

VSS 2014 PROGRAM

(Updated June 1st, 2014)

June 29 : 17:00 – 19 :30 : Registration (in Nantes downtown – Le Lieu Unique - www.lielieuunique.com).

All the sessions and opening/closure ceremonies will be held in Amphitheater S, IRCCyN Building, on the campus of *Ecole Centrale*. The lunches will be taken in Building L of the campus of *Ecole Centrale*.

June 30 : 8:00 – 8:30 : Registration - 8:30 – 9:00 : Opening ceremony

July 1 : 20:00 : Banquet (in a boat on *Erdre* river - <http://bateaux-nantais.fr>)

July 2 : 17:30 – 18:00 : Closure ceremony (IRCCyN building, *Ecole Centrale de Nantes* campus)

Day	9:00 – 10:00				
June 30	Plenary session I Prof. A. Levant University of Tel-Aviv, Israel	10:15 – 12:35 Session 1	14:15 – 15:00 Interactive session (22 posters)	15:25 – 18:00 Session 2	18:10 - 19:10 Panel discussion I Organiser L. Fridman, UNAM, Mexico City, Mexico
July 1	Plenary session II Prof. C. Edwards University of Exeter, UK	10:15 – 12:35 Session 3	14:15 – 15:35 Session 4.1	15:50 – 16:50 Session 4.2	17:00 – 18:00 Panel discussion II Organiser L. Fridman, UNAM, Mexico City, Mexico
July 2	Plenary session III Dr.Ing. J. Komsta Bosch Rexroth Co., USA	10:15 – 12:35 Session 5	14:15 – 15:35 Session 6.1	15:50 – 17:30 Session 6.2	17:30 – 18:00 Closure ceremony

Keep in touch ! The program could be completed.

VSS 2014 will be held on the campus of *Ecole Centrale de Nantes* (www.ec-nantes.fr) , in Amphitheater S, IRCCyN Building (see map next page).

To reach the campus, **from Downtown**, the most convenient way is to use the **Line 2 of streetcar** (*tramway* in french) **direction “Orvault-Grand Val”** and stop at the station “Ecole Centrale – Audencia”. The station is near the campus entrance. The duration between Downtown and Campus by streetcar is less than 20 minutes. In the next pages, a map of the public transportation of Nantes – note that we will provide to each participant a pass allowing to travel on the public transportation network.





IRCCyN Building
Amphitheater S

Lunches

Streetcar station - Line 2
"Ecole Centrale - Audencia"

Ecole Centrale entrance

Tramway ligne 2

To downtown

P parking



For the Registration on Sunday, June 29th, it will be held at the bar of “Le Lieu Unique” (www.lelieuunique.com) in downtown from 17:00 to 19:30. It is located at walking distance from the castle and the railway station (*Gare SNCF* in french).

- If you arrive from Downtown, take the line 1 and stop at the station « Duchesse Anne – Château ».
- If you arrive from the railway station take the exit « South » and go on the right side when you are out of the station. The « Lieu Unique » is far from less than 5 minutes.

In the next pages, a map of the area of the « Lieu Unique » is given.

For the Banquet on Tuesday, July 1st, it will be held on a boat, on the river “L’Erdre” (<http://bateaux-nantais.fr>). The boat is located at walking distance from the station « **Motte Rouge** » on **Line 2 of streetcar** (between downtown and Ecole Centrale). All the details concerning the banquet (exact location, hours, ...) will be given during the workshop.



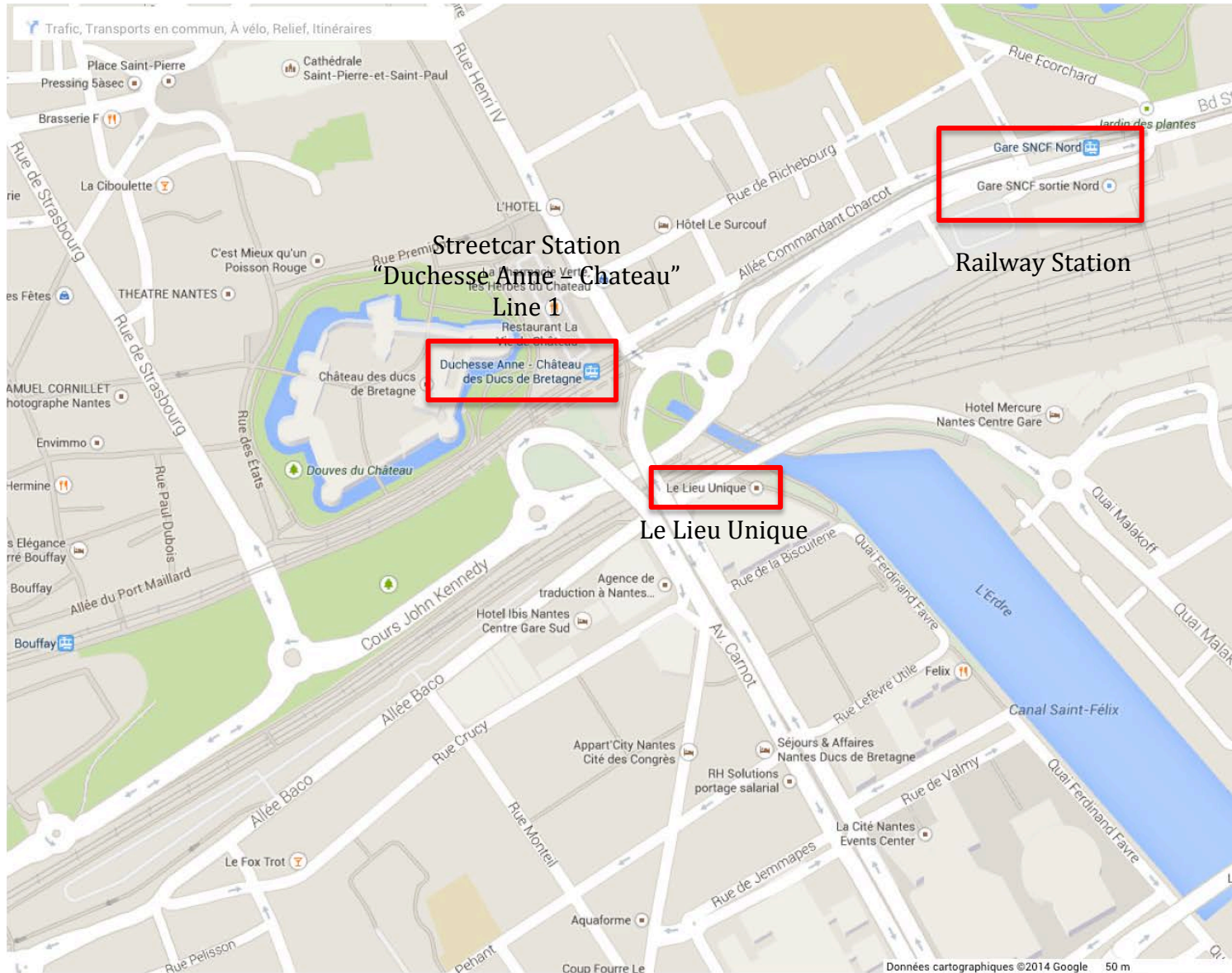
**Partial map of Lines 1 (Bold Green) and 2 (Bold Red) of Nantes streetcar
(for the complete map, go to Public Transportation website www.tan.fr)**



← Station “Ecole Centrale – Audencia” – Line 2 – VSS 2014 place

← Station “Motte Rouge” – Line 2 - Banquet

← Stations “Duchesse Anne - Château” – Line 1 – Sunday’s registration // Railway Station (*Gare SNCF* in French)



PLENARY SESSIONS

PLENARY SESSION I. June 30, 9:00-10:00

Prof. A. Levant, University of Tel-Aviv, Israel

« Some prospects of the modern sliding-mode control »

Abstract. The standard sliding-mode control (SMC) approach is usually described as a specific method of controlling heavily uncertain systems. Its well-known idea is to choose a proper constraint to be established in finite time and to be kept afterwards by high-frequency switching. The solution notably includes the search of a suitable constraint and overcoming the chattering effect. Today, after a long evolution history, the SMC technique is capable to solve the most difficult problems of the contemporary control theory.

The modern SMC method often produces the straight-forward solution of the original control problem. Indeed, the finite-time establishment of a constraint with arbitrary relative degree is now optional. Also the SM-based observation has been shown to provide for the exact robust output derivatives in finite time. Thus, one can practically ideally solve most black-box control problems, provided the input and the output are scalars. The control can be chosen as smooth as needed, excluding any high-energy system vibrations. The results are currently extended to the multi-input multi-output case. The developed methods are proved to be effective also in control of hybrid or switched systems, systems with variable delays, systems with distributed parameters, stabilization of continuous systems, etc. What happens when the parameters of the system uncertainty are themselves uncertain? These uncertainty-iteration problems require tuning of previously constant parameters, i.e. the SM adaptation. The Lyapunov function development is carried out for complicated systems featuring high-relative degrees and finite-time stability. The convergence rate regulation is now feasible, which includes the fixed-time convergence option as the extremal case. SMC optimization, including SMC system accuracy optimization and comparison with high-gain methods, has been recently performed.

While discrete SMs have been already studied for a long time, practical discretization methods for high-order SMC systems draw the attention only now. The author also believes that the practical-relative-degree approach opens a lot of new application possibilities.

The practical SMC theory implementation issues produce new challenging theoretical SMC problems. The approximability problems and stochastic analysis of high-order SMC systems still wait for their time.

PLENARY SESSION II. July 1st, 9:00-10:00

Prof. C. Edwards, University of Exeter, UK.

« Sliding mode fault detection and fault tolerant control: perspectives and applications »

Abstract. Over the last decade, sliding mode ideas have been applied to problems of both fault detection and fault tolerant control. The latter can be viewed as exploiting the well known insensitivity properties of sliding mode controllers to matched uncertainty, whilst the former (typically) exploits knowledge of the equivalent injection signals necessary to retain a sliding motion in an observer formulation, and which therefore contains information about faults which may be present in the systems. This talk will attempt to explain this surge in interest and argue why sliding mode schemes are indeed well suited to tackle such problems. It will also explore the limitations and trade-offs inherent in the sliding mode approach and its connections to other methods. The talk will describe the application of sliding mode controllers and observers to several real engineering problems from the aerospace domain, and will show the results obtained from implementing them on test rigs to demonstrate the feasibility of these schemes.

PLENARY SESSION III. July 2nd, 9:00-10:00

Dr.Ing. J. Komsta, Bosch Rexroth Corporation, Bethlehem, PA, USA

« Theory and Practice of Sliding Mode Control for Industrial Electro-Hydraulic Systems »

Abstract. In modern production machinery, fluid power is the muscle for the most demanding processes and applications, such as industrial presses, rolling mills, molding machines, flight simulators, industrial robots etc. In the last two decades, technical and economic forces have dynamically changed the requirements of hydraulic drive technology. Demands for efficiency, dynamics and quality of production processes, have forced the hydraulic drive industry to search for new and more advanced nonlinear control methods. Standard linear algorithms cannot assure optimal behavior in the presence of dominant system nonlinearities and strong system variations in hydraulic systems. Therefore, since the early 1990's, many innovative linear and nonlinear control algorithms designed for hydraulic drives have been proposed. Of the many different algorithms available for industrial motion systems, one of the most promising is Sliding Mode Control (SMC). SMC is well known for its robustness against modeling uncertainties and external disturbances, as well as possessing a simple structure and a manageable design process. This makes it ideal in many industrial applications.

The presentation discusses integral sliding mode control methods, and higher order SMC disturbance compensators suitable for electro-hydraulic drives. The controllers presented, and the tuning rules developed, fulfill the demands of industry for suitability and handling during system commissioning. The controller performance was empirically verified and the results show that dynamic behavior, accuracy and robustness of electro-hydraulic drives can be significantly improved using nonlinear Sliding Mode Control.

PANEL DISCUSSIONS

Organizer: Prof. L. Fridman, UNAM, Mexico City, Mexico

PANEL DISCUSSION I – June 30, 18:10-19:10

- **Pros and Cons of High Order Sliding Mode Control**

Speakers. Utkin.

All “Pros&Cons” of high-order sliding mode control are discussed in the context of the basic concepts of this control methodology: relative degree, continuous control, chattering suppression.

The objective of the presentation is to establish a bridge between “conventional” or 1st order and “new” high-order sliding mode controls and evaluate the potential of each of them. The attempt to compare two methodologies raises open questions, which can serve as a starting point for further research.

- **How to generalize super-twisting for arbitrary relative degree ?**

Speakers. Kamal, Moreno, Fridman, Levant.

Generalization of the Super-Twisting Algorithm(STA) is discussed. Proposed algorithm called $(r+1)$ -th order STA provides for relative degree r systems with respect to output

- finite-time convergence to the $(r+1)$ -th order sliding mode set;
- absolutely continuous control signal;
- using the information about the output, it is differentiated till the order $(r-1)$.

The convergence conditions for the 3-STA algorithm are proposed. The formula for algorithms of arbitrary order is suggested. The possibilities to prove their convergence will be discussed.

- **Discrete realization of fixed time convergence.**

Speakers. Levant, Efimov, Polyakov, Moreno.

Recently, a new type of convergence for SM controllers and differentiators has been considered. For example, it has been shown that fixed time convergence is not feasible *via* Euler discretization. The possibilities of the discrete realization of fixed time convergence will be discussed.

PANEL DISCUSSION II – July 1st, 17:00-18:00

- **Practical relative degree: frequency domain approach**

Speakers. Fridman, Shtessel, Levant, Boiko.

The exact output tracking in controllable minimum-phase perturbed SISO systems, which mathematical model has well-defined known relative degree r , can be achieved via HOSM controller with an HOSM observer/differentiator of $r-1$ order. However, relative degree of the principal mathematical model that is used for the HOSM controller/observer design inevitably is reduced with respect to relative degree of the real system. It has been shown that the unmodeled dynamics has a fractal nature that increases system's relative degree up to infinity. This yields chattering. Since it is impossible to design the HOSM control for system with relative degree $r \rightarrow \infty$, a new notion of Practical Relative Degree (PRD) has been introduced using the time-domain techniques. A novel approach to defining the PRD using the *frequency domain technique* will be discussed. This approach is based on the following new concepts:

- the *Level of Tolerance* that includes the definitions of the acceptable amplitude and the acceptable frequency of the oscillation in the real sliding mode ;
- the *Performance Margins*, specifically *Performance Gain Margins* (PGM) and *Performance Phase Margins* (PPM) that characterize the additional gain and the additional phase shift that the system can tolerate until the Level of Tolerance is violated.

Two approaches to defining the PRD will be discussed

- if the model of the system is unknown, the PRD of the system is the smallest order of SM controller that generates the oscillations in the system satisfying the *Level of Tolerance*;
- the *Performance Phase Margin* (PPM) and the *Performance Gain Margin* (PGM) could be found for each tested sliding mode controller. The smallest order of controller that satisfies the *Level of Tolerance* with the desired/given PGM and PPM could be also considered as PRD.

- **When the adaptation of SM controllers is needed ?**

Speakers: Y. Shtessel, L. Fridman, L. Hsu, G. Bartolini

Recently two important approaches to SM adaptation were published. SM adaptation when the upper bound of perturbations and their derivatives are known. In this case, 2 approaches can be used

- classical adaptation of SM gain to equivalent control;
- reconstruction of the perturbations basing on HOSM differentiators, and use of the perturbations estimation for direct compensation or as SM control gain.

Although, there are papers published on adapting the SMC for perturbed systems with unknown bounds of perturbations (these algorithms usually yield the gain overestimation), we suggest discussing several recent results on adaptive SMC/HOSM for such systems. The proposed concept consists in dynamically increasing the SMC/HOSM gains until the sliding mode is established. Then, the gains can be dynamically reduced so that the sliding mode is still retained. The proposed questions for the discussion are

- Adapt the control gains or reconstruct the perturbation and compensate ?
 - Does the adaptation make sense in systems with known bounds of the perturbations ?
 - Adaptation in systems with unknown bounds of the perturbations :
 - o gain overestimation ?
 - o how to guarantee the ability to retain the sliding mode with minimal gains ?
 - o the best concepts for the adaptation algorithms ?
 - o Lyapunov approach versus the “minoring- majoring” and other techniques ?
- **How to implement output Super-Twisting Controllers (STC) based on HOSM observers correctly?**

Speakers. Fridman, Kamal, Levant.

Recently, a lot of papers devoted to output based Super-Twisting controllers (STC) using HOSM differentiators have been published. Implementation of the STC requires that the first time derivative of the sliding surface must be Lipschitz in time. STC based on the absolutely continuous estimation of the surface cannot be implemented. That is why the order of differentiators is important there. Different methodologies for output based implementations of STC will be discussed.

June 30th

Session 1 (10:15-12:35) – Theory and methodology I - Chair : A. Polyakov

Time	Title	Authors
10:15 – 10:35	High Order Integral Nested Sliding Mode Control	Juan Diego Sánchez-Torres, Antonio Navarrete-Guzman, Guillermo Rubio-Astorga and Alexander G. Loukianov
10:35 – 10:55	Accelerated High-Order MIMO Sliding Mode Control	Arie Levant, Yaniv Dvir
10:55 – 11:15	On Output-based Sliding Mode Control Design Using Minimax Observer	Sergiy Zhuk and Andrey Polyakov
11:15 – 11:35	A New Class of Fast Finite-Time Discontinuous Controllers	Emmanuel Cruz-Zavala and Jaime A. Moreno
11:35 – 11:55	New Approach to Design Asymptotical Invariant Systems for Arbitrary Disturbances	Sergey A. Kochetkov, Victor A. Utkin
11:55 – 12:15	An Extension of the Unity Vector Control Method	N. Roqueiro, L. M. M. do Carmo, H. B. Silveira and E. F. Colet
12:15 – 12:35	Robust Finite Time Stability and Stabilization: A Survey of Continuous and Discontinuous Paradigms	Harshal B. Oza, Yury V. Orlov and Sarah K. Spurgeon

June 30th

Session 2 (15:25-18:00) – Sliding mode applications in transport and energy domains - Chair : I. Boiko and C. Kunsch

Time	Title	Authors
15:25 – 15:45	Feasibility Study of Variable Gain Super-Twisting Control in Fuel Cells Based Systems	Carolina Evangelista, Paul Puleston and Cristian Kunsch
15:45 – 16:05	Air Breathing Hypersonic Missile Continuous Higher Order Sliding Mode Control for Maximum Target Penetration	P. Yu, Y. Shtessel, S. S. Mehta, and C. L. Pasiliao
16:05 – 16:25	Design of Gain Scheduling Control Strategy for Artificial Gas Lift in Oil Production through Modified Relay Feedback Test	Huda Hussein, Ahmed Al Durra and Igor Boiko
16:25 – 16:45	Non-Smooth Missiles Guidance: Interceptor-Defender Scenario with Uncertainties	Alexander Poznyak
Coffee Break		
17:00 – 17:20	Flight Control System Design with High Order Sliding Modes for Nonlinear Aircraft Model	Erkan Abdulhamitbilal
17:20 – 17:40	Robust Flight Sliding Modes Control System Design for Nonlinear Aircraft with Parameter Uncertainties	Erkan Abdulhamitbilal
17:40 – 18:00	MRFT Based Identification of Process Dynamics	Muhammad Haekal and Igor Boiko

July 1st

Session 3 (10:15 – 12:35) – High order sliding mode (SM) control – Chair : T. Roux-Oliveira

Time	Title	Authors
10:15 – 10:35	Multivariable BMRAC Extension to Arbitrary Relative Degree Using Global Robust Exact Differentiators	Andrei Battistel, Eduardo V. L. Nunes, Liu Hsu
10:35 – 10:55	Extremum Seeking Control via Monitoring Function and Time-Scaling for Plants of Arbitrary Relative Degree	Liu Hsu, Tiago Roux Oliveira and José Paulo V. S. Cunha
10:55 – 11:15	An Application of Computer Aided Parameter Tuning of a Super-Twisting Sliding Mode Controller	M. Kleindienst, M. Reichhartinger, M. Horn and E. Usai
11:15 – 11:35	On the Boundary Control of Distributed Parameter Systems by Second-Order Sliding-Mode Technique. Recent Advances and New Results	Antonello Baccoli, Yury Orlov, Alessandro Pisano and Elio Usai
11:35 – 11:55	A Modified Super-Twisting Algorithm for Systems of Relative Degree More Than One	Michael Basin Pablo Rodriguez-Ramirez
11:55 – 12:15	Robust Output-Feedback Control for Container-Slosh System using Variable Gain Super-Twisting Algorithm	Jyoti Prakash Mishra and Shailaja R. Kurode
12:15 – 12:35	Lyapunov functions for Twisting and Terminal controllers	Tonámetl Sánchez and Jaime A. Moreno

July 1st

Session 4 (14:15-16:50) – Sliding mode applications in power energy and mechanics – Chair : D. Biel

Time	Title	Authors
14:15 – 14:35	A Fixed-Time Second Order Sliding Mode Observer for a Class of Nonlinear Systems	Juan Diego Sánchez-Torres and Alexander G. Loukianov
14:35 – 14:55	Sliding Mode Control of Three-Phase, Boost-Type and Three-Wire, Single-Phase AC/DC Power Converters.	Yazan Alsmadi, Vadim Utkin, Longya Xu Aimeng Wang
14:55 – 15:15	Sliding Mode Control Of A Three-Phase Four-Wire LCL Rectifier	Domingo Biel, Arnau Dòria-Cerezo and Enric Fossas
15:15 – 15:35	Combined Estimation of State-of-Charge and State-of-Health of Li-ion Battery Cells Using SMO on Electrochemical Model	Satadru Dey, Beshah Ayalew and Pierluigi Pisu
Coffee Break		
15:50 – 16:10	Hybrid Sliding Mode Control for Two Cells Converter	M. Benmiloud, A. Benalia, And M. Djemai
16:10 – 16:30	Distributed Tracking For Mechanical Systems Using Second-Order Sliding-Modes	Jorge Dávila
16:30 – 16:50	Sliding Mode Control of a Forestry-Standard Mobile Hydraulic System	Carlos Vázquez, Stanislav Aranovskiy and Leonid Freidovich

July 2nd

Session 5 (10:15-12:35) – Theory and methodology II – Chair : A. Bartoszewicz and B. Drazenovic

Time	Title	Authors
10:15 – 10:35	Fixed Switching Frequency Sliding Mode Control using an Hysteresis Band Controller	Repecho Víctor, Biel Domingo and Fossas Enric
10:35 – 10:55	Continuous Higher Order Sliding Mode Control Based on Adaptive Disturbance Compensation	Edwards Christopher and Shtessel Yuri
10:55 – 11:15	Accuracy of Disturbed Homogeneous Sliding Modes	Livne Miki and Levant Arie
11:15 – 11:35	Discrete-Time Chattering-Free Integral Sliding Mode Control of Continuous-Time Descriptor Systems	Drazenovic Branislava, Milosavljevic Cedomir and Veselic Boban
11:35 – 11:55	A New Reaching Law Based Sliding Mode Flow Controller for Connection-Oriented Data Transmission Networks	Bartoszewicz Andrzej and Lesniewski Piotr
11:55 – 12:15	Output Integral Sliding Mode based Robustified LQ control for Switched Uncertain Systems	Galvan-Guerra Rosalba and Fridman Leonid
12:15 – 12:35	L2-gain analysis of sliding mode controllers	Osuna Topacio and Orlov Yury

July 2nd

Session 6 (14:15-17:30) – Application fields of SM control/observers – Chair : B. Bandyopadhyay

Time	Title	Authors
14:15 – 14:35	Sliding mode control for a class of underactuated systems using feedforward normal form: A slosh-container system	Thakar Parth, Bandyopadhyay Bijnan and Gandhi Prasanna
14:35 – 14:55	Output Feedback Hybrid-Impulsive Second Order Sliding Mode Control: Lyapunov Approach	Shtessel Yuri, Glumineau Alain, Plestan Franck and Weiss Martin
14:55 – 15:15	Recent advances in sliding-mode based consensus strategies	Pilloni Alessandro, Franceschelli Mauro, Pisano Alessandro and Usai Elio
15:15 – 15:35	An Integral Sliding Mode Fault Tolerant Control Scheme for an Octorotor Using Fixed Control Allocation	Alwi Halim, Hamayun Mirza Tariq and Edwards Christopher
Coffee Break		
15:50 – 16:10	Fault Detection for Nonlinear Non-affine Systems via Sliding-Mode Output-Feedback and HOSM Differentiator	Rios Hector, Punta Elisabetta and Fridman Leonid
16:10 – 16:30	Study on Short Periodic Solutions of a Discretized Second-Order Sliding-Mode Control System	Wang Xiangyu and Li Shihua
16:50 – 17:10	Experimental comparisons between implicit and explicit implementations of discrete-time sliding mode controllers: towards chattering suppression in output and input signals	Bin Wang, Brogliato Bernard, Acary Vincent, Boubakir Ahcene and Plestan Franck
17:10 – 17:30	Adaptive Extremum Seeking Scheme for ABS Control	Dincmen Erkin

June 30th

Interactive Session

Time	Title	Authors
Poster	Adaptive control with asymptotical sliding mode of uncertain plants with input and state delays	Mirkin Boris, Gutman Per-Olof and Shtessel Yuri
Poster	Application of Super-Twisting-Like Observers for Bioprocesses	Moreno Jaime A. and Mendoza Ismael
Poster	Backstepping Sliding Mode Controller for a Co-ordinated Links (COOL) Robot Arm	Adhikary Nabanita and Mahanta Chitralekha
Poster	Chaos Synchronization Applied to Secure Communication via Sliding Mode Control and Norm State Observers	Rodrigues Victor Hugo and Roux Oliveira Tiago
Poster	DC motor control on the base of vortex algorithm	Kochetkov Sergey and Utkin Victor
Poster	Design of Guidance Law Based on Nonsingular Terminal Sliding Mode Control and Finite-time Disturbance Observer	Jin Shi, Zhang Zhenxing and Li Shihua
Poster	Direct Power Control with Disturbance Compensation for Grid Connected Power Converters - A Discrete-Time Sliding Mode Approach	Huseinbegovic Senad and Drazenovic Branislava
Poster	Estimation of Tire Parameters via Second-Order Sliding Mode Observers with Unknown Inputs	Tafner Robert, Reichhartinger Markus and Horn Martin
Poster	Experimental Evaluation of a Cascade Sliding Mode-PI Controller for a Coupled-Inductor Boost Converter	Carrero Niliana, Batlle Carles and Fossas Enric
Poster	Graph-based Field Automata for Modeling of Sliding Mode Systems	Kryachkov Mikhail and Polyakov Andrey
Poster	Higher Order Integral Nested Sliding Mode Control of Internal Combustion Engine	Meza-Aguilar Marco, Loukianov Alexander, Sánchez-Torres Juan, Navarrete-Guzmán Antonio and Rivera Jorge
Poster	Higher order sliding mode air-to-fuel ratio in SI engines	Rivera Jorge, Espinosa Javier and Loukianov Alexander
Poster	Linear-Quadratic Optimal Sliding Plane Design for Networked Control of Dynamical Systems	Ignaciuk Przemyslaw

Poster	Mismatched Disturbance Estimation and Compensation for Seeker System using Higher Order Sliding Mode Control	Tamhane Bhagyashri, Mujumdar Amruta and Kurode Shailaja
Poster	MRFT-Based Robust and Adaptive Controller Design for Gas Loop of Liquid-Gas Separator	Al Shehhi Hamdati, Boiko Igor
Poster	Periodic Behaviors of A Discretized Twisting Algorithm Based Sliding Mode Control System	Yan Yan, Yu Xinghuo and Changyin Sun
Poster	Robust Control of Pneumatic Actuators Based on a Simplified Model With Delayed Input	Edjekouane Essaid, Riachy Samer, Ghanes Malek and Barbot Jean-Pierre
Poster	Robust output regulation of variable structure systems with multivalued controls	Miranda Felix and Castanos Fernando
Poster	Sliding Control Variation for Ball-Plate System Stabilization	Valadez Rangel Humberto, Loukianov Alexander, Toledo Bernardino and Corrochano Eduardo
Poster	Sliding Mode Control of Electric Power System Comprised of Fuel Cell and Multiple-Modular DC-DC Boost Converters	Ashok Kumar Roshini Sukanya
Poster	The Block Design of Invariant Tracking System for MIMO Nonlinear Control Plant	Krasnova Svetlana, Utkin Victor