TECHNICAL PROGRAM

10th IEEE International Conference on System of Systems Engineering (SoSE 2015)

May 17 - May 20, 2015
Hilton Palacio Del Rio Hotel
San Antonio, Texas, USA

Conference Theme:

SoSE Modeling, Control and Simulation

10th Annual System of Systems Engineering Conference
May 17-20, 2015 San Antonio, TX, USA
Conference Theme:
"SoSE Controls, Modelling, and Simulation"

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Message from the Program Chairs

Welcome to the 10th International IEEE Conference on System of Systems Engineering (SoSE 2015) in San Antonio, Texas, USA. We are very proud of the quality of the papers submitted to the conference. With the help of our dedicated program committee members and reviewers we have conducted extensive reviews, based on which about 85 papers were selected.

The program chairs would like to acknowledge the program committee members and the reviewers that made it possible to process review and select the papers presented in this conference in a very short time period. Without their help this conference would not have been possible. With sincere apologies to anyone whose name was inadvertently omitted, the help of the following individuals who serve as the Program Committee, helped in reviewing papers, and perform other needed chores, is very much appreciated.

M. Aiello	D. Gan	A. Rad
A. Ajorlou	J. Guo	G. Rebovich
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Matthew Joordens

Deakin University, Australia

Wenbin Luo

St. Mary's University, USA

SoSE 2015 10th International Conference on System of Systems Engineering
San Antonio, TX, USA

(Sunday 5/17)	Day 1 (Mon 5/18)	Day 2 (Tue 5/19)	Day 3 (Wed 5/20)
	Registration (0730-0820)		
	Welcome (0820-0840)	Keynote 3 (0820-0920)	Keynote 5 (0820-0920)
	Keynote 1 (0840-0940)		
	Break (0940-1000)	Panel 1 (0920-1020)	Panel 2 (0920-1020)
	Session 1A/B/C (1000-1205)	Break (1020-1035)	Break (1020-1035)
		Session 3 A/B/C (1035-1240)	Session 5 A/B/C (1035-1240)
	Lunch (1205-1400)	Lunch (1240-1400)	Lunch (1240-1400)
	Keynote 2 1400-1500	Keynote 4 (1400-1500)	Keynote 6 (1400-1500)
	Break (1500-1515)	Break (1500-1515)	Break (1500-1515)
	Session 2 A/B/C (1515-1720)	Session 4 A/B/C (1515-1720)	Session 6 A/B/C (1515-1720)
Reception (1800-1930)		Banquet (1900-2100)	Closing and SoSE 2016: June 12-16, 2016, Norway (1720-1800)

Day 1 (Monday 5/18)		
0730-0820 Registration		
0820-0840 Welcome		
0840-0940 Keynote 1: Dave Welsh - Transformative design thinking of the systems of systems of a Smart City		
0940-1000 Break		

1000 - 1205

Session 1A: Architecture, Design, and V&V Methods and Big Data Analytic	Session 1B: Robotic Systems (I) and SoSE Design	Session 1C: Control Systems (I)
A Wrapper-based feature selection approach using Bees Algorithm for a wood defect classification system (Michael Packianather, Cardiff University, United Kingdom)	Conceptual Design for Fully Autonomous Aerial and Ground System for Precision Agriculture (Matthew Joordens, Deakin University, Australia)	Continuous improvement of technical systems using Design for X (Christer Elverum, Norwegian University of Science and Technology, Norway)
Data-Centric Development of Architecture Models with the DM2 and MS-SDF (Matthew Amissah, Old Dominion University)	Omnidirectional Rule-Based Free Gait Utilizing Restrictedness (Ferat Sahin, Rochester Institute of Technology)	Intelligent Adaptive Cruise Control System Design and Implementation (Islam Kilic, Eskisehir Osmangazi University, Turkey)
A Fast Map-Reduce Algorithm for Burst Errors in Big Data Cloud Storage (Brian T Kelley, University of Texas at San Antonio)	Underwater Swarm Robotics Review (Benjamin Champion, Deakin University, Australia)	Real-Time Direct Field-Oriented and Second Order Sliding Mode Controllers of Induction Motor for Electric Vehicles Applications (Eduardo Quintero, Advanced Studies and Research Center of the National Polytechnic Institute, Mexico)
Towards Security Software Engineering the Smart Grid as a System of Systems (Vanea Chiprianov, University of Pau, France)	A System of Systems Analysis of a Multi-Probe SPM System (Eyup Cinar, Rochester Institute of Technology)	Efficient Design and Analysis of Battery Switching Stations for the Collaborative Wireless Network of Mobile Robots (Hammad Khan, Islamia University Bahawalpur, Pakistan)
A service oriented virtual environment for complex system analysis: Preliminary Report (Charles E. Dickerson, Loughborough University, United Kingdom)	Electric Mobility and Charging: Systems of Systems and Infrastructure Systems (G. Maarten Bonnema, HBV-NISE, Kongsberg, Norway & University of Twente, Enschede, The Netherlands)	Simulation method for multi-machine and multi-task production scheduling in steelmaking-continuous casting process (Jianyu Long, Chongqing University, P.R. China)

1205 - 1400 Lunch		
1400 - 1500 Keynote 2: Reggie Cole - Achieving Affordability Through SoS Integration		
1500 - 1515 Break		

1515 - 1720

Session 2A: Reliability, Security, and Safety and Emerging Navigation Technologies	Session 2B: Robotic Systems (II)	Session 2C: Control Systems (II)
Leveraging Wireless Communication Systems for Aiding Inertial-Based Navigation Systems (Aly El-Osery, New Mexico Tech)	Dual Flexible 7 DoF Arm Robot Learns like a Child to Dance using Q-Learning (Ferat Sahin, Rochester Institute of Technology)	Research directions in SOSE (Vernon Ireland, The University of Adelaide, Australia)
Cognitive Interference Avoidance in 4th Generation GPS (Brian T Kelley, University of Texas at San Antonio)	SLAM based Shape Adaptive Coverage Control using Autonomous Vehicles (Junnan Song, University of Connecticut)	Distributed Leader-Follower Formation Control for Multiple Quadrotors with Weighted Topology (Zhicheng Hou, Université de Technologie de Compiègne & UMR CNRS 7253, Heudiasyc, France)
Defending Mechanisms for Protecting Power Systems against Intelligent Attacks (Longfei Wei, Florida International University)	Simultaneous Localization and Mapping using a Micro-Particle Swarm Optimization (Christopher Monfredo, Rochester Institute of Technology)	Real-Time Flocking of Multiple-Quadrotor System of Systems (Osamah Saif, Université de Technologie de Compiègne, France)
Uncertainty, elicitation of experts' opinion, and human failures: Challenges for RAM analysis of ERTMS SoS (Mohamed Sallak, Compiegne University of Technology & Heudiasyc Laboratory UMR CNRS 7253, France)	Tracking Animals to Determine Swarm Behavior (Benjamin Champion, Deakin University)	A low cost velocity control of double sided LSRM by sliding mode control and PIC18F452 (Mahir Dursun, Gazi University & Faculty of Technology, Turkey)
Cluster-Based Correlation of Severe Braking Events with Time and Location (Guoyan Cao, University of Houston)	Modeling and Dynamic Control for a Hexapod Robot (Ferat Sahin, Rochester Institute of Technology)	Real-time FPGA Decentralized Inverse Optimal Neural Control for a Shrimp Robot (Gener Quintal, Cinvestav, Mexico)

Day 2 (Tuesday 5/19)		
0730-0820	Registration	
0820-0920	**Keynote 3:** Bernard P. Zeigler - Modeling and Simulation for Engineering of Self-Improving Service Systems of Systems: Barriers and Prospects	
0920 - 1020	**Panel 1:** Challenges in moving from a single system perspective to a SoS perspective	
1020-1035	Break	
1035 - 1240	**Session 3A:** Modeling and Analysis Methods (I)	**Session 3B:** Engineering Education and Design	**Session 3C:** Algorithms and Design in SoSE
	A Theory of Complexity Escalation and Collapse for System of Systems (Joseph Bradley, Leading Change, LLC, USA)	An Update on the Framework for a Junior Level Design Course (Aly El-Osery, New Mexico Tech)	Random Sampling in Collaborative and Distributed Mobile Sensor Networks utilizing Compressive Sensing for Scalar Field Mapping (Minh T Nguyen, Oklahoma State University)
	Factory Production Line as SoS: a Case Study in Airplane Engine Component Manufacturing (Gerrit Muller, HBV-NISE & TNO-ESI, Norway)	Systems Engineering in Industry Internship and Academic Projects (Kourosh Rahnamai, Western New England University, USA)	A Systematic Mapping of the Research Literature on System-of-Systems Engineering (Jakob Axelsson, Mälardalen University & Swedish Institute of Computer Science, Sweden)
	A Model of Enterprise Systems Engineering Contributions to Acquisition Success (Jill Drury, The MITRE Corporation)	On the Impacts of Project Based Learning for Workplace Preparedness of Engineering Graduates (Seda Senay, New Mexico Tech)	A Model Based Safety Architecture Framework for Dutch High Speed Train Lines (Katja Schuitemaker, University of Twente, The Netherlands)
	Using Systems Engineering for Improving Autonomous Robot Performances (Stefan Marchlewitz, Bergische Universität Wuppertal, Germany)	The OpenOrbiter CubeSat as a System-of-Systems (SoS) and How SoS Engineering (SoSE) Aids CubeSat Design (Sofiane Chaieb, University of North Dakota)	Direct versus Stigmergic Information Flow in Systems-of-Systems (Bernhard Frömel, Vienna University of Technology, Austria)
	Improved Hybrid Variable and Fixed Step Size Least Mean Square Adaptive Filter Algorithm with Application to Time Varying System Identification (Farqad Yasin Farhan, Iraq)	Fuzzy Control of Cascaded H-Bridge Rectifier Based on Selective Harmonic Elimination Technique (Amirhossein Moeini, University of Texas at San Antonio)	Detection of Aggressive Driving Behavior and Fault Behavior Using Pattern Matching (Jessy George Smith, Cognizant Technology Solutions Limited, India)
1240 - 1400	Lunch	
1400 - 1500	**Keynote 4:** Walt D. Downing - Connecting through Research Partnerships	
1500 - 1515	Break	
1515 - 1720	**Session 4A:** Modeling and Analysis Methods (II)	**Session 4B:** Navigation and Emergence in SoSE	**Session 4C:** Special Session: Moving from SE to SoSE
	A Model Based Approach to System of Systems Risk Management (Andrew Kinder, United Kingdom)	Systems Modeling and Intelligent Control of Meat Drying Process (Hong Ma, University of Guelph, Canada)	SoS Capability Schedule Prediction (Jo Ann Lane, University of Southern California, USA)
	Differential Flatness of the Flux-decay Generator Model (Kevin Wedeward, New Mexico Tech)	Towards an Understanding of Emergence in Systems-of-Systems (Bernhard Frömel, Vienna University of Technology, Austria)	Modeling an Organizational View of the SoS Towards Managing its Evolution (Richard Turner, Stevens Institute of Technology, USA)
	Adaptable Mission Analysis and Decision System (Paul C. Hershey, Raytheon, Inc., USA)	Basic Study on Evaluation of Navigator's Mental Workload by Sticking Plaster-type Sensor (Koji Murai, Kobe University, Japan)	The State of Systems of Systems Engineering Knowledge Sources (Judith S. Dahmann, MITRE Corporation, USA)
	A Novel System and Technique for Enhancing the Lifetime of an Air Breathing Micro PEM Fuel Cell Based Power Source (Ramesh P., India)	A Study on Analysis of Characteristics of Ships Navigators' Look-out by Using OZT (Jun Kayano, Tokyo Unibersity of Marine Science and Technology, Japan)	Challenges of Risk Identification and Assessment in a Complex System of System Environment (Gennaro Avvento, Lockheed Martin, USA)
	A Systematic Investigation of Tools in Model Based System Engineering for Embedded Systems (Muhammad Rashid, Umm Al-Qura University, Saudi Arabia)	FPGA-based Authenticated Key Exchange Scheme Utilizing PUF and CSI for Wireless Networks (Ali Mohamed Allam, University of Helwan, Egypt)	Complex System Governance: Theory to Practice Challenges for System of Systems Engineering (Charles Keating, Old Dominion University)

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Day 3 (Wednesday 5/20)		
0730-0820	Registration	
0820-0920	Keynote 5: Ali Jadbabaie - Distributed Coordination and Consensus in Multi-agent Systems: Consensus, Flocking, and Social Learning	
0920 - 1020	Panel 2: TECHLAV: Testing, Evaluation and Control of Heterogeneous Large-scale Autonomous systems of Vehicles	
1020-1035	Break	
	Session 5A: Modeling and Analysis Methods (III)	**Session 5B:** Robotic Systems (III)	**Session 5C:** Modeling and Analysis Methods (IV)
1035 - 1240	Abandonment: A Natural Consequence of Autonomy and Belonging in Systems-of-Systems (Alejandro Salado, Buskerud and Vestfold University College, Norway)	Design of a Home Multi-Robot System for the Elderly and Disabled (Patrick J Benavidez, University of Texas at San Antonio)	SmartPowerchair: A Pervasive System of Systems (Paul Whittington, Bournemouth University, United Kingdom)
	UAF for System of Systems Modeling (Matthew Hause, Artisan Software Tools, United Kingdom)	Searching Robot Joint and Link Trees for Active Serial Chains using URDF (Michael Mortimer, Deakin University, Australia)	Enabling Emergent Behavior in Systems-of-Systems Through Bigraph-based Modeling (Dominik Wachholder, Johannes Kepler University Linz, Austria)
	Noise Level Classification for EEG using Hidden Markov Models (Sherif Haggag, Sh, Deakin University, Australia)	Software Interface Design for Home-Based Assistive Multi-Robot System (Patrick J Benavidez, University of Texas at San Antonio)	Bond Graph Modeling of a Class of System of Systems (Pushpendra Kumar, Polytech Lille - University of Lille 1 & Laboratory CRIStAL, France)
	Epoch Era Analysis in the Design of the Next Generation Offshore Subsea Construction Vessels (Henrique Gaspar, Aalesund University College, Norway)	Distributed Super Twisting Controller for Multiple Quadrotors (Luis F. Luque-Vega, ITESO University, Mexico)	Simulating SysML Models: Overview and Challenges (Mara Nikolaidou, Harokopio University of Athens, Greece)
	Robustness of Offshore Winches - The Value of Size (Henrique Gaspar, Aalesund University College, Norway)	Quaternion-based Trajectory Tracking Robust Control for a Quadrotor (Carlos Augusto Arellano-Muro, CINVESTAV Unidad Guadalajara, Mexico)	Multi-agent System of Systems to Monitor Wildfires (Mauricio Gomez, Purdue University, USA)
1240 - 1400	Lunch	
1400 - 1500	Keynote 6: Paul Rad - Chameleon: A Large-Scale, Reconfigurable Experimental Environment for Cloud Research "Engineers and Scientist need their own clouds"	
1500 - 1515	Break	
	Session 6A: SoSE Modeling and Control (I)	**Session 6B:** SoSE Modeling and Control (II)	**Session 6C:** Modeling and Analysis Methods (V)
1515 - 1720	Swarm Intelligence for the Control of a Group of Robots (Sreerenjini Nair, University of the Incarnate Word, USA)	Behavioral Detection in the Maritime Domain (James Scrofani, Naval Postgraduate School)	Low-Latency Software Defined Network for High Performance Clouds (Paul Rad, Rackspace, USA)
	Contribution to System of Systems Modeling (Wissam Khalil, Jean Monnet University, France)	Keyboard Control Method for Virtual Reality Micro-robotic Cell Injection Training (Syafizwan Faroque, Deakin University, Australia)	A Conditional Value-at-Risk Approach to Risk Management in System-of-Systems Architectures (Navindran Davendralingam, Purdue University)
	On the Study of Human Reliability in Transportation Systems of Systems (Subeer Rangra, Université de Technologie de Compiègne, France)	Smart Data-Harnessing for Financial Value in Short-Term Hire Electric Car Schemes (Peter Cooper, University of Bristol, United Kingdom)	A Perspective on Decision-Making Research in System of Systems Context (Dan DeLaurentis, Purdue University)
	Real-Time Neural Inverse Optimal Control for Position Trajectory Tracking of an Induction Motor (Maria Elena Antonio - Toledo, CINVESTAV, Unidad Guadalajara, Mexico)	SCV2: A Model-based Validation and Verification approach for System-of-Systems Engineering (Rami Baddour, University of Lugano, Switzerland)	Image Segmentation by Multi-Level Thresholding based on Fuzzy Entropy and Genetic Algorithm in Cloud (Paul Rad, Rackspace, USA)
	Bond Graph Model-Based for Fault Tolerance Level Assessment of a Wireless Communication Link in a System of Systems Concept (Ahmad Koubeissi, Polytech Lille, University of Lille 1, Lebanon)	A Mission-Oriented Approach for Designing System-of-Systems (Eduardo Silva, UFRN, Brazil)	Performance Enhancing of Storage System for Point Cloud Geographic Data (Marian Svalec, University of Zilina, Slovakia)

Keynote 1

Transformative design thinking of the systems of systems of a Smart City

Dave Welsh

The original networks for moving information date back to ancient roads connecting cities. Networks have evolved since then and so have cities. Cities today have grown into complex "systems of systems" of ageing infrastructures, but as much as the Internet has changed our lives it has not changed our cities yet. New demands on public-private data, and growing socio-economic problems are only compounded by a demanding ecological agenda. Natural disasters like Hurricane Sandy and Katrina continue to remind us cities also need a strong resiliency agenda.

As of 2008, most of the world's population now belongs to cities. In the next decades cities will grow at an alarmingly rate. Every city is becoming its own unique civic laboratory—a place where technology and policy is being adapted in novel ways. But how we have built cities so far doesn't scale for the future, and it is recognized by agencies like the World Bank that something has to change. There is public demand for a new model of Urbanism, some say Smart Cities but what is the new science of a Smart City?

This presentation will look at the latest transformative design thinking of the systems of systems of a Smart City from a number of different viewpoints. From the city architect and urban designer's perspective, from the city administration and the citizen's new governance perspective, and from the role IT is having in in bringing us past the Industrial age though the Information age and with any luck into a new age of innovation.

Biography:

Dave Welsh has been at Microsoft Corporation for more than 12 years, and works in Microsoft's Corporate Standards Group. Dave covers Microsoft's global policy on a variety of different standards agendas, these days largely focused on Smart Cities and also IoT. In his job Dave works with Microsoft development teams (including dWindows and Office) on their new Cloud services, as well as also working with Microsoft's customer facing subsidiaries globally.

Educated at Concordia University Center for Building Studies (Montreal) and the Technical University of Eindhoven, Department of Architecture (The Netherlands), Dave specialized in Computer Aided Architectural and Building Design back in the 1970's.

Keynote 2

Achieving Affordability Through SoS Integration

Reggie Cole

There are three basic approaches for achieving affordability. The most common approach is to pursue cost efficiencies, which is both necessary and valuable. The second approach is to prioritize capabilities and trade off requirements, ensuring that the portfolio budget is optimally allocated. The third approach, one that not pursued as often, is to integrate systems to realize SoS capabilities as a substitute for single-system capabilities. The reason this approach is not often used is that when we start to integrate systems to produce capabilities, things get complicated. Looking at the problem from an SoS perspective is very advantageous in navigating these complexities.

Biography:

Reggie Cole is a Senior Fellow and Master Architect with Lockheed Martin, specializing in enterprise and system-of-systems architecture. His background includes development of mission-critical systems for Government and commercial customers, including command and control systems, satellite communication systems, tactical communications systems, commercial telecommunications systems, and integrated manufacturing systems.

Keynote 3

Modeling and Simulation for Engineering of Self-Improving Service Systems of Systems: Barriers and Prospects

Bernard P. Zeigler

Modeling and Simulation (M&S) for Systems of Systems Engineering (SoSE) faces barriers to adoption due to scale of difficulty and cost – enormous size of system and component systems and ever evolving nature of components and their relation to the system. Model engineering, a newly identified subfield of M&S, aims at setting up a systematic, normalized, and quantifiable engineering methodology for construction, management and maintenance of the data, processes and organizations/people involved in the full lifecycle of a SoS model.

A service system has been defined as a SoS that comprises service providers and clients working together to coproduce value in complex value chains. Healthcare delivery, as an example, is the focus of attention to alter its trajectory of sky-rocketing cost and diminishing value to the consumer. Under what conditions can such a SoS learn to reform itself and continuously improve its quality while reducing its cost? A service SoS is made of humans and technology, where for the foreseeable future, self-improvement will be primarily based on human understanding augmented by machine learning, Therefore, in order for the system to continually self-improve it must provide the right data and models to support human experimentation with alternatives likely to improve the value of its services. It follows that there must be implemented systems that allow alternative component configurations (protocols, processes, procedures) to be continually tested and to correlate measured value with component configurations to provide performance ratings that humans can employ to select the most promising options. M&S systems and services then become essential infrastructure components within the panoply of services of any self-improving SoS.

In this talk, we probe the nature of model engineering in the context of self-improving service systems. To establish the background needed for this discussion, we briefly introduce the definition and theory of SoS as it relates to the Discrete Event System Specification (DEVS) formalism, a widely employed computational basis for M&S. With these concepts as foundation, we discuss the barriers and prospects for a service oriented model engineering and simulation environment to support design of self-improving SoS. We close with a discussion of how model engineering and DEVS enable new frameworks for application areas and the opportunities for further research.

Keynote 4

Connecting through Research Partnerships

Walt D. Downing

The University of Texas at San Antonio (UTSA) and Southwest Research Institute (SwRI) have a long history of collaboration due to the close ties between the faculty and staff of both organizations. SwRI currently employs 279 staff members with degrees from UTSA, which represents the most alumni of a single university at SwRI. UTSA has a significant number of full-time faculty members that were formerly employees of SwRI and currently engages 31 SwRI staff members as adjunct or adjoint faculty. UTSA and SwRI have also collaborated in joint PhD programs in Physics and Mechanical Engineering and will soon add a doctoral program in Civil and Environmental Engineering. Aside from these educational connections, UTSA and SwRI have agreed to collaborate in the "Connect Program" – an industry and academia seed grant program. Through funding provided by UTSA's Office of the Vice President for Research and SwRI's internal research program, competitive grants are awarded to co-investigators of both organizations to start new and innovative inter-institutional research programs. The Connect Program is intended to stimulate greater scientific and technological collaboration between the two institutions and lead to the pursuit and acquisition of extramural research funding. This program provides unprecedented opportunities for researchers to work together in addressing issues of mutual interest and need.

Biography:

Walt Downing is executive vice president of Southwest Research Institute (SwRI), which is an independent, nonprofit, applied research and development organization that provides innovative technical solutions in the physical sciences and engineering disciplines. Walt serves as the chief operating officer of SwRI directing the activities of ten technical operating divisions. He is also a member of the SwRI Board of Directors.

Walt holds a Bachelor of Science degree in electrical engineering from Southern Methodist University and a Master of Business Administration degree in management from the University of Texas at San Antonio (UTSA). He has been a management instructor at UTSA. Walt chairs the UTSA College of Engineering Advisory Council and is a member of the UTSA College of Business Advisory Council. He is a registered professional engineer in the states of Texas and Florida.

Keynote 5

Distributed Coordination and Consensus in Multi-agent Systems: Consensus, Flocking, and Social Learning

Ali Jadbabaie

Over the past few years there has been a rapidly growing interest in analysis, design and optimization of various types of collective behaviors in networked dynamic systems. In this talk, I will present some of the work that has been going on in my group over the past 10 years on collective phenomena such as flocking, schooling, rendezvous, synchronization, and motion coordination in multi-vehicle systems. The main underlying theme is to study emergence of agreement and consensus in various contexts. Next, I will present a dynamic model of information aggregation and social learning in which heterogeneous agents in a network would like to learn a true state of the world using a stream of private information and opinion exchanges with their neighbors. The information required for learning an unknown state of the world may not be at the disposal of any single agent and individuals engage in communication with their neighbors in order to learn from their experiences. Motivated by the practical difficulties of Bayesian updating of beliefs in a network setting,

I will present a simple update mechanism in which instead of incorporating the views of their neighbors in a fully Bayesian manner, agents use a simple updating rule that combines their personal experience and the views of their neighbors. I will characterize bounds on the rate of learning of this model and discuss the relationship between the rate of learning and the quality of observations as well as the location and influence of agents. Finally I will show the implications of the network topology and existence of influential agents on the rate of learning.

Biography:

Ali Jadbabaie is currently on leave from University of Pennsylvania (Penn) at MIT, where he is the Interim Director of the Socio-technical Systems Research Center and the Associate Director of a new MIT-wide entity on data and systems sciences with the mission is to bring together research and graduate education in Information and Decision Systems, Complex Sociotechnical Systems, and Statistics. He received his B.S. from Sharif University of Technology in Tehran, his M.S. in electrical and computer engineering from the University of New Mexico, and his Ph.D. in control and dynamical systems from the California Institute of Technology (Caltech). He was a postdoctoral scholar at Yale before joining the faculty at university of Pennsylvania (Penn) in July 2002, where he is currently the Alfred Fitler Moore Professor of Network Science (on leave) in the department of electrical and systems engineering. He has secondary appointments in computer and information science and operations and information management in the Wharton School. A faculty member in Penn's General Robotics, Automation, Sensing & Perception (GRASP) Lab, Prof. Jadbabaie is also the cofounder and former director of the Raj and Neera Singh Program in Networked & Social Systems Engineering (NETS) at Penn Engineering.

NETS is a new undergraduate interdisciplinary degree program focused on network science and engineering, operations research, computer science, and social sciences. He is also a faculty member of The Warren Center for Network & Data Sciences at Penn and a faculty affiliate of the Center for Technology, Innovation and Competition at Penn Law. He is the inaugural editor-in-chief of IEEE Transactions on Network Science and Engineering, a new interdisciplinary journal sponsored by several IEEE Societies. He is a recipient of an NSF Career Award, an ONR Young Investigator Award, the O. Hugo Schuck Best Paper Award from the American Automatic Control Council, and the George S. Axelby Best Paper Award from the IEEE Control Systems Society. He is an IEEE Fellow. His current research interests include the interplay of dynamic systems and networks with specific emphasis on multiagent coordination and control, distributed optimization, network Science, and network economics.

Keynote 6

Chameleon: A Large-Scale, Reconfigurable Experimental Environment for Cloud Research "Engineers and Scientist need their own clouds"

Paul Rad

Cloud services have become ubiquitous to all major 21st century economic activities and has emerged as a critical infrastructure for scientific, enterprise, and commercial computing. To support the creation of such infrastructure, there is a need for quality testbeds for development and testing. Commercial companies create their own testbeds, but academic and government cloud researchers don't have access to them. With funding from the National Science Foundation (NSF), the Chameleon project will provide such a large-scale platform to the open research community allowing them explore transformative concepts in deeply programmable cloud services, design, and core technologies. Chameleon will allow users to explore problems ranging from the creation of Software as a Service to kernel support for virtualization.

This broad range of supported research includes many other areas such as developing Platforms as a Service, creating new and optimizing existing Infrastructure as a Service components, investigating software-defined networking, and optimizing virtualization technologies.

Academic and scientific research often involves the construction of mathematical and numerical models to solve scientific and engineering problems. Traditionally, these complex and intensive computational models have been implemented on super computers or high-performance computing (HPC) infrastructure. HPC has revolutionized engineering and scientific research, however, it is difficult to setup and operate, and can create a painful experience for researchers who often have to wait in a long line whether it's for a few hours or a few days. This session represents an evolution of the cloud testbed for radically transforming how cloud serve the needs of scientific research computing and education.

Biography:

As the Chief Research Officer at UT San Antonio and VP Open Cloud Research at Rackspace, Paul is responsible for bridging the gap between industry and academia research and education. Paul started his career as a computer architect by founding Data Processing Corp. overseas before moving to the United States, and later held product and services leadership roles at Data Concepts and Dell Inc.

He has numerous published articles on enterprise solutions and holds several U.S. patents in the fields of virtualization, cloud computing, software engineering and quality assurance.

Panel 1

Challenges in moving from a single system perspective to a SoS perspective

As our world continues to evolve to be more interconnected, we have witnessed a transformation where most systems are part of a System of Systems. This transformation has made it essential for Systems Engineers and Architects to shift their perspective from focusing on a single system to focusing on the system as part of a system of systems. This panel will look at the challenges in moving from a single system perspective to a SoS perspective. This requires expanding the systems thinking to SoS thinking. The challenges include addressing the differences in applying the SE processes; estimating and managing schedule, cost and risk; and managing the system evolution in the context of SoS.

Panelists:
Moderator – Garry Roedler, Lockheed Martin, USA
Jo Ann Lane, University of Southern California, USA
Richard Turner, Stevens Institute of Technology, USA
Judith S. Dahmann, MITRE Corporation, USA
Gennaro Avvento, Lockheed Martin, USA
Reggie Cole, Lockheed Martin, USA

Panel 2

TECHLAV:
Testing, Evaluation and Control of Heterogeneous Large-scale Autonomous systems of Vehicles

This panel session puts forth a new research enterprise for modeling and control of autonomous vehicles. The effort constitutes a consortium of two universities and a two-year Tribal College forming a multi-disciplinary Center for Testing, Evaluation and Control of Heterogeneous Large-scale Autonomous systems of Vehicles (TECHLAV). This Center will conduct collaborative, integrated research and education programs with a focus on Large Scale Autonomous Systems of Vehicles (LSASV) that can be deployed in uncertain and dynamical environments (e.g. a battlefield). TECHLAV will spur innovation through careful design, adaptation, and testing to achieve two main goals: a) Teaming and Cooperative Control of LSASV, and b) Testing, Evaluation, Validation and Verification (TEV&V) of LSASV.

Panelists:

Barry L. Burks, Vice Chancellor for Research and Economics Development, NCA&T State University

Paul Hershey, Raytheon Corporation

Ali Karimoddini, NCA&T State University

Edward Tunstel, Applied Physics Laboratory, John Hopkins University

Nader Vadiee, Southwest Indian Polytechnic Institute

Mo Jamshidi, the University of Texas, San Antonio

Abbdollah Homaifar, NCA&T State University

SoSE2015 Papers by Sessions

Notes: 1) The paper ID to the left of each paper's title can be used to find the corresponding abstract of the paper at the end of the technical program. 2) In the parentheses, only the presenter's or first author's name is shown.

Session 1A: Architecture, Design, and V&V Methods and Big Data Analytic

1570131033   A Wrapper-based feature selection approach using Bees Algorithm for a wood defect classification system (Michael Packianather, Cardiff University, United Kingdom)

1570105865   Data-Centric Development of Architecture Models with the DM2 and MS-SDF (Matthew Amissah, Old Dominion University)

1570101843   A Fast Map-Reduce Algorithm for Burst Errors in Big Data Cloud Storage (Brian T Kelley, University of Texas at San Antonio)

1570091359   Towards Security Software Engineering the Smart Grid as a System of Systems (Vanea Chiprianov, University of Pau, France)

1570097461   A service oriented virtual environment for complex system analysis: Preliminary Report (Charles E. Dickerson, Loughborough University, United Kingdom)

Session 1B: Robotic Systems (I)

1570091813   Conceptual Design for Fully Autonomous Aerial and Ground System for Precision Agriculture (Matthew Joordens, Deakin University, Australia)

1570101613   Omnidirectional Rule-Based Free Gait Utilizing Restrictedness (Ferat Sahin, Rochester Institute of Technology)

1570091865   Underwater Swarm Robotics Review (Benjamin Champion, Deakin University, Australia)

1570092235   A System of Systems Analysis of a Multi-Probe SPM System (Eyup Cinar, Rochester Institute of Technology)

1570088975   Electric Mobility and Charging: Systems of Systems and Infrastructure Systems (G. Maarten Bonnema, HBV-NISE, Kongsberg, Norway & University of Twente, Enschede, The Netherlands)

Session 1C: Control Systems (I)

1570100343   Continuous improvement of technical systems using Design for X (Christer Elverum, Norwegian University of Science and Technology, Norway)

1570101107   Intelligent Adaptive Cruise Control System Design and Implementation (Islam Kilic, Eskisehir Osmangazi University, Turkey)

1570101029   Real-Time Direct Field-Oriented and Second Order Sliding Mode Controllers of Induction Motor for Electric Vehicles Applications (Eduardo Quintero, Advanced Studies and Research Center of the National Polytechnic Institute, Mexico)

1570092715   Efficient Design and Analysis of Battery Switching Stations for the Collaborative Wireless Network of Mobile Robots (Hammad Khan, Islamia University Bahawalpur, Pakistan)

1570089525   Simulation method for multi-machine and multi-task production scheduling in steelmaking-continuous casting process (Jianyu Long, Chongqing University, P.R. China)

Session 2A: Reliability, Security, and Safety and Emerging Navigation Technologies

1570099473   Leveraging Wireless Communication Systems for Aiding Inertial-Based Navigation Systems (Aly El-Osery, New Mexico Tech)

1570101849   Cognitive Interference Avoidance in 4th Generation GPS (Brian T Kelley, University of Texas at San Antonio)

1570087511   Defending Mechanisms for Protecting Power Systems against Intelligent Attacks (Longfei Wei, Florida International University)

1570091545   Uncertainty, elicitation of experts' opinion, and human failures: Challenges for RAM analysis of ERTMS SoS (Mohamed Sallak, Compiegne University of Technology & Heudiasyc Laboratory UMR CNRS 7253, France)

1570100511   Cluster-Based Correlation of Severe Braking Events with Time and Location (Guoyan Cao, University of Houston)

Session 2B: Robotic Systems (II)

1570101609   Dual Flexible 7 DoF Arm Robot Learns like a Child to Dance using Q-Learning (Ferat Sahin, Rochester Institute of Technology)

1570101515   SLAM based Shape Adaptive Coverage Control using Autonomous Vehicles (Junnan Song, University of Connecticut)

1570101619   Simultaneous Localization and Mapping using a Micro-Particle Swarm Optimization (Christopher Monfredo, Rochester Institute of Technology)

1570091827   Tracking Animals to Determine Swarm Behavior (Benjamin Champion, Deakin University)

1570101615   Modeling and Dynamic Control for a Hexapod Robot (Ferat Sahin, Rochester Institute of Technology)

Session 2C: Control Systems (II)

1570105307   Research directions in SOSE (Vernon Ireland, The University of Adelaide, Australia)

1570101497   Distributed Leader-Follower Formation Control for Multiple Quadrotors with Weighted Topology (Zhicheng Hou, Université de Technologie de Compiègne & UMR CNRS 7253, Heudiasyc, France)

1570101583   Real-Time Flocking of Multiple-Quadrotor System of Systems (Osamah Saif, Université de Technologie de Compiègne, France)

1570101705   A low cost velocity control of double sided LSRM by sliding mode control and PIC18F452 (Mahir Dursun, Gazi University & Faculty of Technology, Turkey)

1570101357   Real-time FPGA Decentralized Inverse Optimal Neural Control for a Shrimp Robot (Gener Quintal, Cinvestav, Mexico)

Session 3A: Modeling and Analysis Methods (I)

1570087489   A Theory of Complexity Escalation and Collapse for System of Systems (Joseph Bradley, Leading Change, LLC, USA)

1570088561   Factory Production Line as SoS; a Case Study in Airplane Engine Component Manufacturing (Gerrit Muller, HBV-NISE & TNO-ESI, Norway)

1570088725   A Model of Enterprise Systems Engineering Contributions to Acquisition Success (Jill Drury, The MITRE Corporation)

1570089243   Using Systems Engineering for Improving Autonomous Robot Performances (Stefan Marchlewitz, Bergische Universität Wuppertal, Germany)

1570091591   Improved Hybrid Variable and Fixed Step Size Least Mean Square Adaptive Filter Algorithm with Application to Time Varying System Identification (Farqad Yasin Farhan, Iraq)

Session 3B: Engineering Education and Design

1570101625   An Update on the Framework for a Junior Level Design Course (Aly El-Osery, New Mexico Tech)

1570088469   Systems Engineering in Industry Internship and Academic Projects (Kourosh Rahnamai, Western New England University, USA)

1570101787   On the Impacts of Project Based Learning for Workplace Preparedness of Engineering Graduates (Seda Senay, New Mexico Tech)

1570088717   The OpenOrbiter CubeSat as a System-of-Systems (SoS) and How SoS Engineering (SoSE) Aids CubeSat Design (Sofiane Chaieb, University of North Dakota)

1570096441   Fuzzy Control of Cascaded H-Bridge Rectifier Based on Selective Harmonic Elimination Technique (Amirhossein Moeini, University of Texas at San Antonio)

Session 3C: Algorithms and Design in SoSE

1570087107   Random Sampling in Collaborative and Distributed Mobile Sensor Networks utilizing Compressive Sensing for Scalar Field Mapping (Minh T Nguyen, Oklahoma State University)

1570087953   A Systematic Mapping of the Research Literature on System-of-Systems Engineering (Jakob Axelsson, Mälardalen University & Swedish Institute of Computer Science, Sweden)

1570088245   A Model Based Safety Architecture Framework for Dutch High Speed Train Lines (Katja Schuitemaker, University of Twente, The Netherlands)

1570088489   Direct versus Stigmergic Information Flow in Systems-of-Systems (Bernhard Frömel, Vienna University of Technology, Austria)

1570091589   Detection of Aggressive Driving Behavior and Fault Behavior Using Pattern Matching (Jessy George Smith, Cognizant Technology Solutions Limited, India)

Session 4A: Modeling and Analysis Methods (II)

1570096407   A Model Based Approach to System of Systems Risk Management (Andrew Kinder, United Kingdom)

1570096981   Differential Flatness of the Flux-decay Generator Model (Kevin Wedeward, New Mexico Tech)

1570100019   Adaptable Mission Analysis and Decision System (Paul C. Hershey, Raytheon, Inc., USA)

1570096413   A Novel System and Technique for Enhancing the Lifetime of an Air Breathing Micro PEM Fuel Cell Based Power Source (Ramesh P., India)

1570096959   A Systematic Investigation of Tools in Model Based System Engineering for Embedded Systems (Muhammad Rashid, Umm Al-Qura University, Saudi Arabia)

Session 4B: Navigation and Emergence in SoSE

1570101223   Systems Modeling and Intelligent Control of Meat Drying Process (Hong Ma, University of Guelph, Canada)

1570100877   Towards an Understanding of Emergence in Systems-of-Systems (Bernhard Frömel, Vienna University of Technology, Austria)

1570091419   Basic Study on Evaluation of Navigator's Mental Workload by Sticking Plaster-type Sensor (Koji Murai, Kobe University, Japan)

1570101553   A Study on Analysis of Characteristics of Ships Navigators' Look-out by Using OZT (Jun Kayano, Tokyo Unibersity of Marine Science and Technology, Japan)

1570100321   FPGA-based Authenticated Key Exchange Scheme Utilizing PUF and CSI for Wireless Networks (Ali Mohamed Allam, University of Helwan, Egypt)

Session 4C: Special Session: Moving from SE to SoSE

1570118991   SoS Capability Schedule Prediction (Jo Ann Lane, University of Southern California, USA)

1570119027   Modeling an Organizational View of the SoS Towards Managing its Evolution (Richard Turner, Stevens Institute of Technology, USA)

1570119003   The State of Systems of Systems Engineering Knowledge Sources (Judith S. Dahmann, MITRE Corporation, USA)

1570118893   Challenges of Risk Identification and Assessment in a Complex System of System Environment (Gennaro Avvento, Lockheed Martin, USA)

1570101035   Complex System Governance: Theory to Practice Challenges for System of Systems Engineering (Charles Keating, Old Dominion University)

Session 5A: Modeling and Analysis Methods (III)

1570101757   Abandonment: A Natural Consequence of Autonomy and Belonging in Systems-of-Systems (Alejandro Salado, Buskerud and Vestfold University College, Norway)

1570100585   UAF for System of Systems Modeling (Matthew Hause, Artisan Software Tools, United Kingdom)

1570103395   Noise Level Classification for EEG using Hidden Markov Models (Sherif Haggag, Sh, Deakin University, Australia)

1570101673   Epoch Era Analysis in the Design of the Next Generation Offshore Subsea Construction Vessels (Henrique Gaspar, Aalesund University College, Norway)

1570101675   Robustness of Offshore Winches - The Value of Size (Henrique Gaspar, Aalesund University College, Norway)

Session 5B: Robotic Systems (III)

1570101835   Design of a Home Multi-Robot System for the Elderly and Disabled (Patrick J Benavidez, University of Texas at San Antonio)

1570102263   Searching Robot Joint and Link Trees for Active Serial Chains using URDF (Michael Mortimer, Deakin University, Australia)

1570101847   Software Interface Design for Home-Based Assistive Multi-Robot System (Patrick J Benavidez, University of Texas at San Antonio)

1570101789   Distributed Super Twisting Controller for Multiple Quadrotors (Luis F. Luque-Vega, ITESO University, Mexico)

1570101829   Quaternion-based Trajectory Tracking Robust Control for a Quadrotor (Carlos Augusto Arellano-Muro, CINVESTAV Unidad Guadalajara, Mexico)

Session 5C: Modeling and Analysis Methods (IV)

1570101259   SmartPowerchair: A Pervasive System of Systems (Paul Whittington, Bournemouth University, United Kingdom)

1570101693   Enabling Emergent Behavior in Systems-of-Systems Through Bigraph-based Modeling (Dominik Wachholder, Johannes Kepler University Linz, Austria)

1570101573   Bond Graph Modeling of a Class of System of Systems (Pushpendra Kumar, Polytech Lille - University of Lille 1 & Laboratory CRIStAL, France)

1570101679   Simulating SysML Models: Overview and Challenges (Mara Nikolaidou, Harokopio University of Athens, Greece)

1570101503   Multi-agent System of Systems to Monitor Wildfires (Mauricio Gomez, Purdue University, USA)

Session 6A: SoSE Modeling and Control (I)

1570100593   Swarm Intelligence for the Control of a Group of Robots (Sreerenjini Nair, University of the Incarnate Word, USA)

1570100477   Contribution to System of Systems Modeling (Wissam Khalil, Jean Monnet University, France)

1570100625   On the Study of Human Reliability in Transportation Systems of Systems (Subeer Rangra, Université de Technologie de Compiègne, France)

1570100555   Real-Time Neural Inverse Optimal Control for Position Trajectory Tracking of an Induction Motor (Maria Elena Antonio - Toledo, CINVESTAV, Unidad Guadalajara, Mexico)

1570101761   Bond Graph Model-Based for Fault Tolerance Level Assessment of a Wireless Communication Link in a System of Systems Concept (Ahmad Koubeissi, Polytech Lille, University of Lille 1, Lebanon)

Session 6B: SoSE Modeling and Control (II)

1570101813   Behavioral Detection in the Maritime Domain (James Scrofani, Naval Postgraduate School)

1570101857   Keyboard Control Method for Virtual Reality Micro-robotic Cell Injection Training (Syafizwan Faroque, Deakin University, Australia)

1570101791   Smart Data-Harnessing for Financial Value in Short-Term Hire Electric Car Schemes (Peter Cooper, University of Bristol, United Kingdom)

1570101859   SCV2: A Model-based Validation and Verification approach for System-of-Systems Engineering (Rami Baddour, University of Lugano, Switzerland)

1570101723   A Mission-Oriented Approach for Designing System-of-Systems (Eduardo Silva, UFRN, Brazil)

Session 6C: Modeling and Analysis Methods (V)

1570119225	Low-Latency Software Defined Network for High Performance Clouds (Paul Rad, Rackspace, USA)

1570106209	A Conditional Value-at-Risk Approach to Risk Management in System-of-Systems Architectures (Navindran Davendralingam, Purdue University)

1570106469	A Perspective on Decision-Making Research in System of Systems Context (Dan DeLaurentis, Purdue University)

1570119331	Image Segmentation by Multi-Level Thresholding based on Fuzzy Entropy and Genetic Algorithm in Cloud	(Paul Rad, Rackspace, USA)

1570102555	Performance Enhancing of Storage System for Point Cloud Geographic Data (Marian Svalec, University of Zilina, Slovakia)

Paper Abstract and Author Index

Each paper's abstract is listed according to its paper ID. Author index can be found at the end of the technical program.

Paper Abstracts

ID: 1570087107

Title: **Random Sampling in Collaborative and Distributed Mobile Sensor Networks utilizing Compressive Sensing for Scalar Field Mapping**

Authors: *Minh T Nguyen and Keith A Teague (Oklahoma State University, USA)*

Abstract: In this paper, we propose an algorithm supporting distributed mobile sensor networks (MSN) for scalar field mapping that has many applications such as environmental monitoring or battle field surveillance, etc. We exploit the integration between compressive sensing (CS) and the collaboration of the mobile sensors. In the algorithm each distributed mobile sensor measures at random positions in the sensing area to create one CS measurement and finally shares the measurement with others by communicating through its neighbors. The convergence time is considered while the sensors exchange their measurements. After all the sensors achieve the number of CS measurements needed, a CS recovery algorithm is applied at each mobile sensor to reconstruct sensory readings from all the positions in the sensing area that need to be observed. The total communication energy consumption is formulated, analyzed and simulated.

ID: 1570087489

Title: **A Theory of Complexity Escalation and Collapse for System of Systems**

Authors: *Joseph Bradley (Leading Change, LLC, USA)*
Mahmoud Efatmaneshnik (University of New South Wales - Canberra & Australian Defence Force Academy, Australia)
Mohammad Rajabalinejad (University of Twente, The Netherlands)

Abstract: In this paper we urge the creation of new managerial tools and techniques that are relevant to the complexity of today's system of systems (SOS). Normal modes of command and control systems cannot be effective under conditions where new constraints are added on a recurrent basis to the system of systems in response to emergent problems within the systems due to increased coupling introduced in component elements of the SOS. We present a first-step understanding of why unanticipated failures find more potential and more pathways to their occurrence when interventions in SOS operations, standards or processes are conducted without enough insight and without a care for basic laws of complexity. We then demonstrate a condition where the incremental changes actually lead to failure of the SOS to meet its performance parameters. We hope that this work set the foundation for exploring the effects of coupling across hierarchical levels of SOS.

ID: 1570087511

Title: **Defending Mechanisms for Protecting Power Systems against Intelligent Attacks**

Authors: *Longfei Wei, Amir Moghadasi, Aditya Sundararajan and Arif Sarwat (Florida International University, USA)*

Abstract: The power system forms the backbone of a modern society, and its security is of paramount importance to nation's economy. However, the power system is vulnerable to intelligent attacks by attackers who have enough knowledge of how the power system is operated, monitored and controlled. This paper proposes a game theoretic approach to explore and evaluate strategies for the defender to protect the power systems against such intelligent attacks. First, a risk assessment is presented to quantify the physical impacts inflicted by attacks. Based upon the results of the risk assessment, this paper represents the interactions between the attacker and the defender by extending the current zero-sum game model to more generalized game models for diverse assumptions concerning the attacker's motivation. The attacker and defender's equilibrium strategies are attained by solving these game models. In addition, a numerical illustration is demonstrated to warrant the theoretical outcomes.

ID: 1570087953

Title: **A Systematic Mapping of the Research Literature on System-of-Systems Engineering**

Authors: *Jakob Axelsson (Mälardalen University & Swedish Institute of Computer Science, Sweden)*

Abstract: The research area systems-of-systems engineering has increased rapidly over the last decade and now contains a substantial body of literature. To get an overview of the field, a systematic mapping of the literature has been done, covering over 3000 papers. It revealed a field massively dominated by US researchers, with an emphasis on military and space systems. A large number of people are involved, but few researchers focus on the area, and citations are fairly low compared to other fields. Important research topics include architecture, modeling and simulation, integration and interoperability, communication, sustainability, and safety and security. There are signs of immaturity within the research area, and it is recommended that existing venues are complemented with an international scientific event with very high standards for submissions.

ID: 1570088245

Title: **A Model Based Safety Architecture Framework for Dutch High Speed Train Lines**

Authors: *Katja Schuitemaker (University of Twente, The Netherlands)*
Jasper Gerard Braakhuis (Consultant Systems Engineering, The Netherlands)
Mohammad Rajabalinejad (University of Twente, The Netherlands)

Abstract: This paper presents a model-based safety architecture framework (MBSAF) for capturing and sharing architectural knowledge of safety cases of safety-critical systems of systems (SoS). Whilst architecture frameworks in the systems engineering domain consider safety often as dependent attribute, this study focusses specifically on sharing architectural knowledge of safety cases between stakeholders and managing safety in systems development. For this purpose, we adapt the A3 architecture overview (A3AO) tool. The application is shown though the case study of Dutch high speed train lines and shows how to derive requirements from various stakeholders by carrying out iterative validations of the A3AOs. The implemented technique consists of systems modeling language-based (SysML) diagrams. Outcomes of the assessment lead to guidelines for two A3AOs. This results in increasing and effective interaction between stakeholders, more overview for managing safety complexity, more insight into finding required safety information, and therefore; an increasing efficiency in safety engineering.

ID: 1570088469

Title: **Systems Engineering in Industry Internship and Academic Projects**

Authors: *Kourosh Rahnamai (Western New England University, USA)*

Abstract: Large complex Industrial projects most often are interdisciplinary and require a complex systems engineering approach to guarantee success. In this paper we present a successful implementation of a true systems engineering approach to a summer internship program in industry. We exported the methods and lessons learned to an academic environment. For each project a group of six to fifteen students were selected to solve a practical industry problem and produce a detailed design for the specified project. Different aspects of the project plan were assigned to members of each group who were the most qualified or who expressed interest in a specific area of specialization. Three industrial and one academic implementation of this method are explained in this paper.

ID: 1570088489

Title: **Direct versus Stigmergic Information Flow in Systems-of-Systems**

Authors: *Hermann Kopetz (Technical University of Vienna, Austria)*
Bernhard Frömel and Oliver Höftberger (Vienna University of Technology, Austria)

Abstract: The information flow among the Constituent Systems of a System-of-Systems can take place via
two different channels: the message transport along communication channels in cyber space which
includes the human-to-human communication in natural language among the humans that are part of
the Constituent Systems, and the indirect information flow via sensors and actuators to the physical
environment, called the stigmergic information flow. In many cases the stigmergic information
flow forms an important link for the closure of control loops that can lead to emergent behavior.
This paper elaborates the concepts of stigmergy and compares the characteristics of the stigmergic
information flow versus the message based information flow in a System-of-Systems.

ID: 1570088561

Title: **Factory Production Line as SoS; a Case Study in Airplane Engine Component Manu-
facturing**

Authors: *Gerrit Muller (HBV-NISE & TNO-ESI, Norway)*
June Andersen (GKN Aerospace, Norway)

Abstract: Factories are examples of system of systems with all related problems of integral ownership, lack of
overview, emerging properties, and many stakeholders making decisions locally. In the past 7 years,
engineers at the GKN Aerospace factory in Kongsberg have been modeling parts of the factory to
tackle the complexity of such factory. In successive papers, they have shown that modeling helps
in understanding, reasoning, communication, and decision making. In this paper, we zoom out
and describe from systems of systems perspective the challenges of modeling the system to improve
factory level performance indicators, such as inventory levels and production cycle times.

ID: 1570088717

Title: **The OpenOrbiter CubeSat as a System-of-Systems (SoS) and How SoS Engineering (SoSE) Aids CubeSat Design**

Authors: *Sofiane Chaieb, Michael Wegerson, Jeremy Straub, Ronald Marsh, Benjamin Kading and David Whalen (University of North Dakota, USA)*

Abstract: This paper discusses the use of the system-of-systems (SoS) methodology and SoS engineering (SoSE) to the challenge of the design and operation of a CubeSat class spacecraft. It considers this in the context of one critical component system, the electrical power system (EPS) which interacts with virtually all other systems onboard the spacecraft. The spacecraft is also considered in the context of being a system-component of a larger mission system-of-systems. The efficacy of SoSE use for this endeavor is considered and recommendations are made for the use of SoS and SoSE by other small spacecraft and, more broadly, spacecraft developers.

ID: 1570088725

Title: **A Model of Enterprise Systems Engineering Contributions to Acquisition Success**

Authors: *Jill Drury, Gary Klein, Mark Pfaff and Craig Bonaceto (The MITRE Corporation, USA)*

Abstract: This paper presents a conceptual causal model for the contributions of enterprise systems engineering (ESE) to systems acquisition success when the systems under development are complex and include direct interaction between users and the finished product (versus an embedded effort). The model takes the form of a directed acyclic graph and its major components consist of collaboration support, ESE technique application, system characteristics, and organizational characteristics. As initial validation, we converted this conceptual model to a computational model using our Descriptive to Executable SIMulation (DESIM) modeling method. By using the executable model, we obtained unbiased data based on subject matter experts' (SMEs') mental models so that we could determine the degree to which the SMEs in the aggregate agreed with the model's components and relationships.

ID: 1570088975

Title: Electric Mobility and Charging: Systems of Systems and Infrastructure Systems

Authors: *G. Maarten Bonnema (HBV-NISE, Kongsberg, Norway & University of Twente, Enschede, The Netherlands, The Netherlands)*
Gerrit Muller (HBV-NISE & TNO-ESI, Norway)
Lisette Schuddeboom (University of Twente, The Netherlands)

Abstract: In light of European and worldwide environmental programs, reduction of CO2 emissions and improvements in air quality receive a lot of attention. A prominent way to improve on both aspects is the replacement of Internal Combustion Engine Vehicles with Electrical Vehicles. Yet, simply replacing vehicles will not result in proper electric mobility because using Electrical Vehicles depends on many systems and infrastructures including the chargers, parking sites and payment structures. In this paper we will take an explorative view on Electric Mobility and match developments in that area with Systems of Systems Engineering. We will also present a case study on charging many Electric Vehicles.

ID: 1570089243

Title: Using Systems Engineering for Improving Autonomous Robot Performances

Authors: *Stefan Marchlewitz and Jan-Peter Nicklas (Bergische Universität Wuppertal, Germany)*
Petra Winzer (University of Wuppertal, Germany)

Abstract: Handling complexity is a major challenge for the development of product systems, especially in the field of autonomous robots. Considering the production system of such an autonomous robot, which is more and more realized by collaborative System of Systems (SoS), increases the complexity. To manage this complexity, a systematic approach is needed. The following paper describes an approach to analyze and derive design recommendations based on the principles of Generic Systems Engineering (GSE). This approach uses a common model of thinking, a unified system model and a standardized procedure to develop a system. The system model is actualized within the procedure and allows a problem localization for further design changes. A simplification is achieved by limiting the considerate part of system over functionalities.

ID: 1570089525

Title: **Simulation method for multi-machine and multi-task production scheduling in steelmaking-continuous casting process**

Authors: *Jianyu Long (Chongqing University, USA)*
Zhong Zheng and Xiaoqiang Gao (Chongqing University, P.R. China)
Kai Chen (CISDI Electric Technology Co., Ltd, P.R. China)

Abstract: The steelmaking-continuous casting (SCC) process, which consists of steelmaking, refining and continuous casting stage, is usually the critical process in iron and steel industry. This paper aims to propose a simulation method for the realistic hybrid flow shop scheduling problem resulting from the SCC process. A mathematic model based on a comprehensive investigation is built first. Then, a simulation method which can decide the time scope of production materials on each stage in the simulation initialization is presented. Additionally, the matching decision algorithm is employed to match the machines and production materials in the simulation running process. To evaluate the simulation method, numerical experiments are conducted with an 8 hours test instance generated according to a real-world production process. The results show that the simulation method is a feasible and effective method for production scheduling in SCC process.

ID: 1570091359

Title: **Towards Security Software Engineering the Smart Grid as a System of Systems**

Authors: *Vanea Chiprianov (University of Pau, France)*
Laurent Gallon (University of Pau & LIUPPA, France)
Khouloud Salameh (University of Pau, France)
Manuel Munier (Univ, France)
Jamal El Hachem (University of Pau, France)

Abstract: The Smart Grid, the next generation power grid, comes with promises of widely distributed automated energy delivery, self-monitoring, self-healing, energy efficiency, utility and cost optimization. However, as attacks on the current power grid and similar systems indicate, the Smart Grid will be vulnerable to all kinds of attacks and will even raise new security challenges, due to its complex nature. In this paper we analyze this complexity of the Smart Grid as a System of Systems, and the specific security challenges it raises. To address these challenges we propose a vision/framework based on principles of Software Engineering. This framework structures and brings together the research on Smart Grid security.

ID: 1570091419

Title: **Basic Study on Evaluation of Navigator's Mental Workload by Sticking Plaster-type Sensor**

Authors: *Koji Murai and Yuji Hayashi (Kobe University, Japan)*
Kazusuke Maenaka (University of Hyogo, Japan)
Kohei Higuchi (AffordSENS Corporation, Japan)

Abstract: The evaluation of mental workload using a physiological index is useful to read the performance of ship bridge teammates: a captain, a duty officer, a helmsman, and a pilot. The physiological indices, heart rate variability (R-R interval), salivary amylase and nitrate, and facial (nasal) temperature, are fine indices for picking up during their ship handling. It usual evaluates for veteran-seafarers on both of simulator and real ship by subjective evaluations; however, we think it is not enough, and need to utilize the numerical values for mental and performance evaluation. This paper proposes that physiological index and body acceleration do well for evaluating navigator's mental workload and performance for real ship and simulator-based ship handling. The result shows the heart rate variability and body accelerations read their mental workload and performance well.

ID: 1570091545

Title: **Uncertainty, elicitation of experts' opinion, and human failures: Challenges for RAM analysis of ERTMS SoS**

Authors: *Mohamed Sallak (Compiegne University of Technology & Heudiasyc Laboratory UMR CNRS 7253, France)*
Walter Schon and Sebastien Destercke (UTC, France)
Christophe Simon (University of Lorraine, France)
Frederic Vanderhaegen (University of Valenciennes, France)
Denis Berdjag (University of Valanciennes, France)

Abstract: This paper has three main objectives. The first objective is to summarize the requirements for RAM (Reliability, Availability, and Maintainability) parameters of European Rail Traffic Management System (ERTMS) defined in the railway standards. The second objective is to emphasize that the RAM requirements should be considered at the ERTMS SoS level. The third objective is to highlight major issues, when dealing with ERTMS SoS, which are not treated or clearly defined in the railway standards. Indeed, the RAM parameters definitions do not take into account all types of uncertainty in failure data and human failures, and do not propose specific methods to obtain failure data from experts' opinion. In this work, a number of methods have been proposed to deal with these issues.

ID: 1570091589

Title: **Detection of Aggressive Driving Behavior and Fault Behavior Using Pattern Matching**

Authors: *Jessy George Smith (Cognizant Technology Solutions Limited, India)*
Kirthi Ponnuru and Mandar Patil (Cognizant Technology Solutions, India)

Abstract: In time series processing, pattern matching is often used to cater to visual perception of behaviors of interest. The selection of data representation methods and distance measures is driven by domain considerations and is critical for implementation from lab to production scale. This paper discusses use cases from different domains where select pattern matching techniques are used. In the first use case, a multi-variable pattern matching method has been used to detect and classify driving behavior. The risk associated with aggressive behavior is computed and applied to derive the driving scores that feed into the fleet performance management service. In the second use case, pattern matching algorithms are used for the real time detection and diagnosis of faults in transformer systems. The evolving risk profile is used as lead indicator of impending failure. This feature is integrated into the condition monitoring system and configured to issue maintenance work orders.

ID: 1570091591

Title: **Improved Hybrid Variable and Fixed Step Size Least Mean Square Adaptive Filter Algorithm with Application to Time Varying System Identification**

Authors: *Farqad Yasin Farhan (Koya University, Iraq)*
Siddeeq Ameen (Dean, Iraq)

Abstract: In this paper a novel simplified adaptive filter algorithm is introduced which is based on the hybrid operation of variable step size and fixed step size least mean square adaptive algorithm. In this proposed algorithm the variable step size is used in the first stage, the algorithm adapts the fixed step size least mean square (LMS) whenever an acceptable mean square error threshold is reached which ensures the required steady state error and stability. Simulation results show that the proposed algorithm outperforms the standard least mean square (LMS) in the desired transient behavior, and outperforms the normalized least mean square (NLMS) algorithm in the desired transient and the steady state behaviors. It is shown that the proposed algorithm is capable of tracking time varying systems with improved performance. Also, the computational complexity of the proposed algorithm is reduced compared with the ordinary least mean square (LMS).

ID: 1570091813

Title: **Conceptual Design for Fully Autonomous Aerial and Ground System for Precision Agriculture**

Authors: *Matthew Joordens, Tom Brodie and Thomas Oberli (Deakin University, Australia)*
Phil Swinsburg (Unmanned Systems Australia, Australia)

Abstract: There are few regulatory restrictions involving the use of fully autonomous unmanned aerial systems in unpopulated, farming areas of Australia. The combination of a fully autonomous aerial and ground systems would provide efficient and cost effective retrieval of soil and vegetation data for use in precision agriculture. The aerial system will survey the site and collect spectral imagery to analyse plant density, stress and nutrition. The ground sensors will collect soil moisture content readings throughout the site. The data from both systems will be collated at a central base station. The base station will also provide housing and interface with the aerial system.

ID: 1570091827

Title: **Tracking Animals to Determine Swarm Behavior**

Authors: *Benjamin Champion, Matthew Joordens and Blake Allan (Deakin University, Australia)*

Abstract: A tracking system based of the IMU8420 data logger has been created. This tracking system can be used to store the various movements of different types of animal's in-between the GPS signals, leading to a much more accurate representation of what the animal is undergoing at any point in time. This data can then be used to determine the behaviors of the animals, and thus new algorithms can be generated to try and mimic this behavior in robotics. The system could be applied to a swarm of animals to determine what an entire swarm is doing, and thus new swarming algorithms can be created.

ID: 1570091865

Title: **Underwater Swarm Robotics Review**

Authors: *Benjamin Champion and Matthew Joordens (Deakin University, Australia)*

Abstract: Underwater robotics is a growing field in which more research is required. A literature review has been conducted on underwater robotics, focusing on the swarm problem with this type of robotics to help overcome this gap. Consensus control of robotic swarms is focused on, with a brief description of formation control and how it can be applied in the underwater setting. The basic concepts behind Particle Swarm Optimization, Ant Colony Optimization, Bees Algorithm and Heterogeneous Swarms has also been presented. The problems that are associated with communicating underwater are shown, with some possible solutions to this problem also being presented. Possible future work is described to conclude the paper.

ID: 1570092235

Title: **A System of Systems Analysis of a Multi-Probe SPM System**

Authors: *Eyup Cinar and Ferat Sahin (Rochester Institute of Technology, USA)*

Abstract: In this paper, we introduce a multi-probe Scanning Probe Microscopy (SPM) tool in the context of system of systems (SoS) concepts. The tool exhibits strong characteristics of SoS such as interoperability, integration and independency of each individual system. Each probe terminal constitutes an independent scanning system that can operate individually. The interoperability of the systems through signal exchange bring strong advantages and help to the users in order to design innovative applications that would not be easily achievable when a single system is used. As an independent system, each probe terminal includes its own controller and feedback mechanism for precise operation which is controlled by individual software running on control PCs. After introducing the overall system, we briefly mention one of the innovative real-world applications that we have been currently working on in an effort to show the strength of SoS engineering and filling the gap between theory and practice.

ID: 1570092715

Title: **Efficient Design and Analysis of Battery Switching Stations for the Collaborative Wireless Network of Mobile Robots**

Authors: *Hammad Khan (Islamia University Bahawalpur, Pakistan)*

Abstract: Collaborative network of mobile robots have been the real advancement towards integrated robotic systems in recent past; however the sustainable battery charging problems persists for such robots to be implemented in industries, disaster management and other daily life applications. Mobile robots can be used effectively if they can be charged without interruption during their working. Continuous charging is not possible while the robots are performing their duties continuously. This paper proposed a solution in form of Battery switching stations (BSS) as part of industrial units or any other integrated robotic systems, which will provide constant charged batteries for robots. This idea has been derived from the usage of BSS for Electrical Vehicles. This paper mainly describes the design and programming of battery replacement mechanism in form of robotic arms. This mechanism is the most critical part in designing of BSS for the integrated robotic systems. Adaptive Neuro Fuzzy Inference System (ANFIS) is used in modeling and control of the robotic arm. ANFIS outputs are also validated and the results shown that the joint angles are accurately predicted by ANFIS for the corresponding coordinates. Batteries in BSS can be charged using alternative energy resources like solar or wind, which will also provide the green and sustainable

ID: 1570096407

Title: **A Model Based Approach to System of Systems Risk Management**

Authors: *Andrew Kinder, Michael Henshaw and Carys Siemieniuch (Loughborough University, United Kingdom)*

Abstract: This paper discusses the approaches required for risk management of 'traditional' (single) Systems and System of Systems (SoS) and identifies key differences between them. When engineering systems, the Risk Management methods applied tend to use qualitative techniques, which provide subjective probabilities and it is argued that, due to the inherent complexity of SoS, more quantitative methods must be adopted. The management of SoS risk must be holistic and should not assume that if risks are managed at the system level then SoS risk will be managed implicitly. A model-based approach is outlined, utilizing a central Bayesian Belief Network (BBN) to represent risks and contributing factors. Supporting models are run using a Monte Carlo approach, thereby generating results, which may be 'learnt' by the BBN, reducing the reliance on subjective data.

ID: 1570096413

Title: **A Novel System and Technique for Enhancing the Lifetime of an Air Breathing Micro PEM Fuel Cell Based Power Source**

Authors: *Ramesh P. (Indian Institute of Technology Bombay, India)*
Jithesh M. (College of Engineering Munnar, India)
Varun Devaraj (Portland State University, USA)

Abstract: Lately, there has been a tremendous amount of research in the field of renewable energy utilizing the fuel cell technology. This paper presents a highly reliable micro PEM fuel cell based power supply system which can operate in adverse and varying ambient conditions with a comparatively lower probability of cell damage. The life of a cell is greatly affected by catalyst poisoning- caused by selective adsorption of carbon monoxide by the platinum catalyst thereby reducing the rate of cell reaction by blocking its active sites; fuel starvation – resulting from the scarcity of oxygen required for the reaction to take place; and local hotspot generation caused by the non-uniformity in membrane impedance which occurs in the course of operation. The proposed system minimizes these threats with the help of an algorithm to overcome the issue of catalyst poisoning and fuel starvation and a mitigation algorithm to minimize the effect of impedance variation. It can be then used to power up portable electronic devices like wireless sensor nodes.

ID: 1570096441

Title: **Fuzzy Control of Cascaded H-Bridge Rectifier Based on Selective Harmonic Elimination Technique**

Authors: *Amirhossein Moeini and Morteza Dabbaghjamanesh (University of Texas at San Antonio, USA)*
Mohsen Rakhshan (Shiraz University, Iran)

Abstract: This paper tries to employ a fuzzy logic (FL) controller in order to provide a controller for the Cascaded H-Bridge (CHB) active rectifier, when a low switching frequency Selective Harmonic Elimination (SHE) method is used. The proposed CHB rectifier has 3-cell in each phase of the converter and needs to have an accurate voltage balancing method to control all of the DC link voltages to the desired value simultaneously as a coherent system. To achieve this goal, a modified voltage balancing method which can significantly reduce DC link ripples is proposed. As a result, this rectifier has all of the requirements of system of systems. Finally, the validity and effectiveness of the proposed method is verified in MATLAB environment.

ID: 1570096959

Title: **A Systematic Investigation of Tools in Model Based System Engineering for Embedded Systems**

Authors: *Muhammad Rashid (Umm Al-Qura University, Saudi Arabia)*
Muhammad Anwar (Consultant MODEVES Project, Saudi Arabia)
Aamir M. Khan (University of Buraimi, Oman)

Abstract: Model Based System Engineering (MBSE) approach has been frequently used as it is highly supportive for early design verification. However, selection of appropriate tools to perform various MBSE activities is always challenging. In this paper, latest MBSE tools have been investigated in contemporary research practices through Systematic Literature Review (SLR). This facilitates practitioners and researchers to select appropriate MBSE tools according to their requirements.

ID: 1570096981

Title: **Differential Flatness of the Flux-decay Generator Model**

Authors: *Kevin Wedeward and Lucas Uecker (New Mexico Tech, USA)*

Abstract: This paper shows that the flux-decay model of a synchronous generator exhibits the property of differential flatness. Differential flatness will be utilized for planning the generator's trajectory as there is a one-to-one correspondence between output curves and trajectories for states and inputs. Flat outputs of the generator are taken to be the generator's complex current injected into the power network, and inputs are taken to be the power set-point for the governor and reference voltage for the voltage regulator. The utility of the property and its application is demonstrated through trajectory planning, open-loop control and simulation of a single machine infinite bus system, as well as a simple linearizing feedback scheme to a 9-bus system with constant impedance loads.

ID: 1570097461

Title: **A service oriented virtual environment for complex system analysis: Preliminary Report**

Authors: *Charles E. Dickerson and Stephen Clement (Loughborough University, United Kingdom)*
David Webster and David McKee (University of Leeds, United Kingdom)
Jie Xu (Leeds University, United Kingdom)
David Battersby (Jaguar Land Rover, United Kingdom)

Abstract: Distributed virtual simulation is a capability that is increasing in demand within the automotive manufacturing industry. The distributed and networked approach to system level design and simulation stands to benefit from a unifying relational oriented modeling and simulation framework due to the large number of simulation technologies that must be integrated. This will also permit innovative use of existing independent simulations for increased concurrency in design and verification and validation. Through relational orientation, high level syntax and semantics for representing models and simulations have been developed for proof of concept analysis. This paper presents an approach to drive a process of analysis of the vehicle as a complex system through the combination of a relational trade-off analysis framework and a distributed simulation execution delivered through a service-oriented integration architecture. This promises to provide a rigorous, traceable and agile approach to early stage conceptual vehicle design and analysis.

ID: 1570099473

Title: **Leveraging Wireless Communication Systems for Aiding Inertial-Based Navigation Systems**

Authors: *Aly El-Osery (New Mexico Tech, USA)*
Stephen Bruder (Embry-Riddle Aeronautical University, USA)
Richard Rivera (New Mexico Tech, USA)

Abstract: Inertial navigation systems (INS) have gained attention as low-cost MEMS inertial measurement units (IMU) are becoming more available. INS provide position, velocity and attitude in environments where GNSS signals are not available, and hence, generate significant interest for a variety of applications. Unfortunately, all INS suffer from drift due to the inherent sensor errors. Consequently, aiding sensors must be used to bound the INS drift. In this paper we present a proof-of-concept of leveraging a system of communication systems to provide an INS aiding source. In particular, orthogonal frequency division multiplexing (OFDM) signals will be explored as they are the current communication standard. In particular, the ability to measure Doppler shift is investigated using software defined radios followed by a simulation to examine the effectiveness of the proposed system.

ID: 1570100019

Title: **Adaptable Mission Analysis and Decision System**

Authors: *Paul C. Hershey (Raytheon, Inc., USA)*
Elizabeth Umberger (Self, USA)
Roland Chang (Raytheon, USA)

Abstract: Discrete Event Simulation (DES) is a proven methodology that enables the effective combination of modeling and formal mathematics. DES has been used for many applications ranging from aeronautics to health care to transportation. In this paper, we apply a novel DES architecture that is dynamically adaptable to support decision making for multiple and diverse mission areas (i.e., missile defense, cyber offense, remote object recognition and location). This paper also advances traditional probabilistic solutions for these mission areas by extending the analytics into the time domain through integration of Bayesian statistics into DES. Using DES in this way provides a straight forward way to determine the overall probabilities for a complex set of individual probabilities and time-based events. DES also allows for random sampling of the input probability distributions and, through iterative computation, provides Monte Carlo analysis with which to derive confidence intervals for the overall probability for the simulated conditions. Confidence interval accuracy is of great importance to the simulation end-user with respect to course of action decisions.

ID: 1570100321

Title: **FPGA-based Authenticated Key Exchange Scheme Utilizing PUF and CSI for Wireless Networks**

Authors: *Mostafa Abutaleb (Helwan University, Egypt)*
Ali Mohamed Allam (University of Helwan, Egypt)

Abstract: Wireless networks offer an economical and easy way for all modern requests. However, it is also easy to eavesdrop upon any wireless channel and capture all transmitted data. Therefore, we must set up an authenticated secure channel before transmission, to make all the transmitted data safe from eavesdropping. The present paper proposes a scheme that depends on the physical layer mechanisms, which consist of Physical Unclonable Functions (PUF) and Channel Status Information (CSI) for providing point-to-point real-time hardware based authentication technique between two parties communicating directly through wireless media and effective key exchange to assure an authenticated secure channel between them. The proposed scheme is depending on provable secure authenticated key exchange protocol. Moreover, we will test the scheme performance and compare with related schemes.

ID: 1570100343

Title: **Continuous improvement of technical systems using Design for X**

Authors: *Christer Elverum and Henrik Vagle Dalsgaard (Norwegian University of Science and Technology, Norway)*
Torgeir Welo (Department of Engineering Design and Materials, Norway)

Abstract: Continuous, incremental improvements of existing products is an important aspect of maintaining competitiveness. One of the main challenges related to improving existing products is to take into account and weigh the various impacts that a change entails. Through a case-study with a company producing flood protection systems , this paper describes and discusses a systematic approach for identifying, evaluating and ranking the impact of identified improvement areas for an existing product. The approach consists of four steps: identify areas for improvement; devise a ranking system; score the different alternatives and compare and prioritize. The approach proved valuable as an early-stage indication of the most important areas for product improvements for the case company.

ID: 1570100477

Title: **Contribution to System of Systems Modeling**

Authors: *Wissam Khalil (Jean Monnet University, France)*
Belkacem Ould Bouamama (Ecole Polytechnique de Lille (France), France)
Rochdi Merzouki (Polytech Lille, France)
Blaise Conrard (CRIStAL - Univ Lille 1, France)

Abstract: Modeling a system of systems, for supervision purpose, is a complex issue influenced by security constraints more important than those of its component systems. This work proposes a hierarchical model of system of systems based on Hypergraphs and Constraint Satisfaction Problems. First of all, the developed model allows the operator to show, by a bottom up analysis of the hyper-graphs, the failure of a local system, and its influence on the other systems. In the other hand, the top down analysis of the hypergraphs, allows to check the possible reconfigurations of the global system of systems that satisfy a maximum number of constraints.

ID: 1570100511

Title: **Cluster-Based Correlation of Severe Braking Events with Time and Location**

Authors: *Guoyan Cao (University of Houston, USA)*
John Michelini (Ford Motor Company, USA)
Karolos Grigoriadis (University of Houston, USA)
Behrouz Ebrahimi (University fo Houston, USA)
Matthew Franchek (University of Houston, USA)

Abstract: In this paper, a systematic strategy is proposed to identify severe braking events occurrence correlation with time and location. The proposed approach, which is constructed based on batch clustering and real-time clustering techniques, incorporates historical and real-time data to predict the time and location of severe braking events. Batch clustering is implemented with the combination of subtractive clustering and fuzzy c-means clustering to generate clusters representing the initial correlation patterns. Real-time clustering is then developed to create and update real-time correlation patterns on the foundation of the batch clustering using evolving Gustafson Kessel Like (eGKL) algorithm. Real-time driving data of operating vehicles each equipped with a data acquisition and wireless communication platform are used to validate the proposed strategy. Drivers can be notified of the potential severe braking locations through maps, and recognize the events occurrence at different times and locations through the variation of the identified correlation patterns.

ID: 1570100555

Title: **Real-Time Neural Inverse Optimal Control for Position Trajectory Tracking of an Induction Motor**

Authors: *Maria Elena Antonio - Toledo (CINVESTAV, Unidad Guadalajara, Mexico)*
Edgar N. Sanchez (Cinvestav Unidad Guadalajara, Mexico)
Alexander Loukianov (CINVESTAV, Unidad Guadalajara, Mexico)

Abstract: This paper describes a neural inverse optimal control law approach for a three-phase induction motor position trajectory tracking and flux magnitude for a different references. A recurrent high order neural network (RHONN) is used to identify the plant model, trained with an Extended Kalman Filter (EKF) algorithm; the control law minimize a cost functional avoiding to solve the Hamilton Jacobi Bellman (HBJ) equation. The applicability of the approach is illustrated via experimentals results. The proposed scheme allows the easy interaction of this kind of motors into a system of systems configuration.

ID: 1570100585

Title: **UAF for System of Systems Modeling**

Authors: *Matthew C Hause (PTC, USA)*
Fatma Dandashi (Mitre Corp., USA)

Abstract: Organizations are changing their emphasis from "We need a new system" to "We need to achieve a specific outcome." As these outcomes become more difficult to define and the associated systems more complex, the management, modeling and simulation of these SoS becomes equally challenging. Often, the SoS is modeled in all its complexity, at a single level of abstraction or level of detail. Instead of a "mega-model" approach, a standards-based, layered "model of models" (MOM) approach is what is necessary. This paper discusses use of the Object Management Group (OMG) Unified Profile for DoDAF and MODAF (UPDM) for architecture modeling. UPDM supports a MOM approach by enabling the development of integrated model layers such as an outcomes model layer and a component layer. An integrated, layered MOM is in keeping with the Model-Based Systems Engineering (MBSE) approach. The model layers can be referenced when detailed analysis is required, or hidden when a SoS viewpoint is required.

ID: 1570100593

Title: **Swarm Intelligence for the Control of a Group of Robots**

Authors: *Sreerenjini Nair, Michael Frye and Erik Coronado (University of the Incarnate Word, USA)*
Yong Qin (Harbin University of Science and Technology, USA)

Abstract: This paper investigates the science of sensory and sensorimotor systems that enable navigation and natural flight in insects with application to the collaborative control of robots. The authors discuss fundamental research being conducted at the Autonomous Vehicle Systems Lab located at the University of the Incarnate Word on developing biologically inspired robots that emulate insect foraging and search behavior. Particle Swarm Optimization (PSO) technique is used in order to analyze the social characteristics of the studied insects and to implement those in the design of multi-robot systems. The authors will also present novel approaches for integrating the studied collective behavioral techniques for the collaborative and formation control of autonomous vehicles.

ID: 1570100625

Title: **On the Study of Human Reliability in Transportation Systems of Systems**

Authors: *Subeer Rangra, Mohamed Sallak and Walter Schon (Université de Technologie de Compiègne, France)*
Frederic Vanderhaegen (University of Valenciennes, France)

Abstract: Humans are and will remain one of the critical constituents of a technological system. The study of Human Factors is a broad domain with equally varying applications. Quantification thereof with a Human Reliability Analysis (HRA) poses considerable challenges and advantages. In increasingly complex modern systems where large resources are allocated towards ensuring system's operational safety, it becomes necessary to analyze the actions of human operator who directly or indirectly influences system reliability. This paper tries to establish a base towards a HRA model, to address existing issues. Railway systems and Advanced Driver Assistance Systems for automobiles are our application domains; we aim to identify the need of and usability in both. Human considered as a component of the System of Systems for risk assessment will allow us to study its impact on system reliability and give feedback to improve system safety.

ID: 1570100877

Title: **Towards an Understanding of Emergence in Systems-of-Systems**

Authors: *Hermann Kopetz (Technical University of Vienna, Austria)*
Oliver Höftberger and Bernhard Frömel (Vienna University of Technology, Austria)
Francesco Brancati (Resiltech S.R.L., Italy)
Andrea Bondavalli (University of Florence, Italy)

Abstract: Emergence is a systemic phenomenon in an System-of-Systems (SoS) that cannot be reduced to the behavior of the isolated parts of a system. It is the objective of this paper to contribute to the understanding of emergent phenomena in SoSs. After a short look at the literature on emergence in the domains of philosophy and computer science, this paper continues with an elaboration on multi-level nearly-decomposable systems, gives a tentative definition of emergence and discusses how emergent behavior manifests itself in an SoS.

ID: 1570101029

Title: **Real-Time Direct Field-Oriented and Second Order Sliding Mode Controllers of Induction Motor for Electric Vehicles Applications**

Authors: *Eduardo Quintero and Edgar N. Sanchez (Cinvestav Unidad Guadalajara, Mexico)*
Ramón Antonio Félix (Universidad de Colima, Mexico)

Abstract: This paper presents a comparison between two control techniques: Direct Field-Oriented Control (DFOC) and Second Order Sliding Mode Control (SOSMC), both are real-time implementations. DFOC is one of the most popular control strategies in the industry for induction motor drives and has the advantage to produce a continuous control signal, helping to extend life of electric vehicle batteries. On the other hand SOSMC is based on the super-twisting algorithm, which reduces chattering, rejects disturbances and produces a continuous control signal. To modulate the inverter pulses, Space Vector Modulation (SVM) is used and to estimate the rotor flux, a sliding mode observer is applied. Experimental implementation in real-time of these controllers have been successfully done, using a 1/4 hp induction motor prototype. Results are presented to illustrate the advantages and drawbacks of these controllers. The proposed schemes allow easy integration of these kind of vehicles into a system of systems configuration.

ID: 1570101035

Title: **Complex System Governance: Theory to Practice Challenges for System of Systems Engineering**

Authors: *Charles Keating (Old Dominion University, USA)*

Abstract: This paper explores challenges in moving Complex System Governance (CSG) from the theoretical/conceptual formulation to practice. CSG is an emerging field with potential to complement and extend System of Systems Engineering (SoSE). We begin with a brief introduction to CSG and the nature of the problem domain of interest for this field. Next, the nature of the CSG field is developed in light of SoSE. Focus is then turned to the spectrum of challenges faced for deployment of CSG. Finally, a path forward to addressing these challenges is explored. The paper concludes with several contributions that CSG can offer to SoSE in the struggle to deal with increasingly complex systems and their associated problems.

ID: 1570101107

Title: **Intelligent Adaptive Cruise Control System Design and Implementation**

Authors: *Islam Kilic and Ahmet Yazici (Eskisehir Osmangazi University, Turkey)*
Omur Yıldız (Savronik Elektronik, Turkey)
Mustafa Ozcelikors and Atakan Ondogan (Eskisehir Osmangazi University, Turkey)

Abstract: Advanced driver assistance systems (ADAS) have a critical role in the development of the active safety systems for vehicles. There are various sub technologies like Adaptive cruise control (ACC), Collision avoidance system, Blind spot detection etc. under ADAS. All these technologies are also accepted as the preliminary technology of autonomous driving. Therefore, during development of these technologies using a system of system (SOS) control approach would help both decreasing the development costs and unifying all these technologies under autonomous driving. In this paper, a SOS based intelligent ACC system design is proposed. The ACC system has high level control, low level control and sensor units.

ID: 1570101223

Title: **Systems Modeling and Intelligent Control of Meat Drying Process**

Authors: *Hong Ma, Simon Yang and Wei Zhang (University of Guelph, Canada)*

Abstract: The objective of this research is to develop models for the meat drying process and design an intelligent controller for the process control system, which leads to a better control accuracy than current PID control systems used in meat manufacturing. There is a coupling issue in meat drying rooms which is a function of temperature and relative humidity with nonlinearity and time relay. The classical algorithm is not effective for the relative humidity control, leading to higher energy costs. Based on the experimental data, a second-order system is used for modeling temperature and relative humidity in the drying room. The disturbance signal on relative humidity is modeled using an adaptive neural fuzzy inference system (ANFIS) and the training data for the ANFIS model are obtained from a current meat drying system. The proposed relative humidity controller uses a fuzzy PID control method to limit the disturbance signal for the meat drying process. Simulated results show the performance of the proposed fuzzy PID control system is superior in terms of relative humidity than the classical PID control method, which is used in current control systems for meat drying process.

ID: 1570101259

Title: **SmartPowerchair: A Pervasive System of Systems**

Authors: *Paul Whittington (Bournemouth University, United Kingdom)*
Huseyin Dogan (Faculty of Science and Technology, Bournemouth University, United Kingdom)

Abstract: This paper presents the characterisation of a concept System of Systems called the SmartPowerchair, in which existing pervasive technologies are integrated into a standard powered wheelchair to enhance the quality of life through independent living. Traditional Systems Engineering focuses on building the right system whereas System of Systems focuses on selecting the right combination of systems and their interactions to satisfy a set of frequently changing requirements. The SmartPowerchair can be characterised as a System of Systems due to the integration of a finite number of constituent systems which are independent and operable, and networked together for a period of time to achieve a certain higher goal. A high-level two-dimensional System of Systems model is developed to illustrate the lifecycle stages of System of Systems and different levels including the Component, System, System of Systems and Capability levels. Usability evaluations and workload measurements of a constituent system is also provided.

ID: 1570101357

Title: **Real-time FPGA Decentralized Inverse Optimal Neural Control for a Shrimp Robot**

Authors: *Gener Quintal (Cinvestav, Mexico)*
Edgar N. Sanchez (Cinvestav Unidad Guadalajara, Mexico)
Alma Y. Alanis (University of Guadalajara & CUCEI, Mexico)

Abstract: This paper presents a field programmable gate array (FPGA) implementation for a decentralized inverse optimal neural controller for unknown nonlinear systems, in presence of external disturbances and parameter uncertainties. This controller is based on two techniques: first, an identifier discrete-time recurrent high order neural network (RHONN) trained with an extended Kalman filter (EKF) algorithm; second, on the basis of the neural identifier a controller which uses inverse optimal control, is designed to avoid solving the Hamilton Jacobi Bellman (HJB) equation. The proposed scheme is implemented in real-time to control a Shrimp robot.

ID: 1570101497

Title: **Distributed Leader-Follower Formation Control for Multiple Quadrotors with Weighted Topology**

Authors: *Zhicheng Hou (Université de Technologie de Compiègne & UMR CNRS 7253, Heudiasyc, France)*
Isabelle Fantoni (Université de Technologie de Compiègne, France)

Abstract: This paper addresses the problem of controlling a leader-follower formation of quadrotors (UAVs), which can be considered as a System of Systems. A distributed control scheme for the motion of the formation is proposed, ensuring consensus of the UAVs and collision avoidance. Each UAV has local and limited neighbors and uses weighted relative positions and velocities of its neighbors. In the simulation section, a comparison of using the formation controllers with weighted and unweighted topology is given. The results show that the proposed control strategy can keep the formation with some initial conditions, unlike the strategy with unweighted topology. The simulations also show that our proposed control strategy can be applied for both one leader and multiple leaders formation.

ID: 1570101503

Title: **Multi-agent System of Systems to Monitor Wildfires**

Authors: *Mauricio Gomez, Yongho Kim, Maria Tolstykh, Michael Munizzi and Eric Matson (Purdue University, USA)*

Abstract: Wildfire monitoring and mitigation have been a worldwide challenge in disaster reduction for quite a while, however as time goes, more and more acres of virgin forests continue being consumed. A problem like a wildfire can be analyzed from a point of view of System of Systems (SoS) for the nature of all the different stakeholders involved. In this work we discuss the benefits of developing a collaborative collection of systems that can quickly and effectively locate and track the spread of wildfires and compare it to monolithic approaches that have been vastly used until this times. Agent based modelling (ABM) is used to show the different interaction of each of the different systems including different system network configuration. Our consideration in SoS problem is to find an effective configuration of communication between agents, and to discover robustness with limited number of existing agents

ID: 1570101515

Title: **SLAM based Shape Adaptive Coverage Control using Autonomous Vehicles**

Authors: *Junnan Song and Shalabh Gupta (University of Connecticut, USA)*

Abstract: The complete coverage problem requires the full exploration of the entire area, with real-world applications like floor cleaning, lawn mowing, search and rescue, etc. These tasks often do not have the exact a priori knowledge of the target area (e.g., exact shape of the lawn or oil spill area). Thus it is essential that the autonomous vehicle uses on-board sensor feedbacks for exploration so as to: i) dynamically build the a priori unknown environment, and ii) adapt its path in situ. In this regard, it is desired that the autonomous vehicle not only adapts to the obstacles (e.g., landmarks, etc.) but also to the shape of the target area (e.g., the lawn) to save time and energy.

Since, GPS may not be accessible in all environments, this paper presents a SLAM-based shape adaptive coverage algorithm which assumes that the exact a priori information of the desired workspace is either unknown or only partially known.This algorithm integrates the on-line information of obstacle and boundary detection with the navigation control. The algorithm is built upon a discrete event supervisory controller which utilizes the concept of multi-resolution navigation to prevent the autonomous vehicle from getting stuck into any local minimum. The efficacy of the algorithm has been validated in a lawn mowing example on the high-fidelity Player/Stage simulator.

ID: 1570101553

Title: **A Study on Analysis of Characteristics of Ships Navigators' Look-out by Using OZT**

Authors: *Jun Kayano (Tokyo Unibersity of Marine Science and Technology, Japan)*

Abstract: Human error is a main cause of collision accidents between ships. And most of them are caused by ship navigators' improper look-out. It is generally said that experienced navigators have adequately watched the other ships which there is a danger to collide with. Therefore, making clear of the characteristics of experienced navigators' look-out will certainly lead to reduce sea accidents. In this study, authors analyzed the data obtained by the ship-handling simulation experiment for making clear the differences of the characteristics of look-out between experienced navigators and inexperienced navigators by using OZT.

ID: 1570101573

Title: **Bond Graph Modeling of a Class of System of Systems**

Authors: *Pushpendra Kumar (Polytech Lille - University of Lille 1 & Laboratory CRIStAL, France)*
Rochdi Merzouki (Polytech Lille, France)
Belkacem Ould Bouamama (Ecole Polytechnique de Lille (France), France)

Abstract: In this paper, a modeling method for a class of system of systems (SoS) is proposed based on the Bond graph modeling approach. A SoS is a large-scale integrated system which is composed of many complex systems called component systems (CSs). Most of the existing SoS models are based on the organizational modeling approach, and the behavioral models of the physical CSs are not considered. Thus, a unified multilevel model of a SoS is developed which combines the organizational and behavioral modeling approaches using Bond graph. The proposed modeling approach is applied to model an Intelligent transportation system (ITS) considering traffic dynamic in a platoon of Intelligent autonomous vehicles (IAVs).

ID: 1570101583

Title: **Real-Time Flocking of Multiple-Quadrotor System of Systems**

Authors: *Osamah Saif and Isabelle Fantoni (Université de Technologie de Compiègne, France)*
Arturo Zavala-Rio (Instituto Potosino de Investigacion Cientifica y Tecnologica, Mexico)

Abstract: The subject of this paper is a real-time flocking control of multiple quadrotors in the context of system of systems. We believe that the most challenging aspect in multiple-quadrotor control is the interaction between quadrotors through sensing and preserving safe interdistances. The final objective is a collision-free flock of multiple quadrotors while navigating to a predefined destination. For this purpose, we develop control laws that are based on the consensus theory introduced by Olfati-Saber in [1]. Our control laws are designed in order to be compatible with experimental implementation and nonlinear model of quadrotors. Simulations and experiments using four quadrotors validate the performance of the proposed control laws. The convergence of interdistances between quadrotors to a desired value are maintained while navigating to a destination point.

ID: 1570101609

Title: **Dual Flexible 7 DoF Arm Robot Learns like a Child to Dance using Q-Learning**

Authors: *Ferat Sahin and Sulabh Kumra (Rochester Institute of Technology, USA)*

Abstract: Many attempts have been made by researchers and scholars to make people feel more conversant to robots. One such example is the dance performance of an Entertainment Robot. In most cases, the challenge to program dance motions for a robot and synchronize them has been too heavy. In addition, pre-programmed dance moves and synchronization information are useful only for a specific music track and are useless for any other. To solve these problems, we developed a new system that can make a robot learn dance moves according to the input music track. The system comprises of two main parts: the first is a beat extraction system for music track; and the second one is a system that learns dance motion for Baxter. In the first part, music track is analyzed using STFT and peak-to-peak time duration is computed. This gives the beats per minute (BPM) of the given music track. The second part takes the BPM and duration of track and feeds it to the developed Q-learning algorithm to make Baxter learn dance moves and synchronize dance motion to beat rate.

ID: 1570101613

Title: **Omnidirectional Rule-Based Free Gait Utilizing Restrictedness**

Authors: *Ferat Sahin and Christopher Johnson (Rochester Institute of Technology, USA)*

Abstract: Adaptable gaits are pivotal for allowing legged robots to navigate difficult terrain. One of the best gait styles to accomplish this goal is the rule-based free gait. First the forward and inverse kinematic solutions are solved for TigerBug, a circular hexapod. Then a rule based free gait is implemented on the circular hexapod in order to provide a platform for future rough terrain navigation.

ID: 1570101615

Title: **Modeling and Dynamic Control for a Hexapod Robot**

Authors: *Ferat Sahin and Brian Stevenson (Rochester Institute of Technology, USA)*

Abstract: In the every expanding field of robotics, mobile robots come in a two primary variations: wheeled and legged. This paper will focus on the latter, specifically a hexapod with a circular body that has its six legs distributed symmetrically around the body. The core goal of the project discussed here is to allow the robot to dynamically change foot placement based on an input vector in addition to controlling the position and orientation of the body. Specific attention is also given to a simulation model that can mimic this control of the robot in a virtual environment. Having a high level of control enhances the robot's ability to move in a very smooth and purposeful manner.

ID: 1570101619

Title: **Simultaneous Localization and Mapping using a Micro-Particle Swarm Optimization**

Authors: *Christopher Monfredo (Rochester Institute of Technology, USA)*

Abstract: Scan matching is a popular way of calculating a robot's position given range data corresponding to objects in the environment. This paper proposes a simultaneous localization and mapping algorithm that uses micro-particle swarm optimization as an alternative method to the traditional scan matching algorithms. The effectiveness of this algorithm is tested and compared to other popular simultaneous and localization algorithms.

ID: 1570101625

Title: **An Update on the Framework for a Junior Level Design Course**

Authors: *Aly El-Osery and Kevin Wedeward (New Mexico Tech, USA)*

Abstract: This paper presents a follow up look at a one semester, junior-level design course in electrical engineering at New Mexico Institute of Mining and Technology. A summary of the class's objectives, content, system of systems- based projects and use in assessment are presented for the past three years. The course has evolved from that reported previously where it was centered on mobile robots, sensing and coordinated behavior to its current incarnation that focuses on the design of beacon-finding mobile robots. Beacon-finding robots are the result of the evolution of the course and desire to have students address projects with design and integration of multiple, independent systems. Students are tasked to build an autonomous mobile robot that can detect a Radio Frequency (RF) beacon, and ultimately use the robot's location and measurements from the beacon to determine the beacon's location without necessarily driving to it. The project blends several technical areas of electrical electrical engineering that include electromagnetics, RF, control theory, analog and digital electronics, signal processing, programming, and microcontrollers along with broader skills related to communication and design.

ID: 1570101673

Title: **Epoch Era Analysis in the Design of the Next Generation Offshore Subsea Construction Vessels**

Authors: *Henrique Gaspar (Aalesund University College & Faculty of Maritime Technology and Operations, Norway)*

Abstract: The objective of the article is to investigate the plausibility of an applied Epoch-Era Analysis (EEA) and whether it can deliver sustained value to stakeholders over time in a complex, uncertain and changing operating context. Additionally, the article discuss how to evaluate and interpret the results of such an analysis. As a basis for the EEA, a concise analysis of the current OSCV market and inherent development trends should also be provided to ensure realistic input parameters.

ID: 1570101675

Title: **Robustness of Offshore Winches - The Value of Size**

Authors: *Henrique Gaspar (Aalesund University College & Faculty of Maritime Technology and Operations, Norway)*

Abstract: This article comments on the systems engineering best practices applied to an offshore support vessel winch. The case focuses on reducing the winch system physical size, while keeping its original specifications. Most of the work will revolve around winch systems as a clear potential for reduction in size is clearly visible, and data is available via industrial partners. Used experience data, factors and other information have been informally gathered from senior sales personnel and senior engineers. Findings are in general applicable for most of the larger volume consuming and personnel requiring products both on ships and on other platforms.

ID: 1570101679

Title: **Simulating SysML Models: Overview and Challenges**

Authors: *Mara Nikolaidou, George Dimitrios Kapos, Anargyros Tsadimas, Vassilis Dalakas and Dimosthenis Anagnostopoulos (Harokopio University of Athens, Greece)*

Abstract: SysML language, proposed by OMG, is a commonly accepted standard to model and study systems-of-systems (SoS). It provides the means to depict SoS components and their behavior in a multi-layer fashion and explore alternative architectures for their design. To validate SysML models in terms of performance criteria, simulation is usually the preferred method employed. To this end, different SysML diagrams are utilized, while numerous simulation methodologies and tools are employed. There are many efforts targeting simulation code generation from SysML models. Model-based system engineering concepts are adopted in most of these to generate simulation models from SysML models. Nevertheless, this process is not standardized, although most of current approaches tend to follow the same steps, even if they employ different tools. The scope of this paper is to provide a comprehensive understanding of the similarities and differences of existing approaches and identify current challenges in fully automating SysML model simulation process.

ID: 1570101693

Title: **Enabling Emergent Behavior in Systems-of-Systems Through Bigraph-based Modeling**

Authors: *Dominik Wachholder and Christian Stary (Johannes Kepler University Linz, Austria)*

Abstract: Today's complexity of distributed application systems, such as dynamic supply networks or distributed healthcare systems, require a systems-of-systems perspective for effective adaptation and sustainable use. Those systems not only need to be operated as separate systems (e.g., optimizing each transport modality in supply networks), but also are required to capture complex situations as interconnected entity (e.g., adapting a transport chain involving different modalities according to weather conditions). Systems-of-systems can handle such challenges through emerging behavior, while letting each of the involved systems operate separately. The latter property requires interoperability of systems. It can be preserved even in dynamically changing environments applying the theory of bigraphs. Dynamic interaction cannot only be represented by means of abstract relationships with respect to contextual conditions, but can also be analyzed and (re-)designed through specifying behavior adaptations. This abstraction supports cross-system decomposition as well as composition of interaction patterns for the purpose of emergent behavior. We demonstrate the potential of this approach by orchestrating a distributed scenario of two independent systems. Systems-of-systems behavior orchestration enables to directly respond to changes in the application system context.

ID: 1570101705

Title: **A low cost velocity control of double sided LSRM by sliding mode control and PIC18F452**

Authors: *Wajdi Zaafrane (University of Tunis, Tunisia)*
Mahir Dursun (Gazi University & Faculty of Technology, Turkey)
Habib Rehoolia (University of Tunis, Tunisia)

Abstract: This paper present a low cost positioning application based on Linear Switched Reluctance Motor (LSRM). Design, modeling and experimental results are detailed and presented in this work. The proposed control strategy is based Sliding Mode Control (SMC) to control the velocity. PIC18F452 and MOSFET inverter are designed and developed for the implementation of the proposed controls strategy. This solution is characterized by its low cost thing that can help to more integration of this actuator in industrial application. The accuracy and quality of the positioning prove the effeteness of the proposed control strategy when it was seen that problems of force and displacement ripples of the LSRM are solved.

ID: 1570101723

Title: **A Mission-Oriented Approach for Designing System-of-Systems**

Authors: *Eduardo Silva (UFRN, Brazil)*
Thais Batista (Federal University of Rio Grande do Norte, Brazil)
Flavio Oquendo (IRISA - UBS, France)

Abstract: In system-of-systems (SoS), a mission is an essential information that can guide the whole SoS development process. Through the so-called mission model, it is possible to identify required capabilities for the constituent system, operations, connections, emergent behavior, among other elements that characterize a SoS. Although the importance of missions for the SoS domain, the literature provides few proposals that focus on mission and none of them encompass a conceptual model for representing missions or a language to define mission models. In this paper, we present mKAOS, a language for SoS mission description that is based on a conceptual model for SoS missions. mKAOS organizes the mission-related information in a set of complementary models that allows a detailed description of mission information independent of implementation details. mKAOS also has an associated tool, mKAOS Studio, an open-source tool for modeling SoS missions using the mKAOS language.

ID: 1570101757

Title: **Abandonment: A Natural Consequence of Autonomy and Belonging in Systems-of-Systems**

Authors: *Alejandro Salado (Buskerud and Vestfold University College, Norway)*

Abstract: A key element differentiating traditional systems from systems of systems is governance. While systems are characterized by belonging to a single governing authority, systems within a system of systems are often independently governed or governed by fully empowered entities. Such independence is a necessary condition for the autonomy of each constituent system and for enabling the concept of belonging. At the same time, the capability to be autonomous and the voluntary nature of belonging, enables a constituent system to voluntarily abandon the system of systems it belongs to as well. Yet, research has not addressed so far the implications and modeling of intended abandonment into the operational effectiveness of a system of systems. This paper presents the concept of system abandonment as a philosophical necessity in the definition of systems of systems, it discusses some visions to measure the risk of abandonment, and proposes a way forward to explore mitigation techniques.

ID: 1570101761

Title: **Bond Graph Model-Based for Fault Tolerance Level Assessment of a Wireless Communication Link in a System of Systems Concept**

Authors: *Ahmad Koubeissi (Polytech Lille, University of Lille 1, Lebanon)*
Mohammed Ayache (UIL, Lebanon)
Rochdi Merzouki (Polytech Lille, France)
Blaise Conrard (CRIStAL - Univ Lille 1, France)

Abstract: The main focus of this paper is on graphical modeling of wireless link of a System of Systems (SoS) for the purpose of Fault Tolerance Level Assessment. Having used hypergraphs previously for modeling the structural organization of SoS, it's now important to introduce another graphical tool for modeling the wireless communication channel (WCL) between component systems of SoS, namely Bond Graph, and to evaluate at the same time, the fault tolerance level of each WCL so that we are able to compare various SoS configurations in terms of communication reliability and robustness. We perform an experiment on cooperative behavior of NAO humanoids forming an SoS to exploit model benefits at microscopic level and at macroscopic level, by developing a simulator that demonstrates how we can assess the fault tolerance level of each WCL in SoS.

ID: 1570101787

Title: **On the Impacts of Project Based Learning for Workplace Preparedness of Engineering Graduates**

Authors: *Seda Senay and Aly El-Osery (New Mexico Institute of Mining and Technology, USA)*

Abstract: Aligning preparedness of graduates with the current and future workplace demands is a complex issue for higher education institutions. Labour market demands can shift very rapidly in knowledge-based economies, so it is not easy to predict what kind of work or trades will come out in the future. Therefore, tying university and college programs too closely to immediate labor market demands is not desired in the US higher education system. However, it is possible to predict the skills graduates will need to prosper in workplace and improve education system without limiting the missions of colleges and universities to training of students for specific job skills. In the case of engineering education, project based learning (PBL) can provide a way to prepare students for the current and future demands of engineering profession, without focusing education solely on the development of specific job skills. This paper is a review on benefits and challenges associated with the implementations of PBL in engineering education.

ID: 1570101789

Title: **Distributed Super Twisting Controller for Multiple Quadrotors**

Authors: *Luis F. Luque-Vega (ITESO University, Mexico)*
Bernardino Castillo-Toledo (CINVESTAV, Mexico)
Alexander Loukianov (CINVESTAV, Unidad Guadalajara, Mexico)
Jawhar Ghommam (Ecole de Technologie Superieure, Canada)
Maarouf Saad (École de technologie supérieure, Canada)
Luis Gonzalez-Jimenez (ITESO University, Mexico)

Abstract: The distributed cooperative tracking control problem for a group of quadrotors in a three-dimensional space is addressed in this paper. The controller design is divided in two stages. In the first stage, local distributed controllers for the translational dynamics are designed, forcing the quadrotor to asymptotically track the desired trajectory with the required separation and therefore a specific formation. In the second stage, the rotational dynamics is asymptotically stabilized. The controllers implemented in both stages are based in a combination of block control technique and the super twisting control algorithm which ensures robustness with respect to external disturbances and parameter uncertainties. Moreover, a first order exact differentiator is used to estimate the virtual control inputs, simplifying the control law design. The stability proof of the complete closed-loop system is shown to be asymptotically stable. Finally, numerical simulations are carried out to show that theoretical conclusions are effective.

ID: 1570101791

Title: **Smart Data-Harnessing for Financial Value in Short-Term Hire Electric Car Schemes**

Authors: *Peter Cooper (University of Bristol, United Kingdom)*
Tom Crick (Cardiff Metropolitan University, United Kingdom)
Theo Tryfonas (University of Bristol, United Kingdom)

Abstract: In the developed world, two distinct trends are emerging to shake-up the current dominance of privately-owned, combustion motor car transport. The first is the emergence of the electric power-train for vehicles as an affordable and mass-marketed means of transport. This carries with it the potential to address many of the immediate shortcomings of the current paradigm, especially CO_2 emissions, air and noise pollution. The second is the rise of new hire models of car ownership – the concept of paying for the use of a car as and when you need it. This carries with it the potential to address many of the existing issues: outlay-induced car use, residential parking and social division. On a similar timescale, we are witnessing the rise of smart technologies and smart cities, concepts that use data about the state of a system or elements of it to create value.
There have been relatively few examples of schemes that have combined the electric and hire-model concepts, despite the huge potential for synergy. Indeed, the majority is against them on both counts – cars are predominantly privately-owned and driven by internal combustion engines. Nevertheless, there is significant potential for this to change over the coming years.

ID: 1570101813

Title: **Behavioral Detection in the Maritime Domain**

Authors: *James Scrofani, Murali Tummala, Donna Miller, Deborah Shifflett and John C. McEachen (Naval Postgraduate School, USA)*

Abstract: The maritime domain is important to the security, prosperity and vital interests of the global community. In order to protect these interests, governments require capabilities that provide situational awareness of the maritime domain. In [11] a spatiotemporal analysis approach is proposed that autonomously analyzes and classifies ship movement and possible intent at sea. The analysis focuses on detection of vessels of interest that exhibit one behavior, paralleling or following behavior. In this paper, we extend this approach by proposing a generalized semantic method that enables consideration of other behaviors of interest. Additionally we conduct a series of simulations using simulated and real AIS data to assess the performance of the algorithm to variation in behavior thresholds.

ID: 1570101829

Title: **Quaternion-based Trajectory Tracking Robust Control for a Quadrotor**

Authors: *Carlos Augusto Arellano-Muro (CINVESTAV Unidad Guadalajara, Mexico)*
Bernardino Castillo-Toledo (CINVESTAV, Mexico)
Alexander Loukianov (CINVESTAV, Unidad Guadalajara, Mexico)
Luis F. Luque-Vega and Luis Gonzalez-Jimenez (ITESO University, Mexico)

Abstract: This paper tackles the problem of trajectory tracking problem of a quadrotor. A sliding mode block control algorithm based on the super twisting algorithm using unit quaternion feedback is applied to the dynamic model of the quadrotor helicopter. The derivative of the virtual control inputs are obtained using the exact first order differentiator, and the aerodynamic forces and moments acting on the quadrotor are estimated via a sliding mode observer to ensure robustness against external disturbances and model uncertainties. Moreover, a comparison of the computational complexity of the controller between the proposed control scheme and the one considering Euler angles is carried out. The stability proof showing the asymptotic stability of proposed control scheme is presented. Simulations shows the good performance of the proposed control scheme.

ID: 1570101835

Title: **Design of a Home Multi-Robot System for the Elderly and Disabled**

Authors: *Patrick J Benavidez (University of Texas at San Antonio, USA)*
Mohan Muppidi (University of Texas at San Antonio & ACE Lab, USA)
Sos Agaian (, USA)
Mo Jamshidi (University of Texas at San Antonio & University of Texas @ San Antonio, USA)

Abstract: Home-based assistive robotic care for the elderly and disabled has long been a goal of robotics researchers. Unfortunately, no single group has solved the problem of making robots that will perform a set of tasks sufficient enough to warrant the cost to the end consumer. Numerous advances and improvements in computing, communication and related robotic technologies have been paving the way towards cheaper, more capable robots. We propose a home robot system consisting of a set of heterogeneous robots with different task spaces, cloud computing to enhance the abilities of the system, integration with existing home infrastructure, and compatibility with mobile technology. A high level of integration with the open source software of the Robot Operating System (ROS) is proposed to accelerate the design process. For the exact types of robots, we propose to use an enhanced floor cleaning robot and a mobility and vision assistance robot in the form of an improved rollator walker.

ID: 1570101843

Title: **A Fast Map-Reduce Algorithm for Burst Errors in Big Data Cloud Storage**

Authors: *Brian T Kelley and Xue Qin (University of Texas at San Antonio, USA)*
Mahdy Saedy (IEEE Senior Member & AT&T Research Labs., USA)

Abstract: In distributed storage for Big Data systems, there is a need for exact repair, high bandwidth codes. The challenge for exact repair in big-data storage is to simultaneously enable both very high bandwidth repair using Map-Reduce and simple coding schemes that also combine robust maximally distance separable (MDS) exact repair. MDS repair is for the rare, but exceptional outlier error patterns requiring optimum erasure code reconstruction. We construct the optimum fast bandwidth repair for big-data sources. Our system uses Map-Reduce, exact repair reconstruction. The algorithm combines MDS with a second fast decode algorithm in a cloud environment. We illustrate cloud experiments for optimum fast bandwidth reconstruction for 1-Exabyte Big Data in the cloud and demonstrate cloud results for Poisson error rate arrival models. Unlike prior methods, we jointly solve the problem of fast bandwidth repair for burst-memory error patterns and for code rates up to 2/3 in a real time error model framework for Big Data. Furthermore, simulations indicate this method outperforms prior fast bandwidth approaches for burst errors. We also illustrate Map-Reduce algorithm optimized for fast bandwidth repair in Big Data storage in clouds.

ID: 1570101847

Title: **Software Interface Design for Home-Based Assistive Multi-Robot System**

Authors: *Patrick J Benavidez (University of Texas at San Antonio, USA)*
Mohan Muppidi (University of Texas at San Antonio & ACE Lab, USA)
Berat Alper Erol (University of Texas at San Antonio, USA)
Sos Agaian (, USA)
Mo Jamshidi (University of Texas at San Antonio & University of Texas @ San Antonio, USA)

Abstract: In many assistive robotic systems, the interface to the user is simply a tablet computer or a monitor attached to a single robot. Missing from approaches are the system extensibility made possible with a tablet computer and a division of work between multiple agents. In this paper we present the design for a software interface to connect users to an assistive robot system for the disabled and elderly. The system is comprised of heterogeneous low-cost assistive robots, a home management portal and a cloud computing backend. The system is designed with the premise that all components do not need to be present for the system to function, but it will be improved when expanded by addition of robots and expanded computing capabilities. This paper focuses on developing the interfaces necessary to connect the user to these systems in a simple and easy to comprehend manner for the target user population.

ID: 1570101849

Title: **Cognitive Interference Avoidance in 4th Generation GPS**

Authors: *Brian T Kelley and Gonzalo Delatorre (University of Texas at San Antonio, USA)*
David Akopian (The University of Texas at San Antonio, USA)

Abstract: GPS systems have revolutionized the way people and social networks in society interact. As GPS becomes more ubiquitous in road transportation, energy, or autonomous delivery drones, there is increasing opportunity for adversaries and malicious attackers to exploit GPS infrastructure so as to hijack or damage position-sensitive systems. We propose the development of a precise positioning system that can be implemented in terrestrial metropolitan networks that is also capable of interference avoidance, hi-jack prevention, and operational in GPS denied environments. The significant contribution of this work is the development of cognitive GPS system that utilizes a novel anti-jamming algorithm to dynamically allocate signal power so as to avoid interference. We also propose a resource elements encryption algorithm to prevent hi-jacking and GPS spoofing.

ID: 1570101857

Title: **Keyboard Control Method for Virtual Reality Micro-robotic Cell Injection Training**

Authors: *Syafizwan Faroque, Ben Horan and Matthew Joordens (Deakin University, Australia)*

Abstract: The rapid development of virtual reality offers much potential for skills training applications. Our ongoing work proposes virtual reality operator trainings in the micro-robotic cell injection procedure. The interface between the operator and the system can be achieved in many different ways. The keyboard is ubiquitous in its use for everyday computing applications and also commonly utilized in virtual reality systems. Based on the premise that most people have experience in using a computer keyboard, as opposed to more sophisticated input devices, this paper considers the feasibility of using a keyboard to control the micro-robot for cell injection. In this study, thirteen participants underwent the experimental evaluation. The participants were asked to perform three simulated trial sessions in a virtual micro-robotic cell injection environment. Each session consisted of ten cell injection trials and relevant data for each trial were recorded and analyzed. Results showed participants' performance improvement after undertaking the three sessions. It is also observed that participants intuitively controlled multiple axes of the micro-robot simultaneously despite the absence of any training to do so. This continued throughout the experiments where average usage gradually increased in the later sessions. Based on the results provided, it is suggested that keyboard control is a feasible, simple and low-cost control method for the virtual micro-robotic cell injection environment.

ID: 1570101859

Title: **SCV2: A Model-based Validation and Verification approach for System-of-Systems Engineering**

Authors: *Rami Baddour (University of Lugano, Switzerland)*
Alkiviadis Paspaliaris and Daniel Solis Herrera (Universita della Svizzera Italiana, Switzerland)

Abstract: Model-Based Systems Engineering provides an effective methodology for designing complex systems and System-of-Systems. Importantly, such an approach opens the possibility to automatically generate executable simulators from system modules using model-to-code transformations, in order to verify the system model's completeness and validate design requirements. However, the user may still need to write code segments to describe the detailed functionality of system components. In this paper, we present the SCV2 tool, which allows the simulation of big size heterogeneous/ multiple-class systems and system-of-systems, imposes code-model consistency and aided statechart design through reverse code-to-model transformations, and provides query-based requirement validation and functionality verification through an intuitive user interface. At the end, we present a use-case showing the utilization of the tool in the WiBRATE FP7 project for early-stage validation of system requirements.

ID: 1570102263

Title: **Searching Robot Joint and Link Trees for Active Serial Chains using URDF**

Authors: *Michael Mortimer, Ben Horan and Matthew Joordens (Deakin University, Australia)*

Abstract: Teleoperation plays an integral role to the integration of robots within society. With an array of different robotic systems ranging from simple mobile platforms and UAVs to advanced humanoid robots such as ASIMO and PR2 teleoperational control is required in many different forms. The recent expansion in virtual reality systems, interactive input controls and even haptic devices provides a range of teleoperational control options. This paper proposes a dynamic user interface to help improve teleoperative control of robotic hardware. In order to develop a dynamic user interface the robot(s) comprising the system and their active components need to be categorized. In order to categorize robots and their active components this paper uses the standardized URDF descriptive format in ROS to search for active serial chains in individual robot systems. Results show the active chains and associated kinematic information extracted from the URDF model of Baxter.

ID: 1570102555

Title: **Performance Enhancing of Storage System for Point Cloud Geographic Data**

Authors: *Marian Svalec (University of Zilina, Slovakia)*
Lubos Takac (University Science Park & University of Zilina, Slovakia)
Michal Zábovský (University od Zilina, Slovakia)

Abstract: This paper deals with the problem of storing and distribution of geographic point cloud data. A scalable file based database system for storing and accessing large amount of point cloud geographic data mostly acquired by LIDAR was developed. The principle of the system is briefly described and the results of experiments with different file formats and their impact to overall performance of the system as well as to space occupied on hard disk drives are presented. Based on results, one format was chosen for a data layer of system. This paper also offers results of tests focused on scaling the main data structure and its optimal setting under certain circumstances.

ID: 1570103395

Title: **Noise Level Classification for EEG using Hidden Markov Models**

Authors: *Sherif Haggag, Sh, Shady Mohamed and Asim Bhatti (Deakin University, Australia)*
Hussein Haggag (Deakin University - Australia, Australia)
Saeid Nahavandi (Deakin University, Australia)

Abstract: EEG signal is one of the most important signals for diagnosing some diseases. EEG is always recorded with an amount of noise, the more noise is recorded the less quality is the EEG signal. The included noise can represent the quality of the recorded EEG signal, this paper proposes a signal quality assessment method for EEG signal. The method generates an automated measure to detect the noise level of the recorded EEG signal. Mel-Frequency Cepstrum Coefficient is used to represent the signals. Hidden Markov Models were used to build a classification model that classifies the EEG signals based on the noise level associated with the signal. This EEG quality assessment measure will help doctors and researchers to focus on the patterns in the signal that have high signal to noise ratio and carry more information. Moreover, our model was applied on an uncontrolled environment and on controlled environment and a result comparison was applied.

ID: 1570105307

Title: **Research directions in SOSE**

Authors: *Vernon Ireland (The University of Adelaide, Australia)*

Abstract: Research directions in system of systems are examined and areas which have been relatively neglected are identified. These include the definition of complexity, the application of power laws and Paretian statistics to most complex systems issues; the greatest innovation occurring at the edge of chaos; chaordic behavior, scale laws, fractals, self-organized criticality, tiny initiating events, adaptive cycles, systemic and cascading risk, attractor cages and fitness landscapes. The use of systems thinking methodology and its application to complex system problems is examined. Finally, the concept of system context is examined and the issue of whether soft system methodology can be applied to the examination of context is discussed. Appropriate economic models is also briefly discussed.

ID: 1570105865

Title: **Data-Centric Development of Architecture Models with the DM2 and MS-SDF**

Authors: *Matthew Amissah and Holly Handley (Old Dominion University, USA)*

Abstract: The Department of Defense Architecture Framework's (DoDAF) [1]data-centric development paradigm offers the potential for depth in architecture data and flexibility in presentation styles aimed at decision support. However the architecture development methodology advocated in versions 2.0 and upwards is a significant shift in approach, compared to prior versions. The framework specification, supporting literature and exemplar implementations fail to offer enough detail on a number of pertinent issues, among them executable modeling and architecture analysis, and the technology or tooling requirements which will facilitate their implementation. As part of ongoing research efforts aimed at addressing this gap this paper offers an overview of the literature on architecture modeling methodologies specifically tailored to the DoDAF, and propose the Modeling and Simulation Systems Development Framework (MS-SDF) [2] as a coherent and comprehensive approach for modeling within the DoDAF.

ID: 1570106209

Title: **A Conditional Value-at-Risk Approach to Risk Management in System-of-Systems Architectures**

Authors: *Navindran Davendralingam, Dan DeLaurentis and Parth Shah (Purdue University, USA)*

Abstract: The development of a system-of-systems(SoS) is challenging due to the complex dynamics attributed to the interdependencies between systems and the inherent technical and programmatic uncertainties. The sheer number of decision variables that need to be considered in SoS development prompts the need for effective analytical support frameworks. Current frameworks and guidelines in addressing SoS challenges lack analytical means of objective SoS level decision-making. Research in this paper adopts computational decision methods rooted in financial risk management that allow SoS practitioners the means to identify optimal 'portfolios' of systems based on dimensions of capability, cost and operational risk. Many risk management processes are in place for individual systems, but these tools and techniques are not always compatible for SoS. Our research leverages a Conditional Value-at-Risk (CVaR) perspective to managing risks that can incorporate simulation/observed data in the decision-making process. We demonstrate the method using a simple SoSE problem.

ID: 1570106469

Title: **A Perspective on Decision-Making Research in System of Systems Context**

Authors: *Dan DeLaurentis, Navindran Davendralingam and Michael Jacobs (Purdue University, USA)*

Abstract: 'System of systems (SoS)' is a special kind of system that appears more and more in many application domains. It has spawned active research across many technical domains and perspectives. One aspect of this research that has perhaps received less attention is the role of decision-making models to capture the essential collaborative nature of SoS. In this paper, we summarize some (not all!) of the approaches presented on this topic in an effort to subsequently identify critical areas that remain in need of further work to improve the effectiveness of the many SoS problems facing the practitioner community. We identify and briefly describe key areas and discuss concept applications in these areas. A link between models used in the design/planning stages and operations/control stage is found to be a useful endeavor.

ID: 1570118893

Title: **Challenges of Risk Identification and Assessment in a Complex System of System Environment;**

Authors: *Gennaro Avvento (Lockheed Martin, USA)*

Abstract: The paper will focus on the challenges of performing the key tasks of risk identification and assessment in a complex System of Systems (SOS) environment - representative of particular class of systems call Complex Adaptive Systems CAS. There are two major initiatives detailed within SEI capabilities that address risk driven engineering and integration challenges posed from a SOS/CAS environment. The first initiative is based on the use of an advanced Conops development and modelling approach implemented through a CONOPS Simulator concept. Next initiative outlines advanced applications of Reference Architectures (RA's) as it relates to system design activities within a SOS/CAS environment. These initiatives are applied as the foundation for a risk adverse design within SOS/CAS Enterprises.

ID: 1570118991

Title: **SoS Capability Schedule Prediction**

Authors: *Jo Ann Lane (University of Southern California, USA)*
Adrian Pitman (Defence Materiel Organisation, Australia)
Elizabeth Clark (Software Metrics, Inc., USA)
Angela Tuffley (RedBay Consulting, Australia)

Abstract: The Australian Defence Materiel Organisation recently developed a process for determining the probability that a system development program will meet their stated delivery or completion date as well as predicting the actual schedule and identifying factors that are driving the schedule. This process, the Schedule Compliance Risk Assessment Methodology (SCRAM), provides a framework for identifying and communicating the issues and risks to, and the root causes of, schedule slippage and providing recommendations to mitigate and/or remediate issues and risks. To date, SCRAM has been successfully applied to a number of major development acquisition programs in Australia and the United States. This paper describes the application of the SCRAM process to predict the completion date of an SoS capability, conduct a root cause analysis of any identified schedule slippage, and identify possible remedial actions that can be taken to reduce schedule slippage.

ID: 1570119003

Title: **The State of Systems of Systems Engineering Knowledge Sources**

Authors: *Judith S. Dahmann (MITRE Corporation, USA)*

Abstract: Application of systems engineering to 'systems of systems' is a topic of increasing interest across the systems engineering community. This paper reviews the upcoming latest versions of three core SE knowledge sources, the Guide to the Systems Engineering Body of Knowledge (SEBoK), the INCOSE Systems Engineering Handbook and the SoS Annex to ISO/IEC 15288, Systems and software engineering - System Lifecycle Processes, and examines how they address various aspects of systems of systems engineering, as an indicator of the current state of knowledge on systems of systems and systems engineering.

ID: 1570119027

Title: **Modeling an Organizational View of the SoS Towards Managing its Evolution**

Authors: *Richard Turner (Stevens Institute of Technology, USA)*
Alexey Tregubov (USC, USA)
Alice E. Smith, Jeffrey Smith, Levent Yilmaz, Donghuang Li and Saicharan Chada (Auburn University, USA)

Abstract: Managing the evolution of independent or loosely coupled systems of systems (SoS) is difficult. Much of the difficulty resides in the ways that elements are combined to make up the SoS and how those elements interface. The Systems Engineering Research Center has been studying how new governance mechanisms drawn from agile, lean and other adaptive approaches could be applied to systems of systems engineering. One of the current tasks is developing a broad, general purpose simulation platform designed to investigate how various combinations of organizational structure, work flow, and governance mechanisms affect the visibility, flow, and overall value produced in developing and evolving SoSs.

ID: 1570119225

Title: **Low-Latency Software Defined Network for High Performance Clouds**

Authors: *Paul Rad (Rackspace, USA)*
Palden Lama (UTSA, USA)
Rajendra V Boppana (University of Texas at San Antonio, USA)
Gilad Berman (Mellanox, USA)
Mo Jamshidi (University of Texas at San Antonio & University of Texas @ San Antonio, USA)

Abstract: Multi-tenant clouds with resource virtualization offer elasticity of resources and elimination of initial cluster setup cost and time for applications. However, poor network performance, performance variation and noisy neighbors are some of the challenges for execution of high performance applications on public clouds. Utilizing these virtualized resources for scientific applications, which have complex communication patterns, require low latency communication mechanisms and rich set of communication constructs. To minimize the virtualization overhead, a novel approach for low latency network for HPC Clouds is proposed and implemented over a multi-technology software defined network. The efficiency of the proposed low-latency SDN is analyzed and evaluated for high performance applications. The results of the experiments show that the latest Mellanox FDR InfiniBand interconnect and Mellanox OpenStack plugin gives the best performance for implementing VM-based high performance clouds with large message sizes.

ID: 1570119331

Title: **Image Segmentation by Multi-Level Thresholding based on Fuzzy Entropy and Genetic Algorithm in Cloud**

Authors: *Paul Rad (Rackspace, USA)*
Mohan Muppidi (University of Texas at San Antonio & ACE Lab, USA)
Sos Agaian (University of Texas, San Antonio, USA)
Mo Jamshidi (University of Texas at San Antonio & University of Texas @ San Antonio, USA)

Abstract: Image segmentation is the first step in applications like object detection, image classification or recognition. In this paper image segmentation by multilevel thresholding based on probability partition and fuzzy entropy is presented and results are compared to that of Otsu multi-level thresholding method. The optimized set of membership functions are determined by maximizing total entropy of the image and then thresholds are obtained from the intersections of membership functions. The results looked similar to that of Otsu thresholding and better in some cases.

ID: 1570131033

Title: **A Wrapper-based feature selection approach using Bees Algorithm for a wood defect classification system**

Authors: *Michael Packianather (Cardiff University, United Kingdom)*

Abstract: Identifying defects and classifying them according to some predefined classes is common in many manufacturing processes. The basis of such approach depends on a set of features extracted from all the classes and using them to train a classifier and then use it to determine which of these classes the unseen data belongs to, with a reasonable accuracy. Hence the performance of the classifier depends on the features' ability to discriminate between the good or normal and the defects. Therefore, one way of improving the classifier is to select the most appropriate features from a given feature set for the purpose of training and testing so that, at the end, overall, better results can be achieved. In this paper, a novel wrapper-based feature selection approach using Bees Algorithm for the application of wood defect classification is presented. Bees Algorithm is a swarm-based optimisation technique mimicking the foraging behaviour of honey bees found in nature. In order to demonstrate the wrapper-based feature selection procedure a Minimum Distance Classifier (MDC) is used in this study. However, the method can be applied to any application using some other classifier. The study shows that, on average, a 10% improvement is achieved when a sub-set of features selected using the proposed wrapper-based method with Bees Algorithm is used in training the MDC when compared to using the original full set of features.

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