



Catalog

2020-2021 Academic year





“ESPRIT has taken steadfast strides towards quality Research, Development & Innovation (RDI), engaging students in the process of scientific inquiry and capacity building, while striving to contribute to the socio-economic development of the region.”

Professor Tahar Ben Lakhdar, ESPRIT CEO and Co-founder

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ESPRIT-Tech The Research, Development, and Innovation Office

Welcome

Research, Development, and Innovation (RDI) have been among the strategic priorities at ESPRIT since its inception. In 2010, the university established ESPRIT-Tech (the RDI office) to oversee the various RDI activities and to work actively with concerned stakeholders to outline the research policies, strategies, and priorities.

ESPRIT puts a special focus on applied research and innovation by promoting RDI activities whose outputs have practical socio-economic impacts, without undermining pure academic research.

The Covid-19 pandemic slowed down RDI productivity during this 2020-2021 academic year as faculty members invested substantial efforts in migrating towards an online teaching model, while striving to maintain a high level of pedagogical innovation and students' engagement. On a brighter side:

- We witnessed a 15% increase in the number of journal publications compared to the previous academic year.
- Because of the Covid-19 pandemic and to address the shortage of summer internship opportunities, availed by enterprises, the RDI teams responded favorably to ESPRIT-Tech call for participation by proposing more than 70 RDI projects to our students. We believe that this experience provided an excellent opportunity to engage ESPRIT students to research, scientific inquiry, and entrepreneurship.
- We organized on July 28th, 2021 a virtual 1-day conference on "*Smart Technologies & Innovations in the Fight Against COVID-19*".

We look forward to establishing new collaborative RDI partnerships with the local community, the private as well as the public sectors. These strategic collaborations will lay the foundations for a more active role of ESPRIT in the socio-economic development of Tunisia.



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Information & Communications Technologies (ICT)				
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2	Wireless Com	Wireless communications	Jihene Ben Abderrazek	Jihene.benabderrazek@esprit.tn
3	MINOS	Networks and Internet of the future	Khaled Hfaiedh	Khaled.hfaiedh@esprit.tn
4	M2M	Ambient & embedded systems	Feten Teber	Feten.teber@esprit.tn
5	WSN-RFID	Wireless sensor networks and RFID	Abderrazak Hachani	Abderrazak.hachani@esprit.tn
6	ESPRIT-Mobile	Mobile applications	Imed Amri	Imed.amri@esprit.tn
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9	I2S	Intelligent Information Systems	Syrine Karoui	Syrine.karoui@esprit.tn
Electromechanical & Industrial Engineering				
10	ICAR	Robotics	Maher Mkhinni	Maher.mkhinni@esprit.tn
11	EVIS	Electric vehicle innovation systems	Taoufik Chaouachi	Taoufik.chaouach@esprit.tn
12	ESPRIT-LEAN	Lean & Industry 4.0	Nacef Sifi	Nacef.sifi@esprit.tn
13	INOBI	Industrial engineering for a better life	Salah Bousbia	Salah.bousbia@esprit.tn
14	ETM	ESPRIT's Tomorrows Materials	Ameni Ellouze	Ameni.ellouze@esprit.tn
Civil & Building Engineering				
15	REEE	Renewable energy & energy efficiency	Imen Guebebia	Imen.guebebia@esprit.tn
16	SBM	Smart Building management	Asma Karaoui	Asma.karoui@esprit.tn
Applied Mathematics				
17	GRAFICS	Risk management	Mohamed Anis Ben Lasmar	Mohamedanis.benlasmar@esprit.tn
18	MMSN	Mathematical modeling and numerical simulations	Mohamed Hedi Riahi	Mohamedhedi.riahi@esprit.tn
Management & Pedagogical Innovation				
19	MAIN' Team	Management & Innovation	Inés Mhaya	Ines.mhaya@esprit.tn
20	ALEER	Engineering Education Research	Lamjed Bettaieb	Lamjed.bettaieb@esprit.tn

#	Research Team	Research Domain	Research Themes
1	ESPRIT-Cloud	Cloud Computing & Security	<ul style="list-style-type: none"> ⇒ Infrastructure as a service ⇒ Virtualization technologies ⇒ Cloud security ⇒ Cloud federations ⇒ Platform as a service ⇒ Learning-based Cloud
2	Wireless Com	Wireless communications	<ul style="list-style-type: none"> ⇒ Future Wireless Networks ⇒ UAV-based Aerial Networks ⇒ Smart agriculture (UAVs & AI) ⇒ Wireless communication for Public Safety ⇒ E-health
3	MINOS	Networks and Internet of the future	<ul style="list-style-type: none"> ⇒ Cyber Security ⇒ Web Services ⇒ Blockchains ⇒ Web Crawling ⇒ SDN & NFV
4	M2M	Ambient & embedded systems	<ul style="list-style-type: none"> ⇒ Healthcare ⇒ Smart homes ⇒ Smart agriculture
5	WSN-RFID	Wireless sensor networks and RFID	<ul style="list-style-type: none"> ⇒ Design of interconnected objects ⇒ Digital Transformation ⇒ Localization and tracking ⇒ Logistic management ⇒ IoT applications
6	ESPRIT-Mobile	Mobile applications	<ul style="list-style-type: none"> ⇒ IoT ⇒ Blockchain ⇒ M-Health ⇒ Augmented Reality / AR ⇒ Virtual Reality / VR ⇒ Mixed Reality / MR
7	DASC	Data Science & AI	<ul style="list-style-type: none"> ⇒ Machine Learning & AI applications ⇒ Social media data analytics ⇒ Education 4.0 ⇒ Risk Cartography
8	ImageIn	Computer vision / image processing	<ul style="list-style-type: none"> ⇒ Machine learning for computer vision ⇒ Medical imaging ⇒ Shape recognition ⇒ Image processing
9	I2S	Intelligent Information Systems	<ul style="list-style-type: none"> ⇒ Intelligent Information Systems (IIS) architectures ⇒ IIS security ⇒ Decision-support systems ⇒ Big data & AI for IIS ⇒ DevOps for IIS
10	ICAR	Robotics	<ul style="list-style-type: none"> ⇒ Automation ⇒ Robotics ⇒ MEMS and IoT applied for mechatronics

#	Research Team	Research Domain	Research Themes
11	EVIS	Electric vehicle innovation systems	<ul style="list-style-type: none"> ⇒ Vehicle's mechanical structures ⇒ Vehicle's aerodynamics ⇒ Electric power converters ⇒ Battery charging and management systems ⇒ Motors' design and development
12	ESPRIT-LEAN	Lean & Industry 4.0	<ul style="list-style-type: none"> ⇒ Industry 4.0 tools and applications ⇒ Pedagogical innovation for Lean education ⇒ Lean Agriculture
13	INOBI	Industrial engineering for a better life	<ul style="list-style-type: none"> ⇒ Innovative pedagogical approaches for industrial engineering education ⇒ Industrial engineering solutions for social innovation and better life
14	ETM	ESPRIT's Tomorrows Materials	<ul style="list-style-type: none"> ⇒ Valorization of waste in plastic/composite materials ⇒ Valorization of natural fibers resulting from their use as reinforcement in composite materials ⇒ New ecological concretes made with carbonated aggregates
15	REEE	Renewable energy & energy efficiency	<ul style="list-style-type: none"> ⇒ Energy audit ⇒ Energy management and optimization ⇒ Sustainable development ⇒ Smart cities
16	SBM	Smart Building management	<ul style="list-style-type: none"> ⇒ Methods to improve occupant comfort ⇒ Smart building applications ⇒ Building Information Modelling (BIM)
17	GRAFICS	Risk management	<ul style="list-style-type: none"> ⇒ Data Mining, Scoring and Big data tools for decision support and actuarial applications ⇒ Efficient algorithms for stochastic control, numerical and statistical processing ⇒ Sensitivity analysis, quantification of uncertainty, and uncertainty modeling ⇒ Rare events analysis for optimal decision making and risk management
18	MMSN	Mathematical modeling and numerical simulations	<ul style="list-style-type: none"> ⇒ Applications of mathematical models and simulation techniques: ⇒ Finance: Inverse problem of estimating volatility in the Black and Scholes model ⇒ Environment: Parametric estimation in hydrogeology ⇒ Oil and Gas: Numerical modeling of the impact of rock mechanics in oil reservoirs on flow in porous media ⇒ Biology: modeling electrical activities of the hearts ⇒ Civil engineering: Mixed 3D-1D formulation for the analysis of composite beams
19	MAIN'Team	Management & Innovation	<ul style="list-style-type: none"> ⇒ Digital Marketing & Data Marketing ⇒ Innovation management ⇒ Development economics ⇒ Business Finance ⇒ Human resources ⇒ Entrepreneurship
20	ALEER	Engineering Education Research	<ul style="list-style-type: none"> ⇒ Active learning in engineering education ⇒ Collaborative project approaches in Engineering education ⇒ Case studies in Engineering education & lessons-learned ⇒ Learning outcome assessment ⇒ Digital technologies in Engineering education

Virtual 1-day conference:

Smart Technologies & Innovations in the Fight Against COVID-19



ESPRIT-Tech organized on Wednesday July 28th 2021 a virtual 1-day conference in collaboration with the IEEE Tunisia Section. The event provided a forum for experts and interested parties to examine and discuss the increasing role that smart technologies and innovations can play in the fight against the COVID-19 pandemic.

The conference focused on two main themes:

- Using smart technologies and innovations to enhance our readiness to cope with the COVID-19 pandemic (mainly through prevention and adaptation)
- Using smart technologies to enhance our ability to cope with the challenges of post COVID-19 economic recovery by enabling innovative ways to support more resilient and sustainable social, economic, and educational activities.

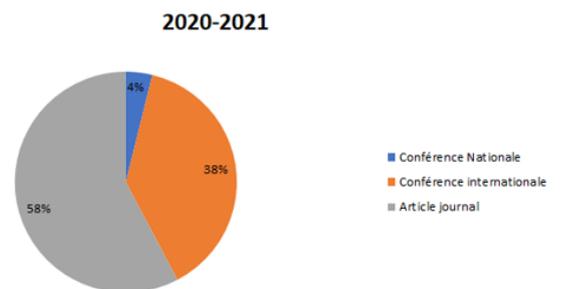
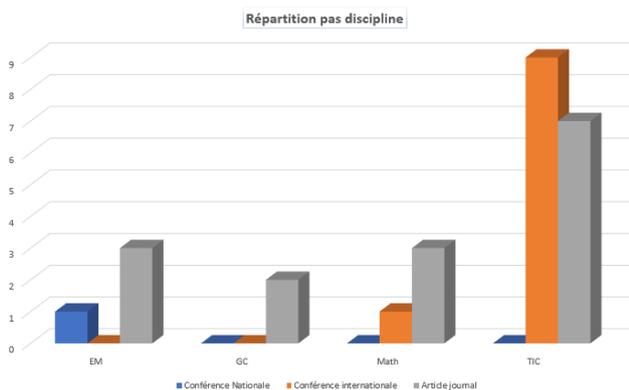
10 invited guest speakers from 5 different countries contributed to this virtual conference. The event attracted more than 305 participants

Archived videos of all the presentations can be accessed from ESPRIT RDI website (<https://www.esprit.tn/Evenements>).

Morning Sessions		Afternoon Sessions	
9:00	Welcome & Opening <ul style="list-style-type: none"> ▼ Lamjed Bettaieb (DGA, ESPRIT) ▼ Faouzi Kamoun (Director, ESPRIT-Tech) 	13:00	Session 2
9:15	The Dynamics of Global Research Trends on Covid-19 Across Scientific Areas Lan Umek, Chair of Economics and Public Sector Management, University of Ljubljana. Slovenia.	13:00	Expérience de Novation City Lors de la Première Vague du COVID-19: The SAFETUNISIA CHALLENGE Hichem Turki, CEO , Novation City, Société du Pôle de compétitivité de Sousse (SPCS). Tunisia
9:45		13:30	Disinfection Technology in Hospitals : Harmful Effects of UVC Samir Hamza, Director, National Institute of Applied Sciences and Technology, INSAT- Tunisia
9:45	Session 1 International Standards Enabling Smart technologies and Innovations in the Fight Against Covid-19 Bilel Jamoussi, Chief of the Study Groups Department at ITU Standardization Bureau , Geneva, Switzerland Digital Transformation Keys of Acceleration Lobna Karoui , Executive Digital Transformation Director at Fortune 500, Greater Seattle Area, USA. Machine Learning Approaches in Controlling Coronavirus with Smart City Framework Haruna Chiroma, University of Hafr Al Batin, KSA. Q & A #1 IEEE HAC/SIGHT Projects Call for Proposals Focused on COVID-19 Response and Pressing Community Need Sam Veeraraghavan, Amazon, Burlington, US.	14:00	Q & A #2
10:15		14:15	Session 3 Work-from-home and the Future of Work in the Post-covid World Mohamed Louadi , Professor, Higher Institute of Management of Tunis (ISG). Tunisia
10:45		14:45	Covid-19 & the Digital Transformation Badreddine Ouali , Chairman & founder VERMEG SARL, Tunisia
11:15		15:15	Engineering Education During the COVID19 Pandemic: ESPRIT as a Case Study Mourad Zerai, Director, Academic Affairs, ESPRIT School of Engineering. Tunisia
11:45		15:45	Q & A #3
12:00	BREAK	16:15	Closing Remarks
13:00		16h25	

R&D publications at a glance

2020-2021 Academic Year (AY)



Information & Communications Technologies



ICT RDI Publications (2020-2021 AY)

#	RDI publication	Type ¹	Abstract on Page #
1	O. Ghdiri, W. Jaafar, S. Alfattani, J. B. Abderrazak and H. Yanikomeroglu, "Offline and Online UAV-enabled Data Collection in Time-constrained IoT Networks", IEEE Transactions on Green Communications and Networking, 2021.	JA	21
2	M El Barachi, F Kamoun, A Hachani, F Belqasmi, M Ben Said, I Amri, A location-based ubiquitous crowdsourcing approach for the emergency supply of oxygen cylinders, Personal and Ubiquitous Computing, Springer, pp. 1-14. October 2020.	JA	22
3	Faouzi Kamoun, Mai El Barachi, Russell Hamilton, Ahmed Ben Hadj Khalifa, The IASO Self-Reporting System: A Persuasive Clinical Mood Tracking and Management Application for Hospital Patients, The International Journal of Healthcare Information Systems and Informatics (IJHISI), IGI Global. 2020.	JA	23
4	Thar Baker, Muhammad Asim, Áine MacDermott, Farkhund Iqbal, Faouzi Kamoun, Babar Shah, Omar Alfandi, Mohammad Hammoudeh, A secure fog-based platform for SCADA-based IoT critical infrastructure, Software: Practice and Experience, Wiley, pp. 503-518, 2020.		24
5	Makram Soui, Nesrine Mansouri, Raed Alhamad, Marouane Kessentini & Khaled Ghedira, NSGA-II as feature selection technique and AdaBoost classifier for COVID-19 prediction using patient's symptoms. Nonlinear Dyn (2021). https://doi.org/10.1007/s11071-021-06504-1 .	JA	25
6	Faouzi Jaidi, Faten Ayachi, and Adel Bouhoula, Advanced Analysis of the Integrity of Access Control Policies: the Specific Case of Databases, The International Arab Journal of Information Technology, Vol. 17, No. 5, September 2020.	JA	26
7	Imen Ben Mansour, Ines Alaya, and Moncef Tagina. "Design of Cooperative OpenMP-based Metaheuristic Approach for Multi-Objective Knapsack Problem". IADIS International Journal on Computer Science & Information Systems. 2020, Vol. 15 Issue 2, p44-57	JA	27
8	O. Ghdiri, W. Jaafar, S. Alfattani, J. B. Abderrazak and H. Yanikomeroglu, "Energy-Efficient Multi-UAV Data Collection for IoT Networks with Time Deadlines," GLOBECOM 2020 - 2020 IEEE Global Communications Conference, 2020, pp. 1-6	CP	28
9	M. Gaha, W. Jaafar, J. Fakhfekh, G. Houle, J. B. Abderrazak and M. Bourgeois "New LiDAR-Based Approach for Poles and Distribution Lines Detection and Modelling", ISPR 2021- the 7th International Conference on Image and Signal Processing, 2021, pp. 85-97.	CP	29

¹ JA : Peer-reviewed journal article; CP: Peer-reviewed conference paper

#	RDI publication	Type ¹	Abstract on Page #
10	Faouzi Kamoun , May El Barachi, Fatna Belqasmi, Abderrazak Hachani , A smart dynamic crowd evacuation system for exhibition centers, <i>Procedia Computer Science</i> , Volume 184, 2021, Pages 218-225, https://doi.org/10.1016/j.procs.2021.04.004 .	CP	30
11	Faouzi Kamoun , Farkhund Iqbal, Mohamed Esseghir , Thar Baker, AI and machine learning: A mixed blessing for cybersecurity, <i>International Symposium on Networks, Computers and Communications (ISNCC-2020)</i> , Montreal, CANADA - October 20 - 22, 2020, pp. 1-7.	CP	31
12	Liza Ahmad, Salam Khanji, Farkhund Iqbal, Faouzi Kamoun , Blockchain-based Chain of Custody: Towards Real-time Tamper-proof Evidence Management, <i>The 13th International Workshop on Digital Forensics, 15th International Conference on Availability, Reliability and Security (ARES2020)</i> , August 25 – August 28, 2020. Dublin, Ireland, pp. 1-11.	CP	32
13	Rawia Sammout, Kais Ben Salah, Khaled Ghedira , Rania Abdelhedi, Najla Kharrat, A Proposal of Clinical Decision Support System using Ensemble Learning For Coronary Artery Disease Diagnosis. <i>EAI MobiHealth 2020 - 9th EAI International Conference on Wireless Mobile Communication and Healthcare</i> . 2020.	CP	33
14	Khaled Hafaiedh , Mouhib Ben Rhouma , Fahd Chargui , Yassine Haouas , Ahmed Kerkeni , AdRobot: A smart segmentation application for automated & personalized marketing campaigns, <i>DTUC '20: Proceedings of the 2nd International Conference on Digital Tools & Uses Congress</i> . October 2020 Article No.: 15, Pages 1–6. https://doi.org/10.1145/3423603.3424052 .	CP	34
15	Hajer Berhouma , A Generic Model for Software Documentation and its Application in Embedded Systems Developed with Scrum, <i>ICSIE 2020: Proceedings of the 2020 9th International Conference on Software and Information Engineering (ICSIE)</i> , November 2020 Pages 33–36. https://doi.org/10.1145/3436829.3436858	CP	35
16	Imen Ben Mansour , Ines Alaya and Moncef Tagina. A New Parallel Hybrid Multiobjective Ant Colony Algorithm based on OpenMP. <i>17th IADIS International Conference on Applied Computing AC 2020</i> , pp. 19-26.	CP	36

Electromechanical Engineering

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Electromechanical Engineering RDI Publications (2020-2021 AY)

#	RDI publication	Type ²	Abstract on Page #
1	Houda Laabidi , Houda Jouini and Abdelkader Mami, "Comparative Analysis of Chopper-Inverter Performances for Wind Conversion System Connected to Grid", World Journal of Engineering, 2021, Vol. 18 No. 4, pp. 523-537. https://doi.org/10.1108/WJE-02-2020-0059 .	JA	37
2	Nahla Touati , Imen Saidi, Internal Model Control for Underactuated Systems based on Novel Virtual Inputs Method, PRZEGLĄD ELEKTROTECHNICZNY, ISSN 0033-2097, R. 97 NR 9/2021.	JA	38
3	Houda Laabidi , Houda Jouini, and Abdelkader Mami, Performance Analysis of MPC Controller Applied for Hybrid PV-Wind Under Varying Weather Conditions, International Journal on Electrical Engineering and Informatics - Volume 12, Number 4, December 2020.	JA	39
4	Nahla Touati , Imen Saidi and Dhaou Soudani, "IMC Filter Design for Frequency Control in Overactuated Systems," 2020 4th International Conference on Advanced Systems and Emergent Technologies (IC_ASET), 15-18 Dec. 2020, pp. 166-170, doi:10.1109/IC_ASET49463.2020.9318224.	CP	40

² **JA** : Peer-reviewed journal article; **CP**: Peer-reviewed conference paper

Applied Mathematics RDI Publications (2020-2021 AY)

#	RDI publication	Type ³	Abstract on Page #
1	Makram Hamouda, Ahmed Bchatnia, Mohamed Ali Ayadi . Numerical solutions for a Timoshenko-type system with thermo-elasticity with second sound. Discrete & Continuous Dynamical Systems - S, 2021, 14 (8) : 2975-2992. doi: 10.3934/dcdss.2021001.	JA	41
2	Nadia Belmabrouk, Mondher Damak, Nejib Yaakoubi , Dirichlet eigenvalue problems of irreversible Langevin diffusion, Statistics & Probability Letters, 2021.	JA	42
3	Houichet, H. , Theljani, A. & Moakher, M. A nonlinear fourth-order PDE for image denoising in Sobolev spaces with variable exponents and its numerical algorithm. Comp. Appl. Math. 40, 70 (2021). https://doi.org/10.1007/s40314-021-01462-1	JA	43
4	Hend Ben Ameer, Nizar Karrat, Mohamed Hédi Riahi , A posteriori error estimation for the estimation of parameters in a porous media, Proceedings of CARI 2020, October 2020, pp. 1-16.	CP	44

³ JA : Peer-reviewed journal article; CP: Peer-reviewed conference paper

Civil & Building Engineering



Civil & Building Engineering

RDI Publications (2020-2021 AY)

#	RDI publication	Type ⁴	Abstract on Page #
1	Imen Rahmouni , Geoffrey Promis , Omar Douzane, and Frédéric Rosquoet, Grain Density-Based Approaches to Predict the Mechanical, Thermal and Hygric Properties of Carbon-Negative Aggregate Concretes, Sustainability, July 2021, pp. 1-18.	JP	45
2	Chabchoub Syrine , Neifar Mondher, Perraton Daniel & Jaballah Lotfi, Numerical investigation to predict fatigue damage response in high-modulus asphalt mixture: a coupled damage-visco-elastoplastic approach, International Journal of Pavement Engineering, June 2021, https://doi.org/10.1080/10298436.2021.1943744 .	JP	46

⁴ JA : Peer-reviewed journal article; CP: Peer-reviewed conference paper

Appendix: Paper Abstracts

Offline and Online UAV-enabled Data Collection in Time-constrained IoT Networks

Oussama Ghdiri, Wael Jaafar, Safwan Alfattani, Jihene Ben Abderrazak, Halim Yanikomeroglu

ABSTRACT

Recently, unmanned aerial vehicle (UAV) technology is endorsed to enable applications in domains such as Internet of things (IoT), wireless sensor networks, and cellular networks. Particularly, time-sensitive and energy-limited IoT networks located in hard-to-reach areas require efficient/cost-effective data collection solution. To address this matter, we consider a multi-UAV enabled IoT network, where several UAVs collect data from time-constrained sensor nodes (SNs). In our framework, SNs are managed by cluster heads (CHs), then UAVs collect data from them. We formulate the problem of minimizing system's deployment costs and operating energy to collect data within deadlines, subject to communication, UAVs mission time, and battery capacity constraints. To solve it, we propose a two-step approach. In the first step, an efficient K-means based method groups SNs and deploys CHs. Then, UAV-based offline and online data collection methods are proposed. In the offline setting where the system's status is known beforehand, UAV paths are determined using near-optimal meta-heuristics. In simulations, the nearest-neighbor and Tabu search provided best offline performances, conditioned on the system's parameters. In the online setting where no system information is available, deep reinforcement learning (DRL) based approaches are proposed. Results demonstrate the superiority of the actor-critic solution.

Keywords: Data collection, Internet of Things, Trajectory, Unmanned aerial vehicles, Optimization, Resource management, Reinforcement learning

O. Ghdiri, W. Jaafar, S. Alfattani, J. B. Abderrazak and H. Yanikomeroglu, "Offline and Online UAV-enabled Data Collection in Time-constrained IoT Networks", IEEE Transactions on Green Communications and Networking, August 2021. DOI: 10.1109/TGCN.2021.3104801.

<https://ieeexplore.ieee.org/document/9513250>

A location-based ubiquitous crowdsourcing approach for the emergency supply of oxygen cylinders

M El Barachi, **F Kamoun**, **A Hachani**, F Belqasmi, **M Ben Said**, **I Amri**

Abstract:

Many people with chronic obstructive pulmonary diseases (COPD) are subjected to emergencies triggered by breathing difficulties. Oxygen therapy, administered from medical oxygen cylinders, can be used to relieve respiratory airways, and restore the supply of oxygen to the body's vital organs. In this paper, we present a location-based ubiquitous crowdsourcing solution to enable COPD patients to request an emergency supply of oxygen cylinders. At the heart of the solution is a trusted platform that acts as a mediator for the ambient social interaction among a virtual and socially engaged community of requestors and suppliers. The geo-temporal data generated by this social interaction can be analyzed to uncover meaningful ambient environmental patterns. Our approach also uses image processing and computer vision techniques to help validate crowd responses. We discuss the details of the human-centric computer interaction design and its key features. We also elaborate on the challenges faced in the design and development of the solution and summarize the actions taken to address them.

Keywords: Crowdsourcing, Ubiquitous mobile sensing, Human-computer interaction, Ambient social interaction, Crisis management, Healthcare information systems, Computer vision

M El Barachi, **F Kamoun**, **A Hachani**, F Belqasmi, **M Ben Said**, **I Amri**, A location-based ubiquitous crowdsourcing approach for the emergency supply of oxygen cylinders, *Personal and Ubiquitous Computing*, Springer. 25, 109–120 (2021). <https://doi.org/10.1007/s00779-020-01469-1>.

<https://link.springer.com/article/10.1007/s00779-020-01469-1>

The IASO Self-Reporting System: A Persuasive Clinical Mood Tracking and Management Application for Hospital Patients

Faouzi Kamoun, Mai El Barachi, Russell Hamilton, Ahmed Ben Hadj Khalifa

Abstract:

Mood swings are commonly observed phenomena among hospitalized patients. As a result, there has been a growing interest in developing solutions that can assist caregivers in acquiring a better understanding of patient mood states and behaviors. A key challenge resides in the need to not only monitor patients' mood state but also to try to influence it and regulate it. This article presents the IASO self-reporting system, a persuasive clinical mood tracking, and a management application for hospital patients. We describe the design process of the system, its technical implementation details, and key features. Unlike most earlier related studies, IASO incorporates the concept of mood-based adaptive art (MBAA) that triggers animated digital art clips with background sounds in response to patients' self-reported mood states, thus offering a tool for creative healing and mood enhancement. Our proposed solution empowers patients to gain more control over their wellbeing, regulates their moods and enables caregivers to receive timely feedback about potential mood swings and dangerous mood conditions.

Keywords: Art Therapy, Design for Well-Being, Electronic Monitoring, M-Health, Mood Management, Mood Regulation, Mood Tracking, Self-Assessment

Faouzi Kamoun, Mai El Barachi, Russell Hamilton, Ahmed Ben Hadj Khalifa, The IASO Self-Reporting System: A Persuasive Clinical Mood Tracking and Management Application for Hospital Patients, The International Journal of Healthcare Information Systems and Informatics (IJHISI), IGI Global. 5(2)- 2020. DOI: 10.4018/IJARPHM.2020070104.

<https://www.igi-global.com/article/the-iaso-self-reporting-system/255729>

A secure fog-based platform for SCADA-based IoT critical infrastructure

Thar Baker, Muhammad Asim, Áine MacDermott, Farkhund Iqbal, **Faouzi Kamoun**, Babar Shah, Omar Alfandi, Mohammad Hammoudeh

Abstract:

The rapid proliferation of Internet of things (IoT) devices, such as smart meters and water valves, into industrial critical infrastructures and control systems has put stringent performance and scalability requirements on modern Supervisory Control and Data Acquisition (SCADA) systems. While cloud computing has enabled modern SCADA systems to cope with the increasing amount of data generated by sensors, actuators, and control devices, there has been a growing interest recently to deploy edge data centers in fog architectures to secure low-latency and enhanced security for mission-critical data. However, fog security and privacy for SCADA-based IoT critical infrastructures remains an under-researched area. To address this challenge, this contribution proposes a novel security “toolbox” to reinforce the integrity, security, and privacy of SCADA-based IoT critical infrastructure at the fog layer. The toolbox incorporates a key feature: a cryptographic-based access approach to the cloud services using identity-based cryptography and signature schemes at the fog layer. We present the implementation details of a prototype for our proposed secure fog-based platform and provide performance evaluation results to demonstrate the appropriateness of the proposed platform in a real-world scenario. These results can pave the way toward the development of a more secure and trusted SCADA-based IoT critical infrastructure, which is essential to counter cyber threats against next-generation critical infrastructure and industrial control systems. The results from the experiments demonstrate a superior performance of the secure fog-based platform, which is around 2.8 seconds when adding five virtual machines (VMs), 3.2 seconds when adding 10 VMs, and 112 seconds when adding 1000 VMs, compared to the multilevel user access control platform.

Keywords: Critical infrastructure, fog computing, IoT, mission-critical data, SCADA systems, secured platform

Thar Baker, Muhammad Asim, Áine MacDermott, Farkhund Iqbal, **Faouzi Kamoun**, Babar Shah, Omar Alfandi, Mohammad Hammoudeh, A secure fog-based platform for SCADA-based IoT critical infrastructure, *Software: Practice and Experience*, Wiley, 50 (5), pp. 471-800, 2020. <https://doi.org/10.1002/spe.2688>

<https://onlinelibrary.wiley.com/doi/10.1002/spe.2688>

NSGA-II as feature selection technique and AdaBoost classifier for COVID-19 prediction using patient's symptoms

Makram Soui, Nesrine Mansouri, Raed Alhamad, Marouane Kessentini & **Khaled Ghedira**

Abstract:

Nowadays, humanity is facing one of the most dangerous pandemics known as COVID-19. Due to its high inter-person contagiousness, COVID-19 is rapidly spreading across the world. Positive patients are often suffering from different symptoms that can vary from mild to severe including cough, fever, sore throat, and body aches. In more dire cases, infected patients can experience severe symptoms that can cause breathing difficulties which lead to stern organ failure and die. The medical corps all over the world are overloaded because of the exponentially myriad number of contagions. Therefore, screening for the disease becomes overwrought with the limited tools of test. Additionally, test results may take a long time to acquire, leaving behind a higher potential for the prevalence of the virus among other individuals by the patients. To reduce the chances of infection, we suggest a prediction model that distinguishes the infected COVID-19 cases based on clinical symptoms and features. This model can be helpful for citizens to catch their infection without the need for visiting the hospital. Also, it helps the medical staff in triaging patients in case of a deficiency of medical amenities. In this paper, we use the non-dominated sorting genetic algorithm (NSGA-II) to select the interesting features by finding the best trade-offs between two conflicting objectives: minimizing the number of features and maximizing the weights of selected features. Then, a classification phase is conducted using an AdaBoost classifier. The proposed model is evaluated using two different datasets. To maximize results, we performed a natural selection of hyper-parameters of the classifier using the genetic algorithm. The obtained results prove the efficiency of NSGA-II as a feature selection algorithm combined with AdaBoost classifier. It exhibits higher classification results that outperformed the existing methods..

Keywords: COVID-19 prediction, Machine learning, Feature selection, AdaBoost, NSGA-II, Hyper-parameters optimization

Makram Soui, Nesrine Mansouri, Raed Alhamad, Marouane Kessentini & **Khaled Ghedira**, NSGA-II as feature selection technique and AdaBoost classifier for COVID-19 prediction using patient's symptoms. *Nonlinear Dyn*, pp. 1453–1475. Springer. (2021).

<https://doi.org/10.1007/s11071-021-06504-1>

<https://link.springer.com/article/10.1007%2Fs11071-021-06504-1>

Advanced Analysis of the Integrity of Access Control Policies: The Specific Case of Databases

Faouzi Jaïdi, Faten Labbene Ayachi and Adel Bouhoula

Abstract:

Databases are considered as one of the most compromised assets according to 2014-2016 Verizon Data Breach Reports. The reason is that databases are at the heart of Information Systems (IS) and store confidential business or private records. Ensuring the integrity of sensitive records is highly required and even vital in critical systems (e-health, clouds, e-government, big data, e-commerce, etc.,). The access control is a key mechanism for ensuring the integrity and preserving the privacy in large scale and critical infrastructures. Nonetheless, excessive, unused and abused access privileges are identified as most critical threats in the top ten database security threats according to 2013-2015 Imperva Application Defense Center reports. To address this issue, we focus in this paper on the analysis of the integrity of access control policies within relational databases. We propose a rigorous and complete solution to help security architects verifying the correspondence between the security planning and its concrete implementation. We define a formal framework for detecting non-compliance anomalies in concrete Role Based Access Control (RBAC) policies.

We rely on an example to illustrate the relevance of our contribution.

Keywords: Access Control, Databases Security, Formal Validation, Integrity Analysis, Conformity Verification

Faouzi Jaïdi, Faten Labbene Ayachi and Adel Bouhoula, Advanced Analysis of the Integrity of Access Control Policies: The Specific Case of Databases. International Arab Journal of Information Technology (IAJIT), 17(5): 808-815, 2020

<https://iajit.org/portal/index.php/archive/volume-17-2020/september-2020-no-5>

Design of Cooperative OpenMP-based Metaheuristic Approach for Multi-Objective Knapsack Problem

Imen Ben Mansour, Ines Alaya, and Moncef Tagina

Abstract:

Parallelism arises as an attractive option when solving Multi-Objective optimization problems (MOPs). Moreover, it seems interesting when metaheuristics demand an intensive use of CPU or memory. In this paper, we propose a parallel implementation of a hybrid ant colony optimization metaheuristic for the multiobjective knapsack problem using the OpenMP framework called MHAC_OMP. The proposed approach combined a MultiObjective Ant Colony Optimization (MOACO) algorithm with Tchebycheff based Local Search (TLS) procedure. The idea behind MHAC_OMP is to evolve several independent MOACO in parallel. Each MOACO hold a local archive to maintain diversity. The parallelization is defined as assuming a shared-memory based on threads in which the initialization phase begins with single thread called the master thread and executed sequentially. Afterward, a parallel region is defined where many threads are created, each one of them executing its own copy of the proposed ant colony algorithm independently. Experimental results show a significant efficiency of the solutions returned over the sequential implementation..

Keywords: Parallel Metaheuristic, Threads, OpenMP, Ant Colony Optimization, Multiobjective Optimization, The Augmented Weighted Tchebycheff Method

Imen Ben Mansour, Ines Alaya, and Moncef Tagina. "Design of Cooperative OpenMP-based Metaheuristic Approach for Multi-Objective Knapsack Problem". IADIS International Journal on Computer Science & Information Systems. 2020, Vol. 15 Issue 2, p44-57.

<http://www.iadisportal.org/ijsis/papers/2020150204.pdf>

Energy-Efficient Multi-UAV Data Collection for IoT Networks with Time Deadlines

O. Ghdiri, W. Jaafar, S. Alfattani, J. B. Abderrazak and H. Yanikomeroglu

Abstract:

In this paper, we focus on energy-efficient UAV-based IoT data collection in sensor networks in which the sensed data have different time deadlines. In the investigated setting, the sensors are clustered and managed by cluster heads (CHs), and multiple UAVs are used to collect data from the CHs. The formulated problem is solved through a two-step approach. In the first step, an efficient method is proposed to determine the minimal number of CHs and their best locations. Subsequently, the minimal number of UAVs and their trajectories are obtained by solving the associated capacitated vehicle routing problem. Results show the efficiency of our proposed CHs placement method compared to baseline approaches, where bringing the CHs closer to the dockstation allows significant energy savings. Moreover, among different UAV trajectory planning algorithms, Tabu search achieves the best energy consumption. Finally, the impact of the battery capacity and time deadline are investigated in terms of consumed energy, number of visited CHs, and number of deployed UAVs.

Keywords:

O. Ghdiri, W. Jaafar, S. Alfattani, J. B. Abderrazak and H. Yanikomeroglu, "Energy-Efficient Multi-UAV Data Collection for IoT Networks with Time Deadlines," GLOBECOM 2020 - 2020 IEEE Global Communications Conference, 2020, pp. 1-6

<https://arxiv.org/pdf/2009.06838.pdf>

New LiDAR-Based Approach for Poles and Distribution Lines Detection and Modelling

M. Gaha, W. Jaafar, **J. Fakhfekh**, G. Houle, **J. B. Abderrazak** and M. Bourgeois

Abstract:

Vegetation is the major cause of overhead power line failures. According to a recent HydroQuebec analysis, more than 60% of the power outages are related to vegetation. Specifically, when branches/trees nearby the distribution network interact with extreme weather conditions, e.g., melting snow and heavy rain, they may bend and cause power outages. To ensure the reliability of our distribution network, millions of dollars are yearly spent for pruning trees and trimming branches. Aiming to reduce these costs, we recently adopted a new approach based on light detection and ranging (LiDAR) data. Indeed, we scanned 150 km of Hydro-Quebec's network using a mobile LiDAR system. Through data analysis, we target automatic detection of hot spots, i.e., locations of threatening branches to distribution lines. However, such an operation cannot be accurately completed without a prior efficient detection of poles and lines locations, even for incomplete or missing LiDAR data. Hence, we propose here a low-complex and robust method for poles/distribution lines detection and lines modelling. Through customized filtering and detection, we efficiently detect poles and distribution lines with high accuracy and recall. Indeed, poles are detected with an accuracy of 94.5% and a recall of 89.7%, while lines are detected with an accuracy of 84% and a recall of 98.9%. Finally, our approach reconstructs power lines with a distance deviation from the real ones below 20 cm, in 89% of the cases. Such accuracy is required to automatically evaluate the closeness of vegetation to distribution lines and prevent power outages.

Keywords: Mobile LiDAR, power lines, distribution lines detection, poles detection, distribution lines modelling.

M. Gaha, W. Jaafar, **J. Fakhfekh**, G. Houle, **J. B. Abderrazak** and M. Bourgeois "New LiDAR-Based Approach for Poles and Distribution Lines Detection and Modelling", ISPR 2021- the 7th International Conference on Image and Signal Processing, 2021, pp. 85-97.

<https://airconline.com/csit/papers/vol11/csit110607.pdf>

A smart dynamic crowd evacuation system for exhibition centers

Faouzi Kamoun, May El Barachi, Fatna Belqasmi, **Abderrazak Hachani**

Abstract:

In this paper, we consider the problem of finding the safest evacuation route in a multi-exit exhibition center while the fire hazard spreads. We first propose a system composed of sensor nodes to collect pertinent safety data. We present a real-time dynamic evacuation system that considers the changing conditions in the risks associated with each hallway segment in terms of walking distance, heat, two major asphyxiant fire gases and congestion. Our system activates smart panels placed at major junctions of the hallways to guide evacuees towards the appropriate exit by displaying the proper escape direction. This work can pave the way towards the development of next-generation smart exhibition centers, where crowd safety is among the top priorities.

Keywords: Smart exhibition center, crowd management, evacuation system, indoor navigation, fire evacuation

Faouzi Kamoun, May El Barachi, Fatna Belqasmi, **Abderrazak Hachani**, A smart dynamic crowd evacuation system for exhibition centers, *Procedia Computer Science*, Volume 184, 2021, Pages 218-225, <https://doi.org/10.1016/j.procs.2021.04.004>.

<https://www.sciencedirect.com/science/article/pii/S1877050921007778>

AI and machine learning: A mixed blessing for cybersecurity

Faouzi Kamoun, Farkhund Iqbal, Mohamed Esseghir , Thar Baker

Abstract

While the usage of Artificial Intelligence and Machine Learning Software (AI/MLS) in defensive cybersecurity has received considerable attention, there remains a noticeable research gap on their offensive use. This paper reviews the defensive usage of AI/MLS in cybersecurity and then presents a survey of its offensive use. Inspired by the System-Fault-Risk (SFR) framework, we categorize AI/MLS-powered cyberattacks by their actions into seven categories. We cover a wide spectrum of attack vectors, discuss their practical implications and provide some recommendations for future research.

Keywords: Security, Cybersecurity , AI, machine learning, deep learning, neural networks, adversarial techniques

Faouzi Kamoun, Farkhund Iqbal, Mohamed Esseghir , Thar Baker, AI and machine learning: A mixed blessing for cybersecurity, International Symposium on Networks, Computers and Communications (ISNCC-2020), Montreal, CANADA - October 20 - 22, 2020, pp. 1-7.

DOI: 10.1109/ISNCC49221.2020.9297323

<https://ieeexplore.ieee.org/document/9297323>

Blockchain-based Chain of Custody: Towards Real-time Tamper-proof Evidence Management

Liza Ahmad, Salam Khanji, Farkhund Iqbal, **Faouzi Kamoun**

Abstract:

Evidence is a tangible demonstrative artifact that proves a fact and shapes the investigation of various misconduct cases involving for instance corruption, misbehavior, or violation. It is imperative to maintain proper evidence management to guarantee the admissibility of an evidence in a court of law. Chain of custody forms the forensic link of evidence sequence of control, transfer, and analysis to preserve evidence's integrity and to prevent its contamination. Blockchain, a distributed tamper-resistant ledger can be leveraged to offer a decentralized secure digital evidence system. In this paper, we propose a secure chain of custody framework by utilizing the blockchain technology to store evidence metadata while the evidence is stored in a reliable storage medium. The framework is built on top of a private Ethereum blockchain to document every transmission from the moment the evidence is seized, thus ensuring that evidence can only be accessed or possessed by authorized parties. The framework is integrated with the digital evidence system where evidence is physically stored and locked using smart locks. To secure the sequence of evidence submission and retrieval, only an authorized party can possess the key to unlock the evidence. Our proposed framework offers a secure solution that maintains evidence integrity and admissibility among multiple stakeholders such as law enforcement agencies, lawyers, and forensic professionals. The research findings shed light on hidden opportunities for the efficient usage of blockchain in other realms beyond finance and cryptocurrencies

Keywords: Digital forensics, Chain of custody, Blockchain, Distributed ledger, Security and privacy.

Liza Ahmad, Salam Khanji, Farkhund Iqbal, **Faouzi Kamoun**, Blockchain-based Chain of Custody: Towards Real-time Tamper-proof Evidence Management, The 13th International Workshop on Digital Forensics, 15th International Conference on Availability, Reliability and Security (ARES2020), ACM. August 25 – August 28, 2020. Dublin, Ireland, pp. 1-11. DOI: 10.1145/3407023.3409199.

<https://dl.acm.org/doi/10.1145/3407023.3409199>

A Proposal of Clinical Decision Support System using Ensemble Learning for Coronary Artery Disease Diagnosis

Rawia Sammout, Kais Ben Salah, **Khaled Ghedira**, Rania Abdelhedi, Najla Kharrat

Abstract:

Coronary Artery heart Disease (CAD) is the leading cause of mortality in the world. It is a complex and multifactorial disease resulting in several acute coronary syndromes and lead to death. In healthcare, an accurate clinical decision support system (CDSS) for CAD prediction has become increasingly important for making granted decisions at premature stage. Intensive research has been conducted on improving classification performance using machine learning techniques and metaheuristics algorithms. But most of these studies introduced the “classic risk factors” for CAD diagnosis i.e., demographic and clinical data. In this study, we present a novel CDSS based on ensemble learning for CAD prediction and we emphasize on adding other medical markers i.e., therapy data, some genetic polymorphisms along with classical factors. The new framework exploits the potential of three base classifiers including Support Vector Machines, Naïve Bayes and Decision Tree C4.5 to improve the prediction performance. Six experimental data used to build the proposed framework: the first one is collected from a Tunisian biotechnology center and the five other datasets from the University of California at Irvine repository. The analysis of the results shows that the proposed CDSS has the highest rate on classification accuracy, precision, recall and F1-measure when compared with CSGA Bagging and Adaptive boosting on the different datasets and proves that some medications and genetic polymorphisms such as Antivitamin K, Dose Beta Blocker, Proton pump inhibitor, CYP2C19*17, Clopidogrel active metabolite have an impact in CAD diagnosis.

Keywords: Coronary artery, heart disease, Genetic factors, Medications, Ensemble learning

Rawia Sammout, Kais Ben Salah, **Khaled Ghedira**, Rania Abdelhedi, Najla Kharrat, A Proposal of Clinical Decision Support System using Ensemble Learning for Coronary Artery Disease Diagnosis. EAI MobiHealth 2020 - 9th EAI International Conference on Wireless Mobile Communication and Healthcare. 2020. Lecture Notes of the Institute for Computer Sciences, Social Informatics and Telecommunications Engineering, vol 362. Springer, Cham . DOI: 10.1007/978-3-030-70569-5_19

<https://www.springerprofessional.de/en/a-proposal-of-clinical-decision-support-system-using-ensemble-le/18886128>

AdRobot: a smart segmentation application for automated & personalized marketing campaigns

Khaled Hafaiedh, Mouhib Ben Rhouma, Fahd Chargui, Yassine Haouas, Ahmed Kerkeni

Abstract:

Digital Advertising and promotional e-campaigns have been a basic pillar of marketing. One of the main challenges marketers face nowadays is about associating the right promotion to the right customer. Making the product-customer assignment accurate is crucial to satisfy customer needs. However, manually analyzing qualitative data for the purpose of defining the right target audience is exhausting and time consuming, especially when the number of costumers is high. In this paper, our aim is to automatically assign personalized campaigns that match specific customer desire, therefore making promotional campaigns consistent with their interests. Automating the process of assigning the right promotion to the right customer according to its specific needs is appealing as customers often show little to no interest in random ads. Our solution, referred to as "AdRobot", aims at overcoming these challenges by gathering complex data and insights into the target audience using data collected from conversations via the designed chatbot. Our strategy consists of performing fine-grained audience classification by segmenting profiles based on some profiling and conversational constraints, so that the audience is matched with the right promotional campaign. In order to achieve this goal, we propose an algorithm that investigates profiling and conversational data collected along with the customers' intents using artificial intelligence heuristics. Results show that "AdRobot" accurately matches promotional campaigns with the right customers according to their needs.

Keywords: Artificial intelligence , automatic segmentation , marketing , personalized campaigns

Khaled Hafaiedh, Mouhib Ben Rhouma, Fahd Chargui, Yassine Haouas, Ahmed Kerkeni, AdRobot: a smart segmentation application for automated & personalized marketing campaigns, DTUC '20: Proceedings of the 2nd International Conference on Digital Tools & Uses Congress. October 2020 Article No.: 15, Pages 1–6.

<https://doi.org/10.1145/3423603.3424052>

<https://dl.acm.org/doi/10.1145/3423603.3424052>

A Generic Model for Software Documentation and its Application in Embedded Systems Developed with Scrum

Hajer Berhouma

Abstract:

Software development life cycle (SDLC) depicts the necessary software development activities while applying methods in different software types. Previous works documented the software activities either by taking into account the development method or the software type. However, the documentation of development activities depends on the choice of the method as well as the software type. This paper presents a generic model of software documentation as well as its case study that applies Scrum in the development of an embedded system. The model provides guidelines for engineers to well choose and structure the development of software documents.

Keywords: Software design engineering, Agile software development, Scrum, Designing software

Hajer Berhouma, A Generic Model for Software Documentation and its Application in Embedded Systems Developed with Scrum, ICSIE 2020: Proceedings of the 2020 9th International Conference on Software and Information Engineering (ICSIE), November 2020 Pages 33–36. <https://doi.org/10.1145/3436829.3436858>

<https://dl.acm.org/doi/abs/10.1145/3436829.3436858>

A New Parallel Hybrid Multiobjective Ant Colony Algorithm based on OpenMP

Imen Ben Mansour, Ines Alaya and Moncef Tagina

Abstract

Parallel computing constitutes a growing area of interest in solving many complex combinatorial optimization problems. This paper presents a parallel implementation of a hybrid ant colony optimization metaheuristic for the multiobjective knapsack problem using the OpenMP framework. The hybrid algorithm coupled a MultiObjective Ant Colony Optimization (MOACO) algorithm with Tchebycheff based Local Search (TLS) procedure. The parallelization main idea is defined as assuming a shared-memory based on threads in which the initialization phase begins with a single thread called the master thread and executed sequentially. Afterward, a parallel region is defined where many threads are created, each one of them executing its own copy of the proposed ant colony algorithm independently. The threads cooperate through sharing a global archive holding all non-dominated solutions found so far. Experimental results show a significant efficiency of the solutions returned over the sequential implementation.

Keywords: Parallel Metaheuristic, Threads, OpenMP, Ant Colony Optimization, Multiobjective Optimization, The Augmented, Weighted Tchebycheff Method

Imen Ben Mansour, Ines Alaya and Moncef Tagina. A New Parallel Hybrid Multiobjective Ant Colony Algorithm based on OpenMP. 17th IADIS International Conference on Applied Computing AC 2020, pp. 19-26.

<http://www.iadisportal.org/digital-library/a-new-parallel-hybrid-multiobjective-ant-colony-algorithm-based-on-openmp>

Comparative Analysis of Chopper-Inverter Performances for Wind Conversion System Connected to Grid

Houda Laabidi, Houda Jouini and Abdelkader Mami

Abstract

Purpose – The purpose of this paper is to propose an efficient current control technique based on model predictive control (MPC) for grid-connected wind conversion system. This nonlinear strategy is applied for the chopper circuit and grid-tied inverter and compared with other two conventional schemes; a traditional proportional-integral (PI) and sliding mode controller (SMC) using the same switching frequency.

Design/methodology/approach – Firstly, the MPC scheme uses the mathematical model to predict future behaviors of the controlled converter outputs for possible switching states. After that, the optimal voltage vector is selected by minimizing a cost function, which is defined as a sum of the absolute values of the controlled current errors. Then, the corresponding switching signals are applied to the converter switches in the next sampling period to track correctly the reference current. Thus, the MPC scheme ensures a minimal error between the predicted and reference trajectories of the considered variables.

Findings – The MPC-based algorithm presents several benefits in terms of high accuracy control, reduced direct current link voltage ripples during steady-state operation, faster transient response, lower overshoots and disturbance rejection and acceptable total harmonic distortion.

Originality/value – The authors introduce several simulation case studies, using PSIM software package, which prove the reliability and effectiveness of the proposed MPC scheme. Therefore, the MPC performances, during dynamic and steady-state condition, are compared with those obtained by a PI regulator and SMC to highlight the improvements, specifically the transfer of smooth power to the grid.

Keywords: Model predictive control, Sliding mode control, Chopper, Grid integration, Total harmonic distortion, Wind energy system, Model predictive controller, Two-level inverter

Houda Laabidi, Houda Jouini and Abdelkader Mami, "Comparative Analysis of Chopper-Inverter Performances for Wind Conversion System Connected to Grid", World Journal of Engineering, 2021, Vol. 18 No. 4, pp. 523-537. <https://doi.org/10.1108/WJE-02-2020-0059>.

<https://www.emerald.com/insight/content/doi/10.1108/WJE-02-2020-0059/full/html>

Internal Model Control for Underactuated Systems based on Novel Virtual Inputs Method

Nahla Touati, Imen Saidi

Abstract:

An internal model control strategy is proposed in this paper for underactuated linear systems. Their associated models are non-square. When applying internal model control strategy, a specific inversion of a square model is needed to design the controller. For that reason, squaring the model of underactuated system by adding virtual control inputs is proposed in this paper. The obtained internal model structure is then modified in order to eliminate the excess inputs. Simulation results on a three inputs/four outputs system is considered to prove the effectiveness and reliability of the proposed method.

Keywords: Internal model control, virtual control, underactuated linear systems, NERGA, ETF.

Nahla Touati, Imen Saidi, Internal Model Control for Underactuated Systems based on Novel Virtual Inputs Method, PRZEGLĄD ELEKTROTECHNICZNY, ISSN 0033-2097, R. 97 NR 9/2021. doi:10.15199/48.2021.09.20

http://pe.org.pl/abstract_pl.php?nid=12693&lang=1

Performance Analysis of MPC Controller Applied for Hybrid PV-Wind Under Varying Weather Conditions

Houda Laabidi, Houda Jouini, and Abdelkader Mami

Abstract:

The studied system contains a photovoltaic conversion chain with a total power of 7.2 kW, a wind conversion chain (5.1 kW), two-level inverter related to the electrical grid through an RL filter. The control systems of the simulation model include the Model Predictive Controller (MPC), which is mainly applied for both DC/DC converters and three-phase inverter. The MPC strategy uses the mathematical model of the considered power converters in order to predict the possible future behaviors of the different controlled variables. It permits selecting the optimal voltage vector, which is able to ensure a minimization of the specified cost function. Modeling and simulation are achieved using PSIM software in order to verify the system's performances, highlighting many scenarios of varying meteorological conditions. The simulation responses prove that the proposed MPC algorithm can offer a fast transient response, an accurate reference tracking, a high-injected power quality with a low current THD (less than 1% in the steady state).

Keywords: Boost circuit; two-level inverter; Hybrid system; Model Predictive Control; THD

Houda Laabidi, Houda Jouini, and Abdelkader Mami, Performance Analysis of MPC Controller Applied for Hybrid PV-Wind Under Varying Weather Conditions, International Journal on Electrical Engineering and Informatics - Volume 12, Number 4, December 2020.

<http://www.ijeei.org/docs-1682003415fe83e86c27ca.pdf>

IMC Filter Design for Frequency Control in Overactuated Systems

Nahla Touati, Imen Saidi and Dhaou Soudani

Abstract

In this paper, an internal model control with insertion of a filter is proposed for overactuated systems. Indeed, the filter is necessary to avoid performance degradation in the case of modeling errors, disturbances affecting the system, and especially when the system inputs are sinusoidal. The choice of robustness filter parameters is presented and discussed in this paper. In fact, the filter can slow the fast dynamics. When choosing a time constant of the filter very small, it can increase the bandwidth of the controlled system. The IMC structure with filter is applied for a multivariable over-actuated system, the simulation results show the effectiveness of the proposed IMC filter design.

Keywords: over-actuated systems, Internal model Control, low-pass filter, robustness, stability and static error

Nahla Touati, Imen Saidi and Dhaou Soudani, "IMC Filter Design for Frequency Control in Overactuated Systems," 2020 4th International Conference on Advanced Systems and Emergent Technologies (IC_ASET), 15-18 Dec. 2020, pp. 166-170, doi:10.1109/IC_ASET49463.2020.9318224.

<https://ieeexplore.ieee.org/document/9318224>

Numerical solutions for a Timoshenko-type system with thermo-elasticity with second sound.

Makram Hamouda, Ahmed Bchatnia, **Mohamed Ali Ayadi**

Abstract:

We consider in this article a nonlinear vibrating Timoshenko system with thermoelasticity with second sound. We first recall the results obtained in [2] concerning the well-posedness, the regularity of the solutions and the asymptotic behavior of the associated energy. Then, we use a fourth-order finite difference scheme to compute the numerical solutions and we prove its convergence. The energy decay in several cases, depending on the stability number μ , are numerically and theoretically studied.

Keywords: Asymptotic behavior of solutions, asymptotic stability, finite difference methods, stability and convergence of numerical methods, thermoelasticity, Timoshenko system.

Makram Hamouda, Ahmed Bchatnia, **Mohamed Ali Ayadi**. Numerical solutions for a Timoshenko-type system with thermo-elasticity with second sound. *Discrete & Continuous Dynamical Systems - S*, 2021, 14 (8) : 2975-2992. doi: 10.3934/dcdss.2021001.

<https://www.aims sciences.org/article/doi/10.3934/dcdss.2021001>

Dirichlet eigenvalue problems of irreversible Langevin diffusion

Nadia Belmabrouk, Mondher Damak, **Nejib Yaakoubi**

Abstract:

The basic objective of this research work is to investigate the asymptotic behavior of the first eigenvalue of an irreversible Langevin diffusion with zero boundary values. In particular, a reversible diffusion is perturbed by adding an antisymmetric drift which preserves the invariant measure. Then, a necessary and sufficient condition is provided for the boundness and the limiting behavior of the first eigenvalue, under Dirichlet boundary conditions and with respect to the invariant measure. In other words, we prove that the first eigenvalue is bounded if and only if the associated stochastic dynamical system has a first integral. Furthermore, we demonstrate that the limiting eigenvalue is the minimum of the Dirichlet functional over all first integrals of the divergence-free vector field. An extension of this model with a time parameter in the boundary conditions is studied, where we give another characterization to achieve the same main result.

Keywords: First eigenvalue; First eigenfunction; First integral; Irreversible diffusion; Stochastic model

Nadia Belmabrouk, Mondher Damak, **Nejib Yaakoubi**, Dirichlet eigenvalue problems of irreversible Langevin diffusion, *Statistics & Probability Letters*, vol. 180. 2021.

<https://doi.org/10.1016/j.spl.2021.109242>

<https://www.sciencedirect.com/science/article/pii/S0167715221002042>

A nonlinear fourth-order PDE for image denoising in Sobolev spaces with variable exponents and its numerical algorithm

Houichet, H., Theljani, A. & Moakher

Abstract :

Image restoration is a very challenging task in image analysis and plays important roles in various fields such as medical imaging. In particular, in ultrasound imaging the obtained images are usually highly corrupted with multiplicative noise which makes important features hard to detect and to preserve. In this work, we use a mathematical model based on a minimization problem. To preserve the important features of the image, we consider a variable exponent function $p(x)$ chosen adaptively based on the map provided by edge-detectors which are constructed from high-order derivatives. The Euler–Lagrange equation of the minimization problem gives rise to a nonlinear $p(x)$ -biharmonic PDE. We then propose a numerical scheme based on the convexity splitting (CS) method for the ultrasound image denoising and we prove its stability and convergence results. Finally, some numerical results are presented to illustrate the effectiveness of our approach.

Keywords: $p(\cdot)$ -Biharmonic equation, Variable exponent, Optimization procedures, Unconditionally stable scheme, Convexity splitting, Image denoising, Topological gradient, Structure tensor, Speckle noise

Houichet, H., Theljani, A. & Moakher, M. A nonlinear fourth-order PDE for image denoising in Sobolev spaces with variable exponents and its numerical algorithm. *Comp. Appl. Math.* 40, 70 (2021). <https://doi.org/10.1007/s40314-021-01462-1>

https://link.springer.com/article/10.1007/s40314-021-01462-1?utm_source=xmol&utm_medium=affiliate&utm_content=meta&utm_campaign=DDCN_1_GL01_metadata

A posteriori error estimation for the estimation of parameters in a porous media

Hend Ben Ameer, Nizar Karrat, **Mohamed Hédi Riahi**,

Abstract :

We identify simultaneously storage and hydraulic transmissivity coefficients in groundwater flow governed by a linear parabolic equation. Both parameters are assumed to be functions piecewise constant in space. The unknowns are the coefficient values as well as the geometry of the zones where these coefficients are constant. This problem is formulated as minimizing a least-square function calculating the difference between measurements and the corresponding quantities computed with the current parameters values. The main point of this work is to construct an adaptative parameterization technique guided by refinement indicators. Using refinement indicators, we build the parameterization iteratively, going from a one zone parametrization to a parametrization with m zones where m is an optimal value to identify. We distinguish the cases where the two parameters have the same parameterization and different parameterizations.

Keywords: Inverse problem, parameter estimation, storage coefficient, hydraulic transmissivity, parameterization, refinement indicators, a posteriori error estimation, mesh adaptation

Hend Ben Ameer, Nizar Karrat, **Mohamed Hédi Riahi**, A posteriori error estimation for the estimation of parameters in a porous media, Proceedings of CARI 2020, October 2020, pp. 1-16.

<http://www.cari-info.org/Actes-CARI-2020/10-S2MA-6.pdf>

Grain Density-Based Approaches to Predict the Mechanical, Thermal and Hygric Properties of Carbon-Negative Aggregate Concretes

Imen Rahmouni , Geoffrey Promis , Omar Douzane, and Frédéric Rosquoet

Abstract:

The suitability of replacing mineral aggregate with carbon-negative ones mainly depends on the properties of the aggregates produced from waste recycling, reducing CO₂ emissions. This study aimed to investigate the predictive approaches adapted to concrete mixtures where mineral aggregates are replaced by carbonated aggregates (at different substitution rates from 25 to 100% with aggregates of various origins). A large experimental campaign of aggregates and carbonated aggregate concretes highlighted their physical, mechanical, thermal and hygric properties and the influence of density and porosity of aggregates on these properties. Thanks to these results, predictive approaches were formulated to establish the main engineering properties: mechanical compressive strength, elasticity modulus, thermal conductivity, thermal mass capacity and hygric diffusivity. These empirical and analytical models were based on the density of aggregates. Maximum deviations of around 15% were obtained with the experimental data, highlighting the influence of grain density on carbonated aggregate concretes. These models could then be used to optimize the formulation of concrete mixtures with carbonated aggregates, replacing international standards adapted to mineral aggregates.

Keywords: Carbonated aggregates; sustainable construction; concrete's multi-physical properties; predictive models

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Numerical investigation to predict fatigue damage response in high-modulus asphalt mixture: a coupled damage-visco-elastoplastic approach

Chabchoub Syrine, Neifar Mondher, Perraton Daniel & Jaballah Lotfi

Abstract:

In this paper, fatigue response under cyclic loading of a high-modulus asphalt mixture (EME14) is numerically investigated based on a coupling approach between damage mechanics and visco-elastoplasticity. The DBN (Di Benedetto-Neifar) model along, an isotropic damage, and a fatigue damage law are adopted to implement both visco-elastoplastic and damage constitutive equations. A set of laboratory experiments are conducted to calibrate the numerical model parameters. In the small deformation domain, complex modulus test results (complex modulus and viscosity) were experimentally fitted based on the 2S2P1D model. Direct tension parameters (stress levels in tension and in compression) were identified through the Di Benedetto viscoplastic criterion. Then, the experimental results of the fatigue test were interpreted to evaluate the damage amount associated with each cycle N and accordingly processed by the DGCB method, developed at the ENTPE (École Nationale des Travaux Publics de l'Etat), to eliminate parasitic effects commonly present in fatigue tests. Hence, a MATLAB program was implemented for uniaxial tension and compression load to estimate damage and fatigue modulus. The consistency between the numerical model outcomes and the experimental measurements showcased the capability of our coupling approach to accurately predict fatigue response under cyclic loading of a high-modulus asphalt mixture (EME14)

Keywords: Numerical investigation, coupling, DBN model, fatigue damage, DGCB method, high-modulus asphalt mixture

Chabchoub Syrine, Neifar Mondher, Perraton Daniel & Jaballah Lotfi, Numerical investigation to predict fatigue damage response in high-modulus asphalt mixture: a coupled damage-visco-elastoplastic approach, International Journal of Pavement Engineering, June 2021, <https://doi.org/10.1080/10298436.2021.1943744>.

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