten Berns*
11:20-11:40	32	357	Efficient Reactive Behavior for Six-legged Walking on Rough Terrain with Proprioceptive Sensing *Dominik Belter*
11:40-12:00	34	367	Walking Analysis of Quadruped Quasi-Passive Dynamic Walking Robot "DUKE-II" Focusing on Trunk Structure *Yasuhiro Sugimoto, Takaki Okamoto and Koichi Osuka*

12:00-12:20	37	375	Myriapod Robot i-CentiPot01 via Mechanical Passivity *Tetsuya Kinugasa, Koichi Osuka, Naoki Miyamoto, Ryota Hayashi, Koji Yoshida, Dai Owaki and Akio Ishiguro*
12:20-12:40	38	383	Effect of Viscoelastic Trunk Mechanism with Arm Swinging in 3D Bipedal Locomotion *Ryo Onishi, Hiroki Oku, Takashi Takuma and Wataru Kase*

Session – Mm2: Assistive Robotics **Session Chair: Manuel Armada**			
Time: 10:40 – 12:20			**Venue: Sala de Atos**
Time	Paper ID	Proc Page	Presentation
10:40-11:00	10	13	Walking Pattern Generation Method for an Exoskeleton Moving on Uneven Terrain *Sergey Jatsun, Sergei Savin and Andrey Yatsun*
11:00-11:20	41	21	Linear Series Elastic Actuator for Powered Knee Orthosis *Myroslav Shysh, Tarik Mrech, Ulrich Schmucker and Andriy Telesh*
11:20-11:40	54	29	ATLAS 2020: The Pediatric Gait Exoskeleton Project *Elena Garcia, Daniel Sanz-Merodio, Juan Sancho and Manuel Prieto*
11:40-12:00	66	39	Pattern Based Standing Assistance for a Low Level of Care *Daisuke Chugo, Shohei Kawazoe, Sho Yokota, Hiroshi Hashimoto, Takahiro Katayama, Yasuhide Mizuta and Atsushi Koujina*
12:00-12:20	79	56	Upper-Limb Exoskeleton for Human Muscle Fatigue S*iti Khadijah Ali and Osman Tokhi*

Session – Mm3: Biologically-Inspired Systems and Solutions **Session Chair: Dimitris Chrysostomou**			
Time: 10:40 – 12:20			**Venue: Sala de Reuniões**
Time	Paper ID	Proc Page	Presentation
10:40-11:00	20	65	TB-Horse II: Design and Analysis of a Bio-Inspired Robot Horse Based on the Breed Mangalarga Marchador *Daniel Rodrigues de Sousa, Wagner Tanaka Botelho, Marias da Graças Bruno Marietto, João Carlos da Motta Ferreira and Edson Pinheiro Pimentel*
11:00-11:20	22	73	Both-End Supported Earth Auger for a Bending Excavation of Peristaltic-Type Lunar Excavation Robot *Ami Fujiwara, Nakatake Toyoharu, Mamoru Nagai, Naoaki Tadami, Yasuyuki Yamada, Taro Nakamura, Hirotaka Sawada and Takashi Kubota*
11:20-11:40	51	81	Development of a Peristaltic Crawling Robot for Practical Use and Field Experiment Evaluation *R. Ishikawa, T. Tomita, Y. Yamada and T. Nakamura*
11:40-12:00	64	89	Design of an Exchangeable, Compact and Modular Bio-Inspired Leg for Six-Legged Walking Robots *Timothee Buettner, Arne Roennau, Georg Heppner and Rüdiger Dillmann*
12:00-12:20	70	97	Multisensory Guidance of Goal-Oriented Behaviour of Legged Robots *Danish Shaikh, Poramate Manoonpong, Gervase Tuxworth and Leon Bodenhagen*

Keynote Address – 2 **Session Chair: Gurvinder Virk**			
Time: 14:00 - 15:00			**Venue: Auditório E**
Time	Paper ID	Proc Page	Presentation
14:00 - 15:00	PL3	5	How Well Have Robots Done to Improve People's Lives? *Steven Dubowsky*

Session – Ma1: Flying and Aerial Robots **Session Chair: Karsten Berns**			
Time: 15:00 – 16:20			**Venue: Auditório E**
Time	Paper ID	Proc Page	Presentation
15:00-15:20	28	189	Ego-Motion Sensor for Unmanned Aerial Vehicles Based on the Raspberry Pi *Gaël Écorchard, Adam Heinrich and Libor Přeučil*
15:20-15:40	48	197	Autonomous Landing of a UAV on a Moving Vehicle for the MBZIRC *Luciano Cantelli, Dario Carmelo Guastella, Carmelo Donato Melita, Giovanni Muscato, Sebastiano Battiato, Fabio D'Urso, Giovanni Maria Farinella, Alessandro Ortis and Corrado Santoro*
15:40-16:00	76	205	Real-time Embedded System of Sliding Mode Observer for Quadcopter UAVs *Ahmad Riyad Firdaus and M. O. Tokhi*
16:00-16:20	83	213	3D Path Planning Methods for Unmanned Aerial Vehicles in Search and Rescue Scenarios *André Dias, Tiago Santos, José Almeida, Alfredo Martins and Eduardo Silva*

Session – Ma2: Modelling and Simulation of CLAWAR **Session Chair: Paulo Ferreira**			
Time: 15:00 – 16:20			**Venue: Sala de Atos**
Time	Paper ID	Proc Page	Presentation
15:00-15:20	1	441	Force Correction Control in Pneumatic Vacuum Contact Devices of Mobile Robots *Valery Gradetsky, Maxim Knyazkov, Artem Sukhanov, Eugeny Semenov and Anastasiia Kryukova*
15:20-15:40	7	449	Modelling of a Thermomechanical Actuator for a Walking Microrobot *Ivan Bogoslavskiy, Nikolay Bolotnik, Vladislav Chashchukhin, Valery Gradetsky, Armen Nunuparov, Dmitry Kozlov, Igor Smirnov and Andrey Zhukov*
15:40-16:00	68	465	Kinematic Modeling of an Omnidirectional Reconfigurable Screw-Propelled Mobile Robot *Jesus Lugo, Vishal Ramadoss, Matteo Zoppi and Rezia Molfino*

16:00-16:20	72	457	Modelling of a Magnetic Adhesion Robot for NDT Inspection of Large Metal Structures *Maz Shirkoohi and Zhanfang Zhao*

Session – Ma3: Special Session on Robotics in Education and Education in Robotics **Session Chair: Isabel Ferreira**			
Time: 15:00 – 16:20			**Venue: Sala de Reuniões**
Time	Paper ID	Proc Page	Presentation
15:00-15:20	5	153	Proposal of a New Servo-Motor Optimized for Educational Robotic Applications *João Silva, Paulo Costa and José A. Gonçalves*
15:20-15:40	29	161	Using Robotics to Teach Systems Engineering: A Hands-on Learning Course Example *Manuel Silva, André Dias and Maria Costa*
15:40-16:00	61	179	Elementary Students Programming In C To Make Their Robots Do Their Bidding *David Miller, Roger Clement, Carol Goodgame and Steve Goodgame*
16:00-16:20	85	169	Arduino Recursive Backtracking Implementation, for a Robotic Contest *Sérgio Silva, Diogo Duarte, Rolando Barradas, Salviano Soares, António Valente and Manuel J. C. S. Reis*

Session – Me1: Tele-Operated Robots, HMI and Virtual Reality **Session Chair: Dimitris Chrysostomou**			
Time: 16:40-18:00			**Venue: Auditorio E**
Time	Paper ID	Proc Page	Presentation
16:40-17:00	43	519	Shredded Image Patching by Using Past Frames of Inner Crawler Cameras for Flexible Mono-Tread Mobile Track *Kenichi Tokuda, Jin Nagaishi, Tetsuya Kinugasa, Takafumi Haji and Hisanori Amano*
17:00-17:20	44	527	Teleoperation of a Six-legged Walking Robot Using a Hand Tracking Interface *Wojciech Cieślak, Sebastian Rodykow and Dominik Belter*

17:20 - 17:40	47	537	Prototyping of Immersive HRI Scenarios *Dennis Krupke, Sebastian Starke, Lasse Einig, Jianwei Zhang and Frank Steinicke*
17:40-18:00	75	545	Assessment Strategy of Human Upper Forearm Inter-Relation and Muscle Fatigue *Wan Mohd Bukhari Wan Daud, Norafizah Abas and Mohammad Tokhi*

Session – Me2: Underwater and Sea Robotics **Session Chair: Jan Veneman**			
Time: 16:40-18:00			**Venue: Sala de Atos**
Time	Paper ID	Proc Page	Presentation
16:40-17:00	13	555	Development of a Flexible Propulsion Unit for a Seabed Excavation Robot *Naoaki Tadami, Ami Fujiwara, Nakatake Toyoharu, Mamoru Nagai, Yasuyuki Yamada, Taro Nakamura, Hiroshi Yoshida, Hiroyuki Sawada and Takashi Kubota*
17:00-17:20	30	563	Novel Volume-Expanding Mechanism for Large Buoyancy Change *Koji Shibuya, Katsuhisa Jimu and Tomoya Yamashita*
17:20 - 17:40	50	571	Underwater tests of the walking robot MAK-1 *Vadim Chernyshev, Vladimir Arykantsev and Yaroslav Kalinin*
17:40-18:00	84	579	Development of Novel Crawler Based Robot for Mooring Chain Climbing *Mehesh Dissanayake, Md Omar Howlader, Tariq Sattar, Tat-Hean Gan and Ivan Pinson*

Session – Me3: Localization and Navigation **Session Chair: André Dias**			
Time: 16:40-17:40			**Venue: Sala de Reuniões**
Time	Paper ID	Proc Page	Presentation
16:40-17:00	31	311	A Practical Application of QR-Codes for Mobile Robot Localization in Home Environment *Marta Rostkowska and Piotr Skrzypczynski*

17:00-17:20	33	319	Terrain Classification for Autonomous Navigation in Public Areas *Jan Wietrzykowski and Piotr Skrzypczynski*
17:20 - 17:40	52	327	UGV Navigation in Unstructured Environments Through UAV Survey *Luciano Cantelli, Dario Calogero Guastella, Donato Carmelo Melita and Giovanni Muscato*

CLAWAR AGM	
Time: 18:00-18:30	**Venue: Auditório E**
Time	Presentation
18:00 - 18:30	CLAWAR Association Annual General Meeting *Gurvinder Virk*

Laboratory Tour	
Time: 18:40-19:10	**Venue: INESC TEC**
Time	Presentation
18:40 - 19:10	INESC TEC CRAS - Centre for Robotics and Autonomous Systems *Eduardo Silva*

Tuesday 12 September 2017

Time: 08:00 - 09:00	
08:00-09:00	Conference Registration (Secretariado)

Keynote Address – 3
Session Chair: Osman Tokhi

Time: 09:00 - 10:00			**Venue: Auditório E**
Time	Paper ID	Proc Page	Presentation
09:00 - 10:00	PL1	3	Compliant Whole-body Control for Humanoid Robots *Jaeheung Park*

CLAWAR AR

Time: 10:00-10:20	**Venue: Auditório E**
Time	Presentation
10:00 - 10:20	CLAWAR Association Report *Gurvinder Virk*

Session – Tm1: Locomotion-2
Session Chair: Giovanni Muscato

Time: 10:40-12:40			**Venue: Auditório E**
Time	Paper ID	Proc Page	Presentation
10:40-11:00	40	391	Localization Method Using ICP Algorithm for a Six-Legged Robot *H. Uchida and Masashi Hosoi*
11:00-11:20	49	399	A Reliable Hierarchical Omnidirectional Walking Engine for a Bipedal Robot by Using the Enhanced LIP Plus Flywheel *S. M. Kasaei, N. Lau and A. Pereira*

11:20-11:40	58	407	A Combined Limit Cycle - Zero Moment Point Based Approach for Omni-Directional Quadrupedal Bounding *Romeo Orsolino, Michele Focchi, Darwin G. Caldwell and Claudio Semini*
11:40-12:00	59	415	Validation of Computer Simulations of the HyQ Robot *Marco Frigerio, Victor Barasuol, Michele Focchi, Darwin Caldwell and Claudio Semini*
12:00-12:20	63	423	Nonlinear Variable Transmission Actuators for Biped Robot Force Feedback Control *Hector Montes and Manuel Armada*
12:20-12:40	65	431	On Decentralized Control of Tripedal Walking Robot Using Reaction Force Feedback *Masato Ishikawa, Naoto Yasutani and Ryoichi Kuratani*

Session – Tm2: Special Session on Wearable Robotics for Assistance and Rehabilitation-1
Session Chair: Juan Moreno

Time: 10:40-12:40			**Venue: Sala de Atos**
Time	Paper ID	Proc Page	Presentation
10:40-11:00	9	629	Automatic and Real-Time Locomotion Mode Recognition of a Humanoid Robot *Joana Figueiredo, Diogo Gonçalves, Juan C. Moreno and Cristina P. Santos*
11:00-11:20	17	637	Adaptive Optimal Control Based on Estimation of Patient Behavior *Wilian dos Santos, Jonathan Jaimes, Juan Carlos Ibarra and Adriano Siqueira*
11:20-11:40	21	645	Validation of a Knee Angle Measurement System Based on IMUS *Nuno Ferrete Ribeiro, César Ferreira, Luís Paulo Reis, Hélder Silva, Pedro Macedo, Luís A. Rocha and Cristina P. Santos*
11:40-12:00	45	653	Adaptive Real-Time Tool for Human Gait Event Detection Using a Wearable Gyroscope *Paulo Félix, Joana Figueiredo, Cristina P. Santos and Juan C. Moreno*

12:00-12:20	53	661	Biomechanical Comparison of Patients with CP with Different Levels of Gait Assistance Using CPWALKER *Carlos Cifuentes, Luis Aycardi, Marcela Munera, Cristina Bayon, Oscar Ramirez, Eduardo Rocon, Anselmo Frizera and Sergio Lerma*
12:20-12:40	57	669	Neurofeedback Vibrotactile System for Parkinsonians Overcome Freezing of Gait: the First Steps in the Detecting the Most Perceived Frequency *Helena Gonçalves, Ana Rodrigues, Graça Minas and Cristina Santos*

Session – Tm3: Inspection **Session Chair: Mário Ribeiro**			
Time: 10:40-12:40			**Venue: Sala de Reuniões**
Time	Paper ID	Proc Page	Presentation
10:40-11:00	25	269	Development of Omnidirectional Wall Climbing Robot for Aircraft Inspections *Takafumi Amakawa, Tomohiro Yamaguchi, Naoaki Tadami, Yasuyuki Yamada and Taro Nakamura*
11:00-11:20	69	277	Biological Inspired Approach for the Inspection of Structures in the Splash Zone *Mario Ribeiro and Manuel Silva*
11:20-11:40	80	285	Climbing Robots for NDT Applications *M Al Rashed, M Kimball, L Vega, D Vera, J Soler, M Correa, A Garcia, GS Virk and T Sattar*
11:40-12:00	81	293	Pipeline Inspection Robotic Solutions *MS Ribeiro, GS Virk, M Al Rashed, M Kimball, M Correa, D Vera and Jose Soler*
12:00-12:20	82	201	Non-Destructive Testing Robots (NDTBots) for In-Service Storage Tank Inspection *Richard Anvo, Tariq Sattar, Tat-Hean Gan and Ivan Pinson*

Keynote Address – 4 **Session Chair: Manuel Armada**			
Time: 14:00-15:00			**Venue: Auditório E**
Time	Paper ID	Proc Page	Presentation

14:00 - 15:00	PL4	9	Monitoring Safety Critical Infrastructure with Mobile Robots *Tariq Sattar*

InnoTechUK Presentation **Session Chair: Manuel Silva**	
Time: 15:00-15:20	**Venue: Auditório E**
Time	Presentation
15:00 - 15:20	InnotechUK Presentation *Gurvinder Virk*

CLAWAR Robotic Demonstration **Session Chair: André Dias**			
Time: 15:20-16:00			**Venue: Auditório E**
Time	Paper ID	Proc Page	Presentation
15:20 - 16:00	67	48	Result of Clinical Trials with Children with Spinal Muscular Atrophy Using the ATLAS 2020 Lower-Limb Active Orthosis *D. Sanz-Merodio, M. Perez, M. Prieto, J. Sancho and E. Garcia*

Laboratory Tour	
Time: 16:30-17:30	**Venue: INESC TEC**
Time	Presentation
16:30 - 17:30	INESC TEC CRIIS - Centre for Robotics in Industry and Intelligent Systems *António Paulo Moreira*

CLAWAR Social Programme	
Time: 17:30-23:30	**Venue: Porto City**
17:30 - 20:00	City tour to the main spots in Porto and guided tour to the Port Wine Cellars *Cockburn's Port Lodge*

20:00 - 23:30	Conference Banquet *BH Foz: Restaurante - Bar*

Wednesday 13 September 2017

Time: 08:00 - 09:00	
08:00-09:00	Conference Registration (Secretariado)

Keynote Address – 5
Session Chair: Bryan Bridge

Time: 09:00 - 10:00			**Venue: Auditório E**
Time	Paper ID	Proc Page	Presentation
09:00-10:00	wr1	589	COST Action CA16116: Wearable Robots for Augmentation, Assistance or Substitution of Human Motor Functions *Jan Veneman*

Session – Wm1: Special Session on Wearable Robotics for Assistance and Rehabilitation-2
Session Chair: Cristina Santos

Time: 10:20 – 12:20			**Venue: Auditório E**
Time	Paper ID	Proc Page	Presentation
10:20-10:40	-	-	Energy Recovering Actuators to Improve the Range, the Efficiency and the Portability: Old Tricks for Future Applications *Francesco Bottiglione*
10:40-11:00	-	-	Bio-Inspired Lower-Limb Exoskeletons for Gait Assistance and Rehabilitation *Carlos A. Cifuentes*
11:00-11:20	-	-	Robot-Assisted Gait: What About the Cardiometabolic Load? *Nina Lefeber*
11:20-11:40	-	-	Robotic Platform for the Rehabilitation of Children With Cerebral Palsy: CPWalker *Eduardo Rocon*
11:40-12:00	-	-	Rendering Lower Limb Neuro-Mechanics in a Wearable Exoskeleton for SCI Subjects *Herman van der Kooij*

12:00-12:20	-	-	Wearable Hand Rehabilitation System With Force Feedback *Krzysztof Kozlowski*

Session – Wm2: Innovative Design of CLAWAR **Session Chair: Tariq Sattar**			
Time: 10:20 – 12:00			**Venue: Sala de Atos**
Time	Paper ID	Proc Page	Presentation
10:20-10:40	6	223	GECO: The Development of a Wall-Climbing Robot *Rob Cardinaels, Julie Maes, Jordi Deseure, Jelle Saldien, Kevin Aelterman, Steven Verstockt and Francis wyffels*
10:40-11:00	11	231	Design of a Glass-Wall Climbing Robot Using Passive Suction Cups *Sibao Wang, Dominico Sundjaja, Guojie Lan, Xin Zheng, Chee-Meng Chew, Wen-Feng Lu and Kim Pong Tan*
11:00-11:20	14	239	Possibilities of Using Wall Climbing Robots for Underwater Application *Valery Gradetsky, Maxim Knyazkov, Artem Sukhanov, Eugeny Semenov, Vlad Chaschukhin and Anastasiia Kryukova*
11:20-11:40	56	247	Centaur Robots - a Survey *Bilal Ur Rehman, Darwin G. Caldwell and Claudio Semini*
11:40-12:00	71	259	Agile Climbing Robot Design for NDT Inspection *Maz Shirkoohi and Zhanfang Zhao*

Session – Wm3: Climbing and Biomedical Robots **Session Chair: Taro Nakamura**			
Time: 10:20–12:00			**Venue: Sala de Reuniões**
Time	Paper ID	Proc Page	Presentation
10:20-10:40	4	109	Compact Climbing Robot with Surface Transition and Turning-on-the-Spot Abilities *Yue Wu, Xiao Teng, Lan Guojie, Chee Meng Chew and Tan Kim Pong*

10:40-11:00	8	118	The Control System of a Wall Climbing Robot with Aerodynamic Fixation *Vladislav Chashchukhin and Armen Nunuparov*
11:00-11:20	39	143	Effect of Heterogeneity in Distributed Building Formation by Autonomous Climbing Agents *Yuichiro Sueoka, Kohei Kubota, Masato Ishikawa and Koichi Osuka*
11:20-11:40	77	127	Wave-Like Propulsion Robot Over Flexible Surfaces *Nir Dgani and David Zarrouk*
11:40-12:00	78	135	Screw-Like Locomotion Over Compliant Surfaces *Tal Dachlika, A. Sintov and David Zarrouk*

Session – Wa1: Special Session on Wearable Robotics for Assistance and Rehabilitation-3 **Session Chair: Gurvinder Virk**			
Time: 14:00 – 16:00			**Venue: Auditório E**
Time	Paper ID	Proc Page	Presentation
14:00-14:20	60	677	An Ankle-Foot Prosthesis: A Preliminary Design and Dynamic Model *César Ferreira, Cristina Santos, Joana Alves, Eurico Seabra and Luís Paulo Reis*
14:20-14:40	62	685	Gait Events Detector for Transtibial Prosthesis *César Ferreira, Luis Paulo Reis and Cristina Santos*
14:40-15:00	wr2	597	Active Orthotic System for Assistance and Rehabilitation *Ivanka Veneva, Dimitar Chakarov, Pavel Venev, Evgeni Zlatanov, Michail Tsveov, Dimitar Trifonov*
15:00-15:20	wr3	605	Requirements Specifications for a Wearable Robotic Exoskeleton for Rehabilitation *Heba Lakany*

15:20-15:40	wr4	613	Upper Limb Loads During Robotic Assisted Gait: A Measuring System to Guide Training *M. Lancini, M. Serpelloni, S. Pasinetti, I. Bodini, G. Sansoni, M. D. Cecco and A. Fornaser*
15:40-16:00	wr5	621	On the Design and Control of an Empowering Manipulator to Increase the Capabilities of Humans in Industrial Applications *Loris Roveda, Alessio Prini, Tito Dinon, Shaghayegh Haghshenas, Nicola Pedrocchi, Francesco Braghin and Lorenzo Molinari Tosatti*

Session – Wa2: Perception, Planning, Control and Scheduling **Session Chair: Dimitris Chrysostomou**			
Time: 14:00 – 15:40			**Venue: Sala de Atos**
Time	Paper ID	Proc Page	Presentation
14:00-14:20	16	477	Energy-Efficient MPC for Biped Robots *Carlos Neves and Rodrigo Ventura*
14:20-14:40	19	485	3D-Printed Low-Cost Modular Force Sensors *Florens Wasserfall, Norman Hendrich, Fabian Fiedler and Jianwei Zhang*
14:40-15:00	46	493	The Motion Analysis and Trajectory Planning of Static Gait for the Quadruped Robot *Ruina Dang, Peng Xu, Qichang Yao, Bo Su, Lei Jiang, Lindong Mu and Chenxing Jiang*
15:00-15:20	55	501	Omni-Directional Steering Control for a Triangle With a Right Angle *Elena Kolesnichenko, Vladimir Pavlovsky, Igor Orlov, Anton Aliseychik and Dmitry Gribkov*
15:20-15:40	74	508	A Genetic Algorithm Approach for the Scheduling in a Robotic-Centric Flexible Manufacturing System *A. I. Pereira, A. Ferreira, J. Barbosa, J. Lima and P. Leitão*

16:20-16:40	**Closure** **Venue: Auditório E**