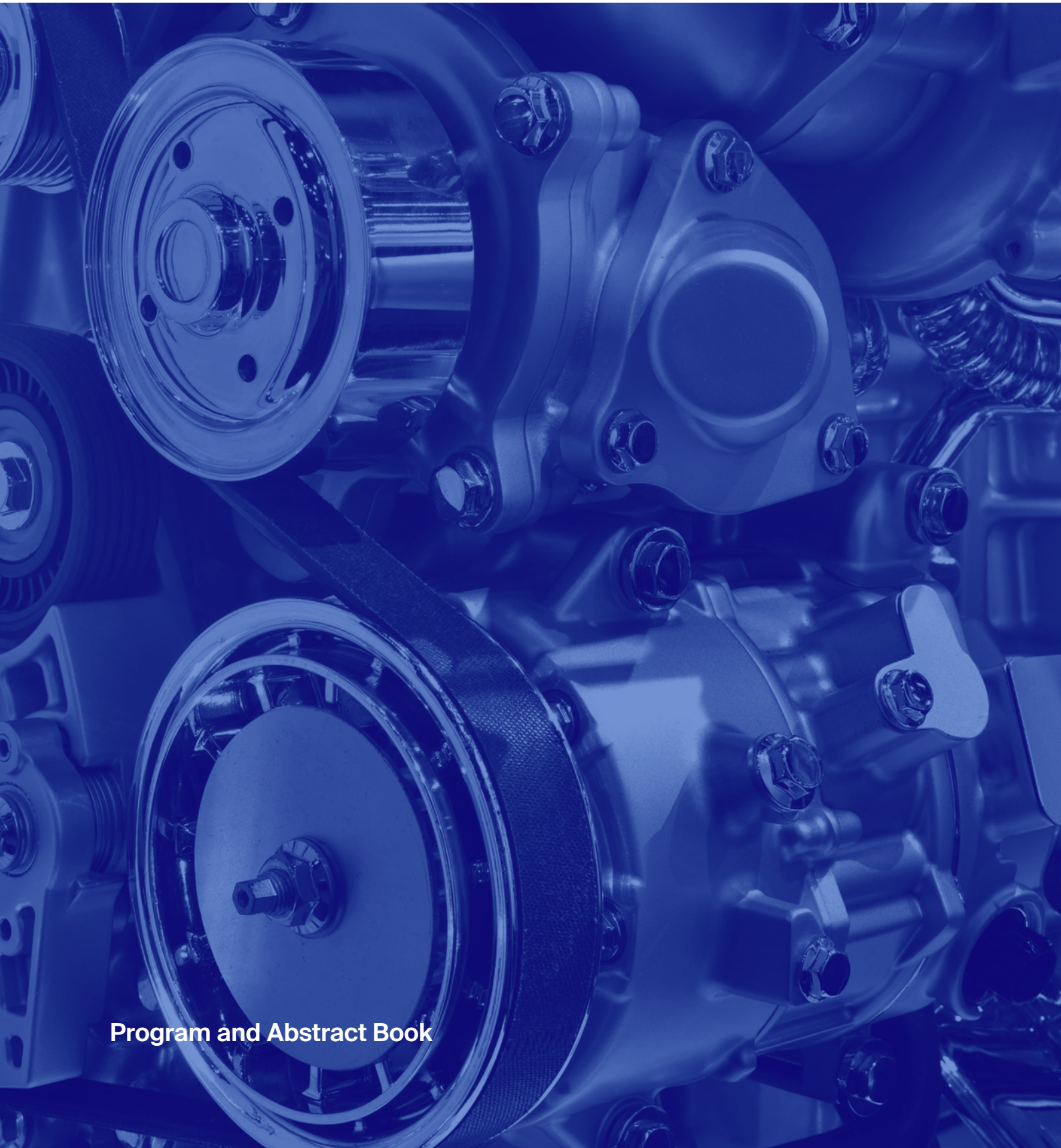


IECMA
2024
Conference

The 2nd International Electronic Conference on Machines and Applications

18–20 June 2024 | Online



Program and Abstract Book

Organizers



Academic Open Access Publishing
since 1996



machines

Co-organizer



Media Partners



robotics



Journal of
***Manufacturing and
Materials Processing***



学术会议云
ALLCONFS.ORG



CONFERENCE2GO

iecma2024.sciforum.net
#IECMA2024

The 2nd International Electronic Conference on Machines and Applications

18–20 June 2024 | Online



Basel • Beijing • Wuhan • Barcelona • Belgrade • Novi Sad • Cluj • Manchester

Organizing Committee

Conference Chair

Prof. Dr. Antonio J. Marques Cardoso

Session Chairs

Prof. Dr. Jose Alfonso Antonino-Daviu

Prof. Dr. Kai Cheng

Prof. Dr. Dan Zhang

Prof. Dr. Giuseppe Carbone

Dr. Daejong Kim

Prof. Dr. Hui Ma

Dr. Matthias Meinke

Dr. Yahui Liu

Event Committee

Prof. Dr. Domenico Mundo

Dr. César Vasques

Prof. Dr. Francisco J. G. Silva

Prof. Dr. Marco Ceccarelli

Dr. Stefano Mariani

Prof. Dr. Wei Gao

Prof. Dr. António Bastos Pereira

Dr. Raul D. S. G. Campilho

Prof. Dr. Jan Awrejcewicz

Prof. Dr. Mark J. Jackson

Prof. Dr. Panagiotis Kyratsis

Dr. Jose Machado

Prof. Dr. Donghong Ning

Prof. Dr. Weidong Zhu

Prof. Dr. Ahmed Abu-Siada

Prof. Dr. Mohamed Boutayeb

Prof. Dr. Deepak Dhungana

Dr. Nicola Ivan Giannoccaro

Prof. Dr. Med Amine Laribi

Prof. Dr. Yucheng Liu

Dr. Edoardo Sinibaldi

Prof. Dr. Ibrahim Tansel

Prof. Dr. Junyong Zhai

Prof. Dr. Ang Liu

Prof. Dr. Ciro Santus

Dr. Giacomo Scelba

Prof. Dr. Raffaele Di Gregorio

Dr. Swee Leong Sing

Prof. Dr. Adel Al-Jumaily

Prof. Dr. Parviz Famouri

Prof. Dr. Yaguo Lei

Prof. Dr. Walter D'Ambrogio

Prof. Dr. Jyoti K. Sinha

Dr. Tao Li

Dr. Angelos P. Markopoulos

Prof. Dr. Wenjun (Chris) Zhang

Prof. Dr. Radosław Zimroz

Prof. Dr. Kamran Behdinin

Dr. Francesco Castellani

Prof. Dr. Fernando J. T. E. Ferreira

Dr. Ignacio González-Prieto

Prof. Dr. Xiaodi Li

Prof. Dr. Nicolae Lobontiu

Prof. Dr. Massimo Sorli

Dr. Guowu Wei

Organised by



Academic Open Access Publishing
since 1996

Conference Secretariat

iecma2024@mdpi.com

Welcome from the Chair

Dear Colleagues,

It is our pleasure to invite you to join the 2nd International Electronic Conference on Machines and Applications (IECMA 2024) after the strong success of the previous annual online conference. IECMA 2024 will be held **online** from **18 to 20 June 2024**.

Machinery and engineering areas play a key role in an ever-increasingly technological society. Transportation, renewable energies, and more efficient buildings are only some of the domains where the intensive application of these systems has been most noticed. In all these applications, efficiency and reliability, automation and control, and advanced manufacturing are of major concern.

The scope of this online conference is to bring together well-known worldwide experts who are currently working on machinery and engineering and to provide an online forum for presenting and discussing new results.

Throughout this event, we aim to cover, among others, the following topics:

- S1. Additive Manufacturing**
- S2. Condition Monitoring and Fault Diagnosis**
- S3. Automation and Control Systems**
- S4. Mechatronic and Intelligent Machines**
- S5. Turbomachinery**
- S6. Electrical Machines and Drives**
- S7. Vehicle Dynamics and Control**

All accepted abstracts will be published on the website of the conference. You are required to submit an abstract (minimum 200—maximum 300-word limit). Please see the abstract guidelines in “Instructions for Authors”.

After the conference, the participants may submit a full paper to MDPI’s *Machines* journal. After the review process, the authors of the accepted papers will receive a **20% discount on the APC** before the paper is published in *Machines*.

On behalf of the Organizing Committee, we cordially invite you to join us at the 2nd International Electronic Conference on Machines and Applications (IECMA 2024).

We look forward to your contributions.



Prof. Dr. Antonio J. Marques
Cardoso

Conference Chair

CISE—Electromechatronic
Systems Research Centre,
University of Beira Interior,
Calçada Fonte do Lameiro,
Covilhã, Portugal

Contents

General Information	1
Session 1. Additive Manufacturing	17
Session 2. Condition Monitoring and Fault Diagnosis	29
Session 3. Automation and Control Systems	43
Session 4. Mechatronic and Intelligent Machines	57
Session 5. Turbomachinery	61
Session 6. Electrical Machines and Drives	63
Session 7. Vehicle Dynamics and Control	69
Session 8. Friction and Tribology	73



machines

an Open Access Journal by MDPI

Machines is an international, peer-reviewed, open access journal on machinery and engineering published monthly online by MDPI. The IFToMM is affiliated with Machines and its members receive a discount on the article processing charges.

Journal Webpage: <https://www.mdpi.com/journal/machines>.

Session Chairs



**Prof. Dr. Jose Alfonso
Antonino-Daviu**
Department of Electrical
Engineering, Universitat de
València, Valencia, Spain



Dr. Daejong Kim
Department of Mechanical and
Aerospace Engineering, The
University of Texas at Arlington,
Arlington, USA



Prof. Dr. Kai Cheng
College of Engineering, Design
and Physical Sciences, Brunel
University London, London, UK



Prof. Dr. Hui Ma
School of Mechanical Engineering
and Automation, Northeastern
University, Shenyang, China



Prof. Dr. Dan Zhang
Department of Mechanical
Engineering, The Hong Kong
Polytechnic University, Hong
Kong, China



Dr. Matthias Meinke
Rheinisch-Westfälische
Technische Hochschule Aachen,
Aachen, Germany



Prof. Dr. Giuseppe Carbone
Department of Mechanical,
Energy and Management
Engineering, Università della
Calabria, Rende, Italy



Dr. Yahui Liu
Driver-Vehicle Automation
Collaboration & Shared Control
Lab, School of Vehicle and
Mobility, Tsinghua University,
Beijing, China

Event Committee



Prof. Dr. Domenico Mundo
DIMEG, Università della
Calabria, Rende, Italy



Prof. Dr. Ang Liu
School of Mechanical and
Manufacturing Engineering,
University of New South Wales,
Sydney, Australia



Dr. César Vasques
Mechanical and Materials
Engineering, School of
Technology and Management,
Instituto Politécnico de Viana do
Castelo, Castelo, Portugal



Prof. Dr. Ciro Santus
Department of Civil and
Industrial Engineering—DICI,
University of Pisa, Pisa, Italy



Prof. Dr. Francisco J. G. Silva
Department of Mechanical
Engineering, ISEP–School of
Engineering, Polytechnic of Porto,
Porto, Portugal



Dr. Giacomo Scelba
Department of Electrical,
Electronics and Computer
Engineering, University of
Catania, Catania, Italy



Prof. Dr. Marco Ceccarelli
LARM2: Laboratory of Robot
Mechatronics, Department of
Industrial Engineering, University
of Rome Tor Vergata, Roma, Italy



Prof. Dr. Raffaele Di Gregorio
Engineering Department,
University of Ferrara, Ferrara,
Italy



Dr. Stefano Mariani
Dipartimento di Ingegneria Civile
e Ambientale, Politecnico di
Milano, Milano, Italy



Dr. Swee Leong Sing
Department of Mechanical
Engineering, National University
of Singapore, Singapore,
Singapore



Prof. Dr. Wei Gao
Faculty of Engineering, University
of New South Wales, Sydney,
Australia



Prof. Dr. Adel Al-Jumaily
School of Computing,
Mathematics and Engineering,
Charles Sturt University, Bathurst,
NSW, Australia



Prof. Dr. António Bastos Pereira
Centre for Mechanical Technology
and Automation, University of
Aveiro, Aveiro, Portugal



Prof. Dr. Parviz Famouri
Lane Department of Computer
Science & Electrical Engineering,
West Virginia University,
Morgantown, WV, USA



Dr. Raul D. S. G. Campilho
Instituto Superior de Engenharia
do Porto, Portugal



Prof. Dr. Yaguo Lei
Xi'an Jiaotong University, China



Prof. Dr. Jan Awrejcewicz
Lodz University of Technology,
Poland



Prof. Dr. Walter D'Ambrogio
Università degli Studi dell'Aquila,
Italy



Prof. Dr. Mark J. Jackson
Kansas State University, USA



Prof. Dr. Jyoti K. Sinha
The University of Manchester, UK



Prof. Dr. Panagiotis Kyratsis
University of Western Macedonia,
Greece



Dr. Tao Li
Nanjing University of Aeronautics
and Astronautics, China



Dr. Jose Machado
University of Minho, Campus of
Azurém, Portugal



Dr. Angelos P. Markopoulos
School of Mechanical Engineering,
National Technical University of
Athens, Greece



Prof. Dr. Donghong Ning
Department of Mechanical and
Electrical Engineering, School of
Engineering, Ocean University of
China, China



Prof. Dr. Wenjun (Chris) Zhang
Department of Mechanical
Engineering, University of
Saskatchewan, Canada



Prof. Dr. Weidong Zhu
Department of Mechanical
Engineering, University of
Maryland, USA



Prof. Dr. Radosław Zimroz
Faculty of GeoEngineering
Mining and Geology, Wrocław
University of Science and
Technology, Poland



Prof. Dr. Ahmed Abu-Siada
Electrical and Computer
Engineering Department, Curtin
University, Australia



Prof. Dr. Kamran Behdinin
Department of Mechanical and
Industrial Engineering, University
of Toronto, Canada



Prof. Dr. Mohamed Boutayeb
Department of Control
Identification Diagnosis,
University of Lorraine, France



Dr. Francesco Castellani
Department of Engineering,
University of Perugia, Italy



Prof. Dr. Deepak Dhungana
Institute of Digitalization, IMC
University of Applied Sciences
Krems, Austria



**Prof. Dr. Fernando J. T. E.
Ferreira**
Department of Electrical and
Computer Engineering,
University of Coimbra, Portugal



Dr. Nicola Ivan Giannoccaro
Department of Innovation
Engineering, University of
Salento, Italy



Dr. Ignacio González-Prieto
Department of Electrical
Engineering, University of
Málaga, Spain



Prof. Dr. Med Amine Laribi
Department GMSC, Université de
Poitiers, France



Prof. Dr. Xiaodi Li
School of Mathematics and
Statistics, Shandong Normal
University, China



Prof. Dr. Yucheng Liu
Department of Mechanical
Engineering, South Dakota State
University, USA



Prof. Dr. Nicolae Lobontiu
Department of Mechanical
Engineering, College of
Engineering, University of Alaska
Anchorage, USA



Dr. Edoardo Sinibaldi
Center for Micro-BioRobotics,
Istituto Italiano di Tecnologia,
Italy



Prof. Dr. Massimo Sorli
Politecnico di Torino, Department
of Mechanical and Aerospace
Engineering, , Italy



Prof. Dr. Ibrahim Tansel
Department of Mechanical
Engineering, Florida International
University, Miami, USA



Dr. Guowu Wei
School of Science, Engineering
and Environment, University of
Salford, UK



Prof. Dr. Junyong Zhai
School of Automation, Southeast
University, China

Invited Speakers



Prof. Dr. Ciro Santus
Department of Civil and
Industrial Engineering—DICI,
University of Pisa, Pisa, Italy



Dr. Stefano Nuzzo
Department of Engineering "Enzo
Ferrari", University of Modena
and Reggio Emilia, Italy



Dr. Giacomo Scelba
Department of Electrical
Electronic and Computer
Engineering, University of
Catania, Catania, Italy



Dr. Davide Barater
University of Modena and Reggio
Emilia, Italy



Dr. Xiang Li
Xi'an Jiaotong University, China



Prof. Dr. Shaoping Bai
Aalborg University, Aalborg,
Denmark



Dr. Med Amine Laribi
Department GMSC, Université de
Poitiers, France



Prof. Dr. Jyoti Sinha
The University of Manchester,
Manchester, UK



Prof. Dr. Weidong Zhu
Department of Mechanical
Engineering, University of
Maryland, Baltimore, USA



Prof. Dr. Panagiotis Kyratsis
Department of Product and
Systems Design Engineering,
University of Western Macedonia,
50100 Kila Kozani, Greece



Dr. Jose E. Ruiz-Sarrio
Associate Researcher with
Universitat Politècnica de
València

Program at a Glance

The 2nd International Electronic Conference on Machines and Applications 18–20 June 2024

	18 June 2024 (Tuesday)	19 June 2024 (Wednesday)
Morning	Session 3. Automation and Control Systems Session 4. Mechatronic and Intelligent Machines	Session 2. Condition Monitoring and Fault Diagnosis
Afternoon	Session 6. Electrical Machines and Drives	Session 1. Additive Manufacturing

IECMA Program

18 June 2024 (Tuesday)

Time: 9:00 (CEST, Basel) | 03:00 (EDT, New York) | 15:00 (CST Asia, Beijing)

Session 3. Automation and Control Systems

Session 4. Mechatronic and Intelligent Machines

Time in CEST	Speaker	Title
9:00–9:10	Prof. Dr. Antonio J. Marques Cardoso	Welcome from the conference chair
9:10–9:15	Dr. Qi Zou Session host of S3	Welcome from the session host
9:15–9:35	Prof. Dr. Shaoping Bai Invited Speaker	A novel variable stiffness mechanism and its application in human-robot interaction
9:35–9:50	Raul Campilho Selected Speaker	Development of an orthogonal transfer system for the automated warehouse industry
9:50–10:05	Nirojh T Selected Speaker	Brake Fluid Level Management
10:05–10:10	Prof. Dr. Giuseppe Carbone Session Chair of S4	Welcome from the conference chair
10:10–10:30	Dr. Med Amine Laribi Invited Speaker	Robot design: application to medical robotics
10:30–11:45	Fernando A. V. Figueiredo Selected Speaker	SCARAmouche: A 3D-Printed Low-Cost SCARA Robot
10:45–11:00	Nikolaos Tapoglou Selected Speaker	A CAD-Driven Approach to Cutting Tool Geometry Design of Solid end mills

18 June 2024 (Tuesday)
Time: 15:00 (CEST, Basel) | 09:00 (EDT, New York) | 21:00 (CST Asia, Beijing)
Session 6. Electrical Machines and Drives

Time in CEST	Speaker	Title
15:00–15:10	Dr. Jose E Ruiz Sarrió Session Host	Welcome from the session host
15:10–15:30		High-frequency phenomena in electrical machines and their potential utilization for fault diagnosis and condition monitoring
15:30–15:50	Dr. Stefano Nuzzo Invited Speaker	Wound field synchronous machines for propulsion: state of the art and trends
15:50–16:10	Dr. Giacomo Scelba Invited Speaker	Resolution of Rotor Position Measurement in Electric Drives: Modelling and Impact on Speed Estimation
16:10–16:30	Dr. Davide Barater Invited Speaker	WBG based power converters for green transportation: challenges and design solutions
16:30–16:50	Prof. Dr. Weidong Zhu Invited Speaker	A Novel All-Geared Infinitely Variable Transmission for Tidal Energy Harvesting
16:50–17:05	Sam Niroshan Thayapararajah Selected Speaker	Development of an air pressure-sensing unit for domestic applications
17:05–17:20	Maria Giorgia Spitaleri Selected Speaker	Current Measurements for the characterization of SiC power devices used in electric traction drives

19 June 2024 (Wednesday)
Time: 9:00 (CEST, Basel) | 03:00 (EDT, New York) | 15:00 (CST Asia, Beijing)
Session 2. Condition Monitoring and Fault Diagnosis

Time in CEST	Speaker	Title
09:00–09:10	Prof. Dr. Hui Ma Session Chair of S2	Welcome from the session chair
09:10–09:30	Prof. Dr. Ciro Santus Invited Speaker	Resonant test rig for rotating fatigue testing of drill pipes
09:30–09:50	Dr. Xiang Li Invited Speaker	Dynamic Vision-Enabled Contactless Machine Micro-Vibration Sensing and Fault Diagnosis
09:50–10:10	Prof. Dr. Jyoti Sinha Invited Speaker	Industrial Challenges in the Vibration-based Condition Monitoring of Machines
10:10–10:25	Maciej Skowron Selected Speaker	Early fault diagnosis of rotor cage bars and stator windings of induction motor based on axial flux signal using transfer learning
10:25–10:40	Bruno Albuquerque de Castro Selected Speaker	Condition Monitoring Applied to Power Transformers using an Acoustic Emission Technique

19 June 2024 (Wednesday)**Time: 15:00 (CEST, Basel) | 09:00 (EDT, New York) | 21:00 (CST Asia, Beijing)****Session 1. Biomimetics of Materials and Structures**

Time in CEST	Speaker	Title
15:00–15:10	Prof. Dr. Kai Cheng Session Chair of S1	Welcome from the session chair
15:10–15:30	Prof. Dr. Panagiotis Kyratsis Invited Speaker	Integrating Artificial Intelligence into the shoe design process
15:30–15:45	Anastasios Tzotzis Selected Speaker	Design of additively manufactured and modularized low-cost Unmanned Surface Vessels for safety purposes
15:45–16:00	Vasiliki E. Alexopoulou Selected Speaker	Correlation of printing speed with the printing accuracy of resolution holes of a custom-made high-speed fused filament fabrication (FFF) printer
16:00–16:15	Alice Todeschini Selected Speaker	Learning the buckled geometry of 3D-printed stiffeners of pre-stretched soft membranes
16:15–16:30	Alok Bihari Singh Selected Speaker	Transforming Healthcare: A Review of Additive Manufacturing Applications in the Healthcare Sector

About Us

Launched in 2009 by MDPI, Sciforum is an event management platform that supports open science by offering the opportunity to participate in, as well as to organize, academic events. Having hosted hundreds of events (be it in-person events, virtual events, or webinars), Sciforum helps organizers reduce their administrative efforts by providing a comprehensive set of tools to successfully manage academic events.

Sciforum Will Help You To

- Easily build your own event's website
- Define your own submission settings
- Manage submissions and its peer-review
- Handle registrations and invoicing
- Easily contact your event attendees and authors
- And much more...

Are you also looking for publication opportunities?

Do you need assistance managing some organizational aspects?

Let us know what else you need!

Where to Find Us

 [linkedin.com/showcase/sciforum](https://www.linkedin.com/showcase/sciforum)

 [facebook.com/mdpisciforum](https://www.facebook.com/mdpisciforum)

 twitter.com/sciforum

 info@sciforum.net



sciforum.net

Our Customers



Abstracts

Session 1. Additive Manufacturing

sciforum-088523: Correlation of Printing Speed with the Printing Accuracy of Resolution Holes of a Custom-Made High-Speed Fused Filament Fabrication (FFF) Printer

Vasiliki E. Alexopoulou, Ioannis T. Christodoulou and Angelos P. Markopoulos

¹ Laboratory of Manufacturing Technology, School of Mechanical Engineering, National Technical University of Athens, 15780 Zografou, Greece

² AGH University of Kraków, Department of Manufacturing Systems, Faculty of Mechanical Engineering and Robotics, 30-059 Krakow, Poland

Fused filament fabrication (FFF) is a 3D-printing technology in which melted thermoplastic filament is extruded through a nozzle on the building bed over the previously solidified layer. This machine enables the fabrication of highly customized and lightweight objects, which are useful in the electronics, biomedical, aerospace and automotive industries. However, FFF 3D-printing is yet not widely used in industry due to the high printing times required. To reduce the printing times, different methods have been applied by researchers, such as nozzle adjustments and the introduction of parallel robots in the FFF machine. We have also developed such a high-speed FFF 3D-printer in the Laboratory of Manufacturing Technology of the School of Mechanical Engineering of the National Technical University of Athens (NTUA). This machine is based on an advanced electromechanical system that allows precise nozzle movement and filament deposition. This novel machine allows us to achieve speeds up to 350[mm/s], while minimizing losses regarding the quality and mechanical strength of the fabricated object. The construction of this high-speed FFF 3D-printer has already been optimized and now the testing phase has begun. The aim of this study is to give an in-depth analysis of the development of this machine (hardware and software) and to investigate the effect of this FFF 3D-printer on the dimensional accuracy of the 3D-printed objects. Specifically, resolution holes with diameters of 4[mm], 3[mm], 2[mm], 1[mm] and 0.5[mm] were built with different printing speeds (150, 200, 250 and 350 [mm/s]) according to the ISO ASTM 52902-2021 standard and the measurements were obtained using a microscope. The results showed that the current FFF 3D-printer achieved acceptable dimensional accuracy (errors below 10%) even for the highest printing speeds. Moreover, the slight decrease in dimensional accuracy observed as the printing speed increases is probably, due to the amplification of oscillation and elasticity phenomena (elasticity of the belt-driven system) in the 3D-printer.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088047: Design of Additively Manufactured and Modularized Low-Cost Unmanned Surface Vessels for Safety Purposes

Anastasios Tzotzis, Athanasios Manavis, Nikolaos Efkolidis and Panagiotis Kyratsis

University of Western Macedonia

The need for Unmanned Surface Vessels (USVs) has been continuously growing in recent years due to the increased demand for automated inspection, surveillance and monitoring platforms. This paper proposes a framework for the development of a modularized, low-cost USV, manufactured with the Fused Filament Fabrication (FFF) technology. The vessel can be operated via Radio Control (RC) and is able to operate autonomously as well. The purpose of this platform is mainly safety applications; however, it is possible to utilize it for scientific tasks, such as water quality monitoring and water structure inspection. Its main advantages are summarized in the modular design, the ability to propel by air and the low build cost. The modular design allows for easy assembly of the vessel, as well as enabling a dynamic size change of the hull. It is noted that the vessel is intended for use in relatively calm waters such as lakes, ponds and reservoirs, especially in waters with dense vegetation. Therefore, the propulsion system was designed with these conditions in mind. Regarding the build cost, the combination of 3D printing, hobby-grade hardware and reliable open-source protocols led to the development of a fully operational and efficient safety platform, with a low cost (EUR 600). Especially when compared to the cost of commercially available USVs, it delivers a high capability/price (C/P) ratio. Finally, the performance of the platform in terms of buoyancy, stability, steering ability and navigational capabilities was validated through field experimentation in the lake Polyfytos in Kozani, Greece.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-087677: Evaluation of Wire Arc Additive Manufacturing for Cavitation Erosion-Damaged Blade Repairs

Shinichiro Ejiri

Nikkiso Co., Ltd., Industrial Division, Fluid Technology Center, Tokyo 150-6022, Japan

Wire arc additive manufacturing (WAAM) is an additive manufacturing technology that is suitable for large parts and parts with complex shapes such as blades. The area is the topic of research and development for industrial applications. Various studies have revealed the industrial advantages of applying WAAM to part manufacturing compared to traditional fabrication methods. In this study, to further clarify the advantages of industrial applications of WAAM, a study on the repair of impellers that have been damaged by cavitation erosion using WAAM was conducted on turbopumps used in a wide range of industries. A fan-type inducer used in industrial centrifugal pumps was used as a test model. The fan-type inducer was installed in a centrifugal pump experimental apparatus, and then, paint erosion tests were conducted. This test was used to investigate the area of damage to the blades that was caused by cavitation erosion. The results show that the area damaged by cavitation erosion is the trailing edge of the suction tip side of the blade. Based on the paint erosion tests, the machining time for repairing blades with a hybrid system of WAAM and machining were calculated and compared with those required to fabricate a new part. The conclusion was reached that the application of WAAM to the fabrication process of industrial turbopumps has advantages not only in the manufacture of parts, but also in the repair of the parts.



© 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088766: Experimental Identification of the One-Dimensional Piezoresistive Behaviour of 3D-Printed Conductive Carbon-Fibre PLA Structural Samples

César M. A. Vasques ¹, João P. R. Ferreira ², João C. C. Abrantes ² and Fernando A. V. Figueiredo ^{2, 3, 4}

¹ Department of Mechanical Engineering, University of Aveiro, Portugal

² proMetheus, Instituto Politécnico de Viana do Castelo, Viana do Castelo, Portugal

³ Smile.Tech—Robótica, Vila Nova de Gaia, Portugal

⁴ Instituto Superior Politécnico Gaya (ISPGaya), Vila Nova de Gaia, Portugal

This paper presents an experimental investigation into the one-dimensional piezoresistive behavior of 3D-printed conductive carbon-fiber polylactic acid (PLA) structural samples. The ability to accurately characterize the piezoresistive properties of such materials is crucial for their application in various fields, including flexible electronics, smart structures, and sensing systems, to name but a few. This study involves the fabrication of carbon-fiber PLA composite samples using a 3D-printing technique and the subsequent testing under different mechanical loading conditions. A comprehensive experimental setup is established to measure the electrical resistance changes in the samples corresponding to applied strain. The obtained data are analyzed to determine the piezoresistive coefficients and investigate the linearity and repeatability of the material's response. The results reveal a clear relationship between the applied strain and the resistance change, demonstrating the piezoresistive behavior of the 3D-printed conductive carbon-fiber PLA structural samples. The findings contribute to a better understanding of the material's sensing capabilities and pave the way for its utilization in various applications requiring strain sensing and structural health monitoring. Further research is warranted to optimize the fabrication process, investigate the effects of different printing parameters, and explore the material's potential for integration in advanced sensing systems and smart structures in various operating scenarios.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088763: Exploring Advanced Structural Designs with 3D-Printed Metallic Isogrid Lattice Cylindrical Shells: Manufacturing, Testing and Simulation

César M. A. Vasques ^{1,2}, Adélio M. S. Cavadas ², Ricardo F. R. Pinto ² and Pedro M. R. Resende ²

¹ Department of Mechanical Engineering, University of Aveiro, Portugal

² proMetheus, Instituto Politécnico de Viana do Castelo, Viana do Castelo, Portugal

This paper delves into the exploration of advanced structural designs through the application of 3D-printed metallic isogrid lattice cylindrical shells. Combining the benefits of isogrid lattice configurations and additive manufacturing, these cylindrical shells offer a unique blend of enhanced strength-to-weight ratio and structural efficiency. The study briefly focuses on the complete process, encompassing design, manufacturing, testing, and simulation. A 3D-printing approach using the laser powder-bed fusion process and tailored for the manufacturing of metallic high-performance maraging steel isogrid lattice parts is developed, considering material selection, print parameters, and post-processing techniques. Mechanical testing is conducted to characterize the structural performance of the fabricated cylindrical shells, including load-bearing capacity, stiffness, and failure modes. Furthermore, finite element simulations are employed to validate the experimental results and gain deeper insights into the structural behavior under various loading conditions. The findings demonstrate the feasibility and effectiveness of 3D-printed metallic isogrid lattice cylindrical shells as exceptional load-bearing structures with superior mechanical properties. This study contributes to an initial understanding of the relationship between design parameters, material characteristics, and structural performance, paving the way for the design and optimization of lightweight and robust structures in diverse engineering applications. Future research avenues are proposed to further refine the fabrication process, explore advanced material combinations, and broaden the applicability of 3D-printed metallic isogrid lattice cylindrical shell structures in fields such as aerospace, automotive, and other industries demanding high-strength, lightweight components.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088713: Integrating Artificial Intelligence into the Shoe Design Process

Prodromos Minaoglou, Anastasios Tzotzis, Nikolaos Efkolidis and Panagiotis Kyratsis

Prodromos Minaoglou, Anastasios Tzotzis, Nikolaos Efkolidis, Panagiotis Kyratsis
Department of Product and Systems Design Engineering, University of Western Macedonia, 50100 Kila Kozani, Greece

Artificial Intelligence (AI) is a branch of computer science that deals with the adoption of human behavioral elements in computer-based systems. Some of these systems support learning, understanding, making inferences and adaptability. In recent years, Artificial Intelligence has brought a rapid technological revolution to many different sectors of industry. It is a tool that can greatly influence the different stages of the design process. In this particular study, the goal is to integrate Artificial Intelligence into the design process of a product, and more specifically of a soccer shoe, using the additive manufacturing principles as an industrial production methodology. Different stages to be followed during the design of a product include mind mapping, digital sketches, Computer-Aided Design (C.A.D), rendering and prototyping facilities (digital and physical equipment). By integrating Artificial Intelligence tools into the traditional design process, designers can enhance the outcomes of their final products through the use of automation and control systems based on a holistic approach to industrial design. This paper introduces a distinct and innovative design framework that combines the benefits of AI digital applications with the expertise of the designer. Specifically, the proposed design methodology will be used to create a prototype of the designed soccer shoe using rapid prototyping tools for user feedback on its form. The conclusions of the study are that Artificial Intelligence is a tool that can be integrated and improve the design process of a product, while at the same time supporting designers' creativity and innovation.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-086651: Learning the Buckled Geometry of 3D Printed Stiffeners of Pre-Stretched Soft Membranes

Simone Battisti, Daniel Calegari, Paolo Marcandelli, Alice Todeschini and Stefano Mariani

Dept. of Civil and Environmental Engineering, Politecnico di Milano

In this work, we propose an Artificial Intelligence (AI)-based methodology to learn the buckled configuration of stiffeners 3D-printed onto a pre-stretched soft membrane. The membrane acts as a muscle and, if properly pre-deformed, leads to the buckling of the stiffeners so that the resulting configuration can provide new system functionalities. Fused deposition modeling was carried out through a Voron 2.4 3D printer, specifically calibrated for PLA printing on a Lycra fabric. The printed PLA allows a controlled deformation of the substrate–stiffener system; different patterns or stiffeners geometries were investigated, to better understand their effects on the buckled configuration. A finite element model was then set to numerically reproduce the results obtained in the experimental campaign; to catch at best the outcomes, in terms of out-of-plane deflection in the buckled mode, an inverse problem was solved to tune the (nonlinear) constitutive models adopted for PLA and Lycra. Since the numerical model proved to be excessively time-consuming, a surrogate was developed by way of deep learning. In the first stage, YOLO (You Only Look Once) was used and trained properly for feature selection: different geometries of the stiffeners were allowed for and their classification was carried out, in addition to the numerical estimation of their relevant features related to the in-plane geometry. In the second stage, a regression part was added to the AI-based tool to learn the out-of-plane deflection, handled as a label in the learning stage. The results testify to the capability of the proposed approach and its efficiency for subsequent use in the shape optimization of the 3D-printed geometry to attain specific targets of coupled system response.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088764: On the Inspection of a Demonstration 3D-Printed Maraging Steel Part

César M. A. Vasques ¹, Adélio M. S. Cavadas ², Pedro M. R. Resende ² and João C. C. Abrantes ²

¹ Department of Mechanical Engineering, University of Aveiro, Portugal

² proMetheus, Instituto Politécnico de Viana do Castelo, Viana do Castelo, Portugal

The increasing adoption of additive manufacturing (AM) in the production of high-performance metallic components highlights the critical need for rigorous quality control and inspection processes. While AM provides unparalleled design freedom and customization potential, concerns remain about the consistency of powder raw materials and the resulting mechanical properties of 3D-printed parts. This article examines these concerns through a case study focusing on 3D-printed metal components manufactured using the laser powder-bed fusion process, specifically with maraging steel. A demonstration maraging steel part is meticulously characterized across several dimensions: geometry, shape limitations, chemical composition, microstructure, surface roughness, and hardness. This comprehensive analysis evaluates material homogeneity, the impact of heat treatments, and the overall suitability of 3D-printed components as replacements for critical parts traditionally produced with conventional manufacturing techniques. The results indicate that 3D-printed maraging steel parts can indeed satisfy the stringent requirements of demanding applications where dimensional accuracy and structural integrity are non-negotiable. However, this paper emphasizes the importance of continued research and process optimization. Areas for improvement include refined powder quality control, optimized post-processing techniques, and deeper investigations into the long-term reliability of 3D-printed metallic components. Addressing these factors will further accelerate the adoption of AM across industries where performance and dependability are paramount.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088926: Revisiting the Horizons of Additive Manufacturing Technology for Ergonomic Product Design

Yogesh Mishra, Makkhan Lal Meena and Govind Sharan Dangayach

Mechanical Engineering Department, Malaviya National Institute of Technology, Jawahar Lal Nehru Marg, Jhalana Gram, Malviya Nagar, Jaipur, Rajasthan 302017, India

Additive Manufacturing (AM) is an effective method of generating highly customized products by adding materials layer by layer to produce the entire item as a single unit, regardless of complexity. AM technology has transformed product design and production by providing unparalleled flexibility and efficiency in creating intricate shapes. By thoroughly examining the existing literature, this study explores how AM supports ergonomic product design. This work explores the benefits of AM in tailoring items to meet the specific requirements of individual users, thereby enhancing comfort, safety, and functionality. This article examines how AM intersects with ergonomic product design, emphasizing its ability to transform conventional design principles and improve user experience.

Further, this research also examines the current issues and obstacles encountered by the personnel on the shop floor because of the need for more individual customization. AM technology may provide personalized equipment that is ergonomically tailored to each user. This study emphasizes the significance of human-centered design techniques and AM technologies to guarantee the smooth integration of ergonomic concepts into product development. This research highlights the obstacles and restrictions related to using AM in ergonomic product design, such as material limits, process constraints, and scalability concerns.

In conclusion, this research proposes reassessing the boundaries of AM technology in the field of ergonomic product design. Designers may employ AM methods to expand creativity and develop visually appealing and ergonomically optimized items for improved user experience and comfort. This research offers guidance for the advancement of AM technology in the field of ergonomics.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088872: Transforming Healthcare: A Review of Additive Manufacturing Applications in the Healthcare Sector

Alok Bihari Singh

Malaviya National Institute of Technology, Jaipur, India

Additive Manufacturing (AM) holds transformative potential in revolutionizing healthcare by facilitating the creation of patient-specific medical devices and apparatus. This review explores the diverse applications of AM within the healthcare sector, focusing on machines with which AM techniques can be implemented. The keywords “additive manufacturing,” “healthcare sector,” and “medical additive manufacturing” were searched using prominent databases like Scopus, Web of Science, and Google Scholar. The articles that met the inclusion criteria were selected for this study. Beginning with an overview of fundamental principles and technologies like stereolithography, selective laser sintering, and fused deposition modeling, along with the machines, this study delves into the fabrication of patient-specific implants, prosthetics, anatomical models, surgical guides, and drug delivery systems. Highlighting AM’s ability to produce complex geometries and customize medical devices according to individual patient anatomy, case studies illustrate successful implementations, improving patient outcomes and surgical efficiency. Challenges such as regulatory hurdles and material biocompatibility are addressed alongside ongoing research efforts to enhance AM’s efficacy. This study also discusses key trends and future directions, including integrating advanced materials, bioprinting techniques, and artificial intelligence to drive innovation in patient-centric healthcare solutions. This focused exploration underscores AM’s potential in advancing healthcare apparatus for improved patient care.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-091114: Analysis and Non-Invasive Diagnostics of Bearing Faults in Three-Phase Induction Motors

Juan A. Barreno, Fernando Bento and Antonio J. Marques Cardoso

CISE—Electromechatronic Systems Research Centre, University of Beira Interior

This article focuses on the analysis and non-invasive online diagnostics of the operating condition of bearings integrated in three-phase squirrel cage induction motors, an electric machine that, due to its constructive and operational characteristics, has a significant presence in the industry.

The proposed signal-processing analysis tool is based on the non-invasive monitoring of stator electrical currents. To improve robustness in the diagnosis of bearing faults over the state-of-the-art, a hybrid approach is employed. The Short-Time Fourier Transform (STFT) and Park's Vector Approach (PVA) are combined and applied to the stator currents. The hybridisation allows benefits of both methods to be combined: (i) a proper evaluation of time-varying phenomena; and (ii) the possibility to distinguish the type of fault affecting the bearing.

To demonstrate the feasibility of the approach, comparisons are made between the proposed hybrid technique and both the STFT and the Extended Park's Vector Approach (EPVA), which have been previously considered in the diagnosis of these and other induction motor faults.

The validation of the proposed solutions is conducted through computational simulations and laboratory tests, ultimately aiming at generating a database of results that will initiate future research in this area. To emulate bearing failures in an experimental context, artificial damage to bearing components is introduced.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-090822: A Fundamental Investigation of Bearing Cage Pocket Lubrication and Friction

Saeed Aamer

Mechanical Engineering, Purdue University

The focus of this study is to examine the effect of fundamental pocket geometries of a cylindrical roller bearing (CRB) cage on its lubrication and friction performance. Lubrication in bearings presents an interesting tradeoff, with excessive lubrication resulting in high friction and fluid drag, while poor lubrication inherently results in wear and component damage. Three cage pockets of varying conformity with the roller were investigated to determine pocket friction due to fluid shear as well as lubricant availability within the pocket. A custom Bearing Cage Friction Test Rig (BCFTR) was utilized to isolate a single roller within a cage pocket geometry. The BCFTR was configured with a 6-axis load cell to accurately measure friction developed between the roller and pocket, while the roller speed was controlled through a precise servo motor. A lubricant sealing enclosure was installed around the roller to control the lubricant fill condition during testing. The enclosure was designed to include swappable, transparent cage inserts with adjustable roller pocket clearances. Testing was conducted for a range of roller speeds, pocket clearances, and lubricant fill conditions, and a high-speed camera was used to capture lubricant flow within the roller–pocket gap. A multiphase computational fluid dynamics (CFD) model was developed for an equivalent geometry, matching the range of test conditions. The robust model was able to accurately predict both the experimentally measured pocket friction and the imaging of the pocket lubrication state. Through the study, cage pocket conformity was determined to have a prominent effect. Reducing pocket conformity aids in minimizing pocket friction. However, the larger pocket inlet and outlet zones resulting from a low-conformity design promote high recirculation, which generates aeration within the lubricant. Furthermore, a low-conformity pocket design faces challenges in retaining the lubricant in the roller–pocket contact.



© 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-086381: Application and VALIDATion of a Lockout/Tagout Approach on A Stamping Production Process

Francisco Rocha and Raul Campilho

ISEP—School of Engineering

With machines becoming increasingly more complex as technology advances and automation becomes an increasingly important aspect of all types of manufacturing processes, the complexity of engaging with machinery also increases, which can lead to increased risk and injury rates. LOTO, or lockout/tagout, aims to control hazardous energies by developing blocking methods for the energies present in industrial equipment and to create safety procedures instructing workers on how to perform their tasks safely.

In this context, this work aims to use LOTO methodologies to develop a safety procedure for three different machines located in a factory specializing in the manufacturing of metal cans used for packaging. Some preliminary research identified the resources needed for the implementation of LOTO methodologies, such as the improvement of the tagging system that identifies the equipment and the energy blocking points, and the acquisition of the equipment needed to correctly block and dissipate the energy present in the machines. Following these tasks, each of the three machines was individually analyzed, documenting the tasks performed by workers on the machine and the energies involved in those tasks, as well as the implementation of the needed changes and improvements. Once the needed information was gathered, a safety procedure was developed and implemented for each machine, showcasing the documented tasks, along with the energies that need to be blocked, and a guide was created on how to perform each task safely. The implemented changes and safety procedure seemed not to slow down the duration of the tasks and were able to reduce the injury rates seen on the machine. However, due to the time constraints placed on this work and the large timescale needed to correctly evaluate rates of injury, it is suggested to collect more data after the implementation of the safety procedures for a more robust conclusion.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088464: Condition Monitoring Applied to Power Transformers Using an Acoustic Emission Technique

Izadora Rodrigues Bittencourt¹, Bruno Albuquerque Castro¹, Jorge Alfredo Ardila Rey², André Luiz Andreoli¹ and Abdo Youssif Khoury Filho

¹ São Paulo State University (UNESP), School of Engineering, Bauru, Department of Electrical Engineering

² Departamento de Ingeniería Eléctrica, Universidad Técnica Federico Santa María, Santiago de Chile 8940000, Chile

Power transformers are important electrical machines that allow power flow in the transmission and distribution energy systems. Therefore, condition monitoring and fault diagnosis applied to power transformers are crucial in order to guarantee high levels of energy supply to the whole world. In this scenario, one of the most common failures is the discharge activities in the dielectric components due to insulation degradation caused by overload operation, moisture, overheating, as well as manufacturing flaws such as conductor tilting, conductor bending, the deposition of dirt in bushings, etc. In this context, it is important to develop systems that allow the type of failure to be classified since different flaws require different maintenance actions. Hence, this article presents a new approach to classify three operational conditions: surface discharges on bushings, electric arcs inside the transformer, and machines without flaws. An acoustic sensor was attached to the machine wall and the 100 acoustic signals per operational condition were acquired with a frequency rate of 1 MHz. After that, signal processing analysis based on the spectrum content was carried out. The results indicated that skewness combined with the average frequency and equivalent bandwidth statistics is a promising tool to assess the operational conditions and classify the type of failure. Therefore, this work contributes to the improvement of power transformer maintenance systems.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-085120: Design of Disc Brake Dynamometer for Domestic Applications

Shanuka Gayan Premathilaka, Nishshanka Bandara and Sam Niroshan Thayapararajah

Department of Engineering Technology, University of Jaffna

Dynamometers are specifically designed for the measurement of the engine's brake power. Although several types are physically available, disc brake dynamometers stand out as a more accurate and easily manipulable system. This paper aims to develop a highly accurate disc brake dynamometer while establishing the relationships between several process parameters. In the methodology, the initial stage was to measure the force requirements to the accelerator, brake lever, and clutch. A 3D model was developed using AutoCAD and the necessary accessories were identified. A CG125 engine was selected for the study. The most relevant preliminary design stages were formulated before the experimentation. An interface was added to display the outcome of the analysis. In the results, a real-time graphical relationship was built for brake power and engine speed. Seven sets of data in two different circumstances were obtained. The obtained results were validated against previous experimental results. Both sets of results were matched in most situations for the selected engine. The variation was comparatively less. The engine RPM was stipulated between 2000 and 8000, with the maximum power at the upper limit. The developed domestic application provided major benefits such as the control of the system at a single location, the automatic generation of relationships between the concerned parameters, the presence of a safety switch that can immediately halt the process in emergencies, the use of lambda sensors for corrections, and less maintenance. In terms of limitations, the system is limited to a permanent engine. Thus, this research can be further improved upon with the use of several engines at a time. Errors concerning the software can be avoided with comparative studies. Indeed, this dynamometer's precision and safety were improved more than any other type of conventional disc brake dynamometer.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088658: Early Fault Diagnosis of Rotor Cage Bars and Stator Windings of Induction Motor Based on Axial Flux Signal Using Transfer Learning

Maciej Skowron

Wroclaw University of Science and Technology

In view of the development of electric drives, they manage the operation of motors, in addition to ensuring the properties of the drive, and perform the function of monitoring the machine's technical condition. In the case of popular industrial applications induction motors, electrical circuit damages are more than half of all appearing faults. In connection with the above, the task of early detection of defects becomes a priority in drive systems. Increasingly, the diagnosis of electric motors uses artificial intelligence techniques, in particular, neural networks in the form of classic or deep structures. However, providing useful functions requires the development of many diagnostic patterns that carry information about the technical condition of the machine. Therefore, expanding the scope of the system to include new types of defects requires a reimplementation of the neural structure. The solution to the problem of the universality of features is the use of transfer learning. To demonstrate the advantages of transfer learning, a fault diagnostic system for stator windings and rotor cage bars of an induction motor was developed. The developed system was based on direct analysis of the axial flux signal, bypassing the classical methods of symptom extraction. Particularly noteworthy is the fact that the system can detect two types of defect based on the symptoms acquired for one type of defect. Verification was carried out in the steady and transient states for the full range of load torque. Analysis of the detection of rotor cage bar defects in the absence of load is of particular importance due to the absence of the motor slip parameter, which limits the use of classical diagnostic methods. In addition, thanks to the use of direct signal processing by a convolutional neural network, it was possible to repeatedly reduce the response time to an emerging defect.



© 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088335: Effective Strategies for Early Detection of Inter-Turn Short-Circuit Faults in Permanent Magnet Synchronous Motors

Maria Teresa Santos ¹, Khaled Laadjal ¹ and Antonio J. Marques Cardoso ²

¹ CISE—Electromechatronic Systems Research Centre, University of Beira Interior, Portugal

² CISE-Electromechatronic Systems Research Centre, University of Beira Interior, Portugal

The rising utilization of permanent magnet synchronous motors (PMSMs) across various industrial domains underscores the pressing need to proactively manage potential issues, particularly inter-turn short-circuit faults (ITSCFs). These faults, recognized as among the most hazardous PMSM failures, can have severe repercussions if left undetected, leading to significant repair costs and posing safety risks.

In response to this challenge, this study introduces an innovative online diagnostic method aimed at mitigating ITSCF risks. This approach involves the real-time estimation of impedance symmetrical components (ISCs) using the Short-Time Fourier Transform (STFT) technique, seamlessly integrated into the LabVIEW environment. The method based on applying the Discrete Fourier Transform (DFT) algorithm on a short-time sliding window, offering simplicity, speed, and the precise determination and tracking of frequency and harmonic amplitudes. This allows considering the non-stationary aspect of the problem and fits well with the proposed application.

Moreover, the method's broad applicability, along with its elimination of motor parameter estimation requirements and minimal variable measurement needs, renders it highly advantageous for motors. By adopting this approach, industries can enhance the reliability and safety of PMSMs while minimizing the financial and operational risks associated with ITSCFs. To validate the efficacy of the proposed technique, extensive testing of PMSMs was conducted under diverse operating conditions, including varying fault severity, transient load variations, and speed fluctuations.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088760: Fault Diagnosis in Induction Motor Installation Using Discrete Wavelet Energy and Low-Cost Sensors

Matheus Godoy ¹, Guilherme Lucas ² and André Luiz Andreoli ³

¹ Sao Paulo State University

² São Paulo State University

³ Department of Electrical Engineering, São Paulo State University (UNESP)

In industries, three-phase induction motors (TIMs) are crucial elements in production lines. Consequently, faults in these machines are closely linked to huge losses in productivity. Therefore, predictive fault detection methods are valuable tools in this field. Within this framework, the correct installation of the motor is the first step to avoiding flaws. The key procedures are leveling, alignment, and tightening. However, over time, the TIM's fixing bolts can become loose. This phenomenon leads to other types of mechanical failure, damaging the machine. Therefore, this work studied the application of piezoelectric sensors and the Discrete Wavelet Energy Technique (DWET) to identify loose bolts in the base of three-phase induction motors. The four mounting bolts were tested during the experiments, and after the signal processing, they could be individually diagnosed as tight or loose. The fault classification was achieved by using 3D classification maps. The clusters related to each bolt condition were well defined and spatially far from each other. Also, different wavelet levels were tested, and their efficiency was compared through silhouette and precision statistical indexes. Piezoelectric sensors were applied as transducers to acquire the vibration of the motor due to their low cost and availability. Several experiments were carried out with different conditions to ensure the efficiency of the proposed system. Finally, the results showed that the new low-cost system successfully diagnosed and classified loose bolts in TIMs.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-091074: Fault Diagnosis of the Hydraulic System for a Bridge Erecting Machine Based on Ontology Bayesian Networks

Huan Zhang and Gangfeng Wang

Key Laboratory of Road Construction Technology and Equipment of MOE, School of Construction Machinery, Chang'an University, Xi'an 710064, China

Aiming at the problems of various fault types, such as the great difference in fault knowledge expression and the weak fault causality reasoning ability in hydraulic systems of bridge erecting machines, which lead to a low accuracy of fault component location in hydraulic systems, a hydraulic system fault diagnosis method based on ontology Bayesian networks was proposed. Firstly, by analyzing the fault knowledge of the hydraulic system for a bridge erecting machine in detail, the fault ontology was formally defined, and the fault ontology model of the hydraulic system was constructed with probabilistic extension. Subsequently, the conversion rules for the ontology Bayesian network were established, based on which the automatic transformation from the ontology model to the Bayesian network model was realized by using the Jena API. This conversion process was facilitated by the maximum likelihood estimation algorithm, resulting in an optimal Bayesian network model for fault diagnosis. Finally, a certain model of the hydraulic system for a bridge erecting machine was investigated using this methodology, and the Netica simulation platform was employed to conduct diagnostic reasoning from observed fault phenomena to fault components. The experimental results demonstrate that this approach enhances the accuracy of fault diagnosis and can provide a reference for the fault diagnosis of construction machinery hydraulic systems.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-090404: Investigation of the Impact of Current Controller Parameters in Field-Oriented Control on Fault Detection in PMSM

Mateusz Krzysztofiak

Wroclaw University of Science and Technology

The ability to adjust various dynamic properties is facilitated by utilizing vector control methods. In vector control, selecting the appropriate parameters significantly influences not only dynamic parameters but also the ability to detect potential faults in the drive system, considering that the control structure tends to compensate for faults. This study focuses on a comprehensive analysis of the impact of current controller parameters in field-oriented control on fault detection. The main analysis was conducted regarding the identification and characterisation of potential faults in permanent magnet synchronous motors, including demagnetization and short circuits, which affect machine operation parameters. The presented research includes an assessment of the controller's bandwidth on the harmonic content present in control signals. This analysis sheds light on the complex relationship between controller parameters and sensitivity to fault detection. The proposed methods and solutions were analyzed both through simulation in co-simulation processes and experimental validation. This research confirms the importance of the proposed fault detection indicators in improving the reliability and effectiveness of fault detection mechanisms in drive systems with permanent magnet motors. The results emphasize the crucial role of current controller parameters in field-oriented control in providing accurate fault detection information. This information can be used as an important resource for teaching neural networks to implement automatic fault detection structures.



© 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-091239: New Hybrid Deep Learning Approach Using Transfer Learning for Fault Classification

Alasmer Ibrahim ¹, Fatih Anayi ² and Michael Packianather ³

¹ Cardiff University, Cardiff School of Engineering

² Wolfson Centre for Magnetics, Cardiff University Cardiff, CF24 3AA, UK

³ High-Value Manufacturing Group, Cardiff University Cardiff, CF24 3AA, UK

Induction motors operate in difficult environments in the industry. Monitoring their performance in such circumstances is significant, as it can provide a reliable operation system to secure the production line. Recently, Artificial Intelligence techniques (AI) were applied to the condition monitoring and fault diagnosis systems in order to build an efficient classification model. This paper focuses on developing a new hybrid diagnosis model for fault classification. The development of this model provides a novel technique for the diagnosis of single and multiple induction motor faults. The aim is to find a new alternative source to extract automatic features from the motor parameters. Three deep learning networks including Visual Geometry Group 19 model (VGG-19), Residual Network 50 model (ResNet-50), and EfficientNet-B0 model (EfficientNet-B0) were applied to pre-train the suggested model. The use of these networks can also allow the attributes to be automatically extracted and associated with the decision-making part. The model's performance was assessed by calculating some evaluation metrics, such as the confusion matrix, accuracy, precision, recall, and F1 Score. The evaluation of the proposed model was achieved by applying different types of motor data including stator current data and motor vibration data. In addition, Convolutional Neural Networks (CNNs) were applied as an image processing method to achieve the model features. The experimental results proved the robustness and capability of the proposed model for fault classification by combining the suggested networks. The suggested hybrid model achieved a high classification accuracy.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-090981: Proposal of Testing Equipment for Permeability Assessment in Advanced Composite Pressure Vessels

Rui J.C. Fernandes ¹, Raul D.S.G. Campilho ^{1,2} and Rui B.P.M. Marques ²

¹ Department of Mechanical Engineering, ISEP-School of Engineering, Polytechnic Institute of Porto, R. Dr. António Bernardino de Almeida, 431, 4200-072 Porto, Portugal

² INEGI—Institute of Science and Innovation in Mechanical and Industrial Engineering, Pólo FEUP, Rua Dr. Roberto Frias, 400, 4200-465 Porto, Portugal

Pressure vessels serve as vital components for the containment of liquids or gases in various industrial applications. The utilization of pressure vessels constructed from composite materials presents a significant advantage compared to conventional vessels crafted from metal alloys or those incorporating liners, specifically, in terms of weight reduction. This attribute holds particular significance in industries such as aerospace, where it is imperative to minimize weight. By applying composite materials in pressure vessel design, substantial gains in weight reduction can be achieved, thereby contributing to enhanced performance and operational efficiency in critical aerospace applications. This work presents the mechanical design, including experimental validation, of a permeability test setup, used to estimate the permeability of composite materials used in type V aerospace pressure vessels. The test setup includes two steel chambers, between which the composite sample is placed for evaluation. During the test, the gas that the pressure vessel will hold is introduced under pressure by the receiving chamber. The other chamber (measurement chamber) serves to measure the pressure variation by a pressure transducer. With the data collected by the pressure transducer, the sample permeability can be assessed. During the design process, alternatives were also considered during the design, and the justifications of each selected and implemented solution were presented. The test setup was fabricated, and the correct operation validated. The validation of the proposed setup was accomplished using materials with different permeability characteristics, and the respective data analyzed and compared between materials and values from the literature. Permeability tests were also carried out and the results obtained were analyzed. The validation stage was successfully completed, since the obtained results from the setup agreed with those found in the literature, and the test setup was created and it is currently operational.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-091093: Resonant Test Rig for the Rotating Fatigue Testing of Drill Pipes

Ciro Santus ¹, Lorenzo Romanelli ², Alessandro Burchianti ³, Nicola Pieri ³ and Tomoya Inoue ⁴

¹ University of Pisa—DICI, Dept. of Civil and Industrial Engineering

² Department of Civil and Industrial Engineering—DICI, University of Pisa, Largo Lucio Lazzarino 1, 56122 Pisa, Italy

³ ACTA Srl, Via della Villana 154, 57016 Rosignano Solvay, Italy

⁴ Engineering Department, Japan Agency for Marine-Earth Science and Technology—JAMSTEC, Yokosuka 238-8550, Japan

Drill strings are key components for oil and gas extraction, and also in scientific explorations, such as to reach deep sub-seafloor sediments. Drill strings are mainly composed of drill pipes, whose failure is usually triggered by fatigue. Because of this, a dedicated test rig to investigate the fatigue strength of drill pipes gives the opportunity to find design stress parameters and crack initiation sites. The University of Pisa (Italy), in collaboration with ACTA Srl (Italy), developed a resonant test rig which allows fatigue tests to be performed on drill pipe specimens, saving time and energy costs with respect to an alternative fatigue facility, such as a four-point bending testing equipment. In this resonant test rig, an eccentric mass on one side rotates at an angular speed near, but lower than the first natural frequency of the structure, thus providing a rotating bending moment on the drill pipe specimen. Several aspects of the test rig, such as the strain gauge calibration and the correct set-up of the control system, are fundamental to perform proper tests. A description of the test rig and of its various components is given in this presentation. A fatigue test series example is also presented in collaboration with JAMSTEC (Japan) who are interested in explorative drilling, especially at deep sub-seafloor locations.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Abstracts

Session 3. Automation and Control Systems

sciforum-091071: Research on a Hydraulic Cylinder's Synchronous Control of Lifting Equipment for Large Prefabricated Components Based on IGWO-BP-PID

Chao Zhang, Gangfeng Wang and Junkang Yang

Key Laboratory of Road Construction Technology and Equipment of MOE, School of Construction Machinery, Chang'an University, Xi'an 710064, China

The lifting tonnage of large prefabricated components is heavy, and the adverse condition of partial load hoisting often occurs, which is conducive to dangerous accidents. In order to improve the synchronization control precision of hydraulic cylinders in lifting equipment, a synchronous control strategy combining IGWO-BP-PID (improved gray wolf optimization and back propagation proportion integration differentiation) and state difference feedback is studied. Firstly, the hydraulic cylinders are divided into two groups in the longitudinal direction by analyzing the structure of the special lifting equipment and the hydraulic principle. The gray wolf position is updated in the GWO to achieve the optimization of BP-PID parameters through IGWO. Then, three controllers are used to analyze the system control, and the control effect of IGWO-BP-PID is verified. Finally, the synchronous control strategy combining IGWO-BP-PID and state differential feedback is adopted to jointly simulate the hydraulic cylinders in AMESim/Simulink, and this is compared and analyzed with the experimental data. The results show that the IGWO-BP-PID controller has no overshoot and a better control effect. Compared with conventional PID control, this proposed method shortens the oscillation adjustment time of the hydraulic cylinders, and the synchronization control accuracy is higher. The validity of the synchronization control strategy for lifting equipment is verified through a field test on lifting an off-loaded, large prefabricated component.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-084989: A Driver-Assisted Automatic Pneumatic Braking System: CONCEPTUalized Product Development

Sam Niroshan Thayapararajah, Delagamaathige Ravindu Deshaka Aluthwaththa and Ranamukage Wishwantha Wijayangana Ranamuka

Department of Engineering Technology, University of Jaffna

Driving is one of the prominent necessities of any individual. Due to the growth of the population, transportation has become tight, thus increasing the risk of accidents. There are several reasons that have been highlighted for such accidents, namely, long-distance driving without appropriate relaxation, driving at night, using mobile devices while driving, and driving under the influence of alcohol. Even though several pieces of research are available on automatic braking, this research specifically analyzes the importance of real-time data, while the system is driver-assisted. This research comprised an ultrasonic sensor, speed sensor, Arduino UNO Board, rain sensor, DC actuator, air compressor, and air reservoirs along with the major elements of the braking system. The results were analyzed in three various situations in wet and dry conditions. In addition, 1 m of tolerance was provided for the internal adjustments of the vehicle. At first sight, if the distance between the object and the vehicle is larger than the braking distance tolerance limit, the system functions normally where activation is unnecessary. If the distance between the vehicle and the object interface is less than the braking distance tolerance limit, using the sensing mechanism, the brakes will be actuated and the vehicle will stop immediately. Finally, when the vehicle and object are too close, the system will not function again while giving a warning sign for the driver to steer in the proper direction. Overall, the variation in braking distance concerning vehicle speed was analyzed in both wet and dry conditions. Indeed, the research results provided a practically applicable automatic braking system with the driver's control. This proactive method of accident mitigation represents a novel solution with the future scope of coordinating the automated braking system with a speed reduction system by regulating the accelerator's rotation.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088594: Bismuth Chalcogenides Inside Single-Walled Carbon Nanotubes

Marianna V. Kharlamova

Faculty of Physics, University of Vienna, Strudlhofgasse 4, 1090 Vienna, Austria

Bismuth chalcogenides are topological insulators with unique crystal structures. They exhibit new phases in the interiors of carbon nanotubes. One-dimensional phases provide new physical properties. These can be applied in machines and other applications. The electronic properties of bismuth chalcogenides have attracted the attention of researchers. Spectroscopy is applied to investigate alterations in the band structures and the electronic structures of filled carbon nanotubes. Here, we investigate the electronic properties of bismuth chalcogenide-filled single-walled carbon nanotubes (SWCNTs). Transmission electron microscopy shows the filling of SWCNTs with atomic nanowires. The loaded substances are detected inside the SWCNTs. Atoms of bismuth chalcogenides are found within the SWCNT walls. Energy dispersive X-ray analysis proves the chemical composition and the stoichiometry of the compounds inside the SWCNTs. Raman spectroscopy shows slight modifications of Raman modes. These include slight shifts of peaks and alterations in peak profiles. The applications in machines require information on the modified electronic properties of the filled SWCNTs. This work opens new avenues for the novel applications of carbon nanotubes. Automation and control systems need new materials with the researched band structure. The physics of this system brings new phenomena. The effects on the electronic structures investigated in this work are useful in other applications, too.



© 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-085982: Brake Fluid Level Management

Niroshan T.S., Marasinghe M.A.K.P., Thushanth T and Nirojh T

Department of Engineering Technology, University of Jaffna

Hydraulic braking systems prevail as the most popular type of modernized braking application. This braking system is most efficient due to the controlled use of braking fluid. Supply line failures and damaged oil tanks deteriorate the functionality of the system, which inherently leads to accidents with a loss of control. This research aims to develop an alternative fluid supply line to the master cylinder for cases of emergency. Advantages such as less space, automated operation, and ease of manufacturing and assembling have been identified as key promoters for this development. A gravitational means of fluid transportation is encouraged. When the master cylinder chamber requires braking fluid, the main fluid reserve supplies the amount needed. With this alternative supply, even if the main supply system fails, the master cylinder will receive enough fluid oil when needed. This system will be helpful in emergencies until drivers can find a repair station to fix the braking system failure. The device was formulated with the minimum number of components necessary, namely, a level sensor, a non-return valve, a reserve tank, and a few fluid lines. The application of a prototype to 25 selected vehicles highlighted that 30% of the samples were able to utilize the fluid management system in an appropriate manner. Its drawbacks include the misalignment of the flow systems and an inadequate supply to ignite the engines. In addressing these limitations, a pump can be incorporated to undermine the issues of reserve tanks. Thus, brake fluid level management rectifies the drawbacks of a conventional setup while minimizing emergencies.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088767: Concept and Preliminary Design of a 3D-Printed Mechatronic Robotic Gripper Prototype for Textile Handling Automation

César M. A. Vasques ^{1,2}, João P. R. Ferreira ² and Fernando A. V. Figueiredo ^{2,3,4}

¹ Department of Mechanical Engineering, University of Aveiro, Portugal

² proMetheus, Instituto Politécnico de Viana do Castelo, Viana do Castelo, Portugal

³ Smile.Tech—Robótica, Vila Nova de Gaia, Portugal

⁴ Instituto Superior Politécnico Gaya (ISPGaya), Vila Nova de Gaia, Portugal

The automation of textile handling processes poses significant challenges due to the complex nature of textile materials. This paper presents the concept and preliminary design of a novel mechatronic robotic gripper prototype specifically developed for textile handling tasks. The proposed gripper leverages the advantages of 3D printing technology, enabling the fabrication of intricate and customizable structures with high precision. The gripper incorporates a combination of soft and rigid materials to ensure gentle yet firm grasping of textiles, while also providing adaptability to different fabric types. The design integrates sensing and actuation components to enable intelligent gripping and manipulation of textiles, thereby enhancing automation capabilities. This paper details the design considerations, mechanical and electrical components, and the control system architecture of the gripper prototype. Preliminary experimental results demonstrate the gripper's capability to handle various textile materials effectively, with promising performance in terms of accuracy, stability, and reliability. The proposed 3D-printed mechatronic robotic gripper prototype represents a significant advancement in textile handling automation, offering potential applications in industries such as apparel manufacturing, logistics, and household textiles. Further research is warranted to optimize the gripper's design, control algorithms, and scalability to meet the diverse requirements of textile handling automation systems for various operating scenarios.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-084434: DEVELOpment and EVALuation of Building Energy Efficiency through the DESign and Implementation of Automation and Control Systems in Mozambique

Samuel Aires Master Lazaro

College of Civil Engineering, Taiyuan University of Technology, No. 79 West Street Yingze, Taiyuan 030024, China

The global push for sustainable development and lower energy usage has prompted increased interest in using automation and control systems in building infrastructures. These systems are now being investigated in Mozambique to determine their ability to increase energy efficiency. This study focuses on the complex processes of creating, deploying, and assessing these systems which use cutting-edge technology such as sensors, machine learning algorithms, and smart devices. The study includes case studies and experimental results that demonstrate the real-world usefulness of these methods. The capacity of automation and control systems to regulate temperature, lighting, and other energy-intensive components significantly reduces overall energy usage within buildings. Furthermore, these systems can discover and diagnose defects in a building's energy systems, allowing for fast and efficient repair—a critical factor in Mozambique, where energy supply is frequently unstable and maintenance is complex. The results of this study imply considerable energy savings, which will help to reduce the country's carbon footprint and advance sustainable development goals. The combination of advanced technologies, practical effectiveness in real-world scenarios, contextual relevance to Mozambique, a holistic approach, emphasis on timely maintenance, and the promotion of sustainable development make this study unique and valuable in building energy efficiency. In conclusion, this study catalyses the creation and implementation of Building Energy Management Systems in Mozambique by providing relevant insights for policymakers, building owners, and energy managers.



© 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088517: Development of an Orthogonal Transfer System for the Automated Warehouse Industry

Rafael Fonseca and Raul Campilho

ISEP—School of Engineering

The exponential increase in e-commerce and the demands of consumers, who are increasingly demanding speed, present a huge challenge to the intralogistics industry. In this sense, intralogistics is an area that has been the subject of intensive research. Companies need to digitize, automate, and robotize all logistics processes to optimize the flow of materials and information and remain competitive in the global market.

This work aims to develop an orthogonal transfer mechanism for the automated warehouse industry. The equipment is intended to be integrated into a roller conveyor line for transporting small boxes, and its purpose is to distribute and organize logistics within warehouses. To achieve this goal, research was first carried out on existing solutions on the market to identify their respective strengths as well as to study hypotheses for improvement. The equipment was designed and dimensioned using the finite element method to ensure that the solution found could withstand the workload. Cost analysis and the construction of a prototype are also addressed. Operational tests were carried out to assess whether the final product is capable of meeting all the objectives set. The designed equipment proved to be a viable and competitive solution when it comes to the automatic orthogonal transfer of boxes. It has an innovative lifting mechanism capable of lifting more loads than existing transfer equipment on the market and is capable of operating 24 h a day at a rate of more than 30 units/min.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088596: Ferrocenes Inside Single-Walled Carbon Nanotubes

Marianna V. Kharlamova

Faculty of Physics, University of Vienna, Strudlhofgasse 4, 1090 Vienna, Austria

It is of paramount importance to create applications for SWCNTs in automation and control systems. Ferrocene-filled single-walled carbon nanotubes (SWCNTs) are interesting systems with unique properties. SWCNTs were first filled with ferrocene in 2005 [?]. Since then, many more studies have dealt with the filling of SWCNTs with ferrocenes. The structures of ferrocenes in SWCNTs with different diameters have been investigated [?]. The growth dynamics of inner carbon nanotubes inside ferrocene-filled SWCNTs attract the interest of researchers [?]. Controlling the physics of ferrocene-filled SWCNT systems opens up superior possibilities. The outer diameter of SWCNTs is well defined. This controls the size of catalyst particles inside SWCNTs. This shows great promise for new applications in automation and control systems. In this paper, the preparation of ferrocene-filled SWCNTs allowed us to control the physics of the interior of carbon nanotubes. The growth dynamics and electronic properties of carbon nanotubes were investigated with spectroscopy. The growth rates of three carbon nanotubes were compared. The Fermi level differences in pristine SWCNTs and samples of vacuum-annealed, ferrocene-filled SWCNTs were shown.

References

1. Guan L. H., Shi Z. J., Li M. X., Gu Z. N. Carbon 2005, 43(13), 2780–2785.
2. Plank W., Pfeiffer R., Schaman C., Kuzmany H., Calvaresi M., Zerbetto F., Meyer J. ACS Nano. 2010, 4(8), 4515–4522.
3. Shiozawa H., Pichler T., Gruneis A., Pfeiffer R., Kuzmany H., Liu Z., Suenaga K., Kataura H. Adv. Mater. 2008, 20 (8), 1443–1449.



© 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088943: Kinematics and Accuracy of the 3D-Printed Low-Cost Delta-Robot Óscar

César M. A. Vasques ^{1,2} and Fernando A. V. Figueiredo ^{2,3,4}

¹ Department of Mechanical Engineering, University of Aveiro, Portugal

² proMetheus, Instituto Politécnico de Viana do Castelo, Viana do Castelo, Portugal

³ Smile.Tech—Robótica, Vila Nova de Gaia, Portugal

⁴ Instituto Superior Politécnico Gaya (ISPGaya), Vila Nova de Gaia, Portugal

Robotics stands as a pivotal force shaping the future of our society, revolutionizing industries from healthcare and manufacturing to transportation and exploration. While serial anthropomorphic robots dominate the industrial landscape, parallel Delta robots have long occupied a niche position, renowned for their exceptional speed, precision, and mechanical simplicity. Now, with the transformative power of additive manufacturing (AM) and 3D printing, the field of mechatronics is poised for unprecedented innovation. AM liberates design constraints, allowing greater complexity in geometry and the seamless integration of diverse materials, all while maintaining production accessibility. These advancements address a multitude of intricate engineering challenges, unlocking solutions that were once restricted by traditional design and manufacturing limitations. This work delves into the kinematics modeling and accuracy analysis of the Oscar family, a series of cost-effective, 3D-printed Delta robots. It presents a comprehensive examination of both forward and inverse kinematics modeling techniques, assessing the efficacy of the methodologies employed. Furthermore, this study will explore how subtle changes in design parameters impact the robot's positional accuracy throughout its workspace. By carefully analyzing these relationships, we can gain valuable insights that will guide the development of future Delta robots, pushing the boundaries of performance and affordability within this exciting field.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088410: Parameter Identification of Flexible-Link Manipulators Using Evolutionary Algorithms

Fabian Andres Lara-Molina

Department of Mechanical Engineering, Federal University of Triângulo Mineiro, Uberaba 38064-200, MG, Brazil

This paper addresses the parameter identification of a one-link flexible manipulator based on the experimental measurement of inputs/outputs, the finite element model, and the application of evolutionary algorithms.

A novel approach is proposed to find the inertia, stiffness, and damping parameters by minimizing the difference between the numerical model's outputs and the testbed's outputs, considering the joint position and acceleration of the link's tip. The flexible manipulator's instrumentation, data acquisition, and actuation uses the NI myRIO board to control the XM430-W350 Dynamixel servomotor, and the U2D2 interface couples the servomotor and the NI myRIO board. The accelerometer MMA7361 is connected to the input of the A/D (analog-to-digital converter). The programs of NI myRIO are coded using LabVIEW. The dynamic model is initially obtained using the finite element method and the Lagrange principle. Then, an optimization problem minimizes the difference between numerical and experimental outputs to determine the set of parameters using evolutionary algorithms. A comparative analysis to obtain the identified parameters is established using genetic algorithms, particle swarm optimization, and differential evolution.

The proposed identification approach permitted the determination of the dynamic parameters based on the complete dynamic model of the flexible-link manipulator, which is different from the approaches reported in the literature that identify a simplified model. This information is essential for the design of the motion and vibration control laws.



© 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-091075: Research on Structural Optimization of Bridge-Erecting Machine's Main Girder Using Improved Beluga Whale Algorithm

Yi Chen, Gangfeng Wang, En Yang and Tao Qin

Key Laboratory of Road Construction Technology and Equipment of MOE, School of Construction Machinery, Chang'an University, Xi'an 710064, China

Under a traditional design scheme, the design quantity of the main girder of the bridge-erecting machine is redundant and there are many consumables, which reduces the production efficiency, and existing optimization methods have the problem of low convergence accuracy. Therefore, this paper proposes an improved beluga whale optimization algorithm based on the quadratic interpolation strategy and carries out the lightweight design of the main girder of the bridge-erecting machine. By introducing the quadratic interpolation strategy, the algorithm is not easy to categorize into the local optimal solution in the later stage of optimization, but it has excellent global search ability. Ten test functions were used to evaluate and compare the effectiveness of the original beluga whale optimization algorithm, the improved beluga whale optimization algorithm, and three other prevalent optimization algorithms, focusing on their convergence characteristics. Then, a mechanical analysis was carried out on the bridge-erecting machine girder under real loading conditions. According to the design standard of the main girder of the bridge-erecting machine, under the conditions of meeting the requirements of strength, stiffness and stability, an optimization model was established, and the optimization of the main girder of the bridge-erecting machine was carried out. It was verified that compared with the initial girder weight of the bridge-erecting machine, the optimized girder weight was greatly reduced. The results show that the optimization effect is remarkable and the research has significant practical value.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-090598: System for Detecting Moving Objects Using 3D LiDAR Technology

Md Milon Rana ¹, Md.Mehedi Hasan ² and Orora Tasnim ¹

¹ Hajee Mohammad Danesh Science and Technology University

² World university of Bangladesh, Dhaka-1230, Bangladesh

The advent of 3D LiDAR (Light Detection and Ranging) technology has revolutionized the way moving objects are detected and tracked in various environments. Traditional systems often fall short in complex scenarios, such as poor visibility conditions or areas with unpredictable movement patterns. This necessitates an advanced solution that can accurately identify and monitor moving entities in real time, ensuring high levels of reliability and efficiency across diverse applications.

The “3D LiDAR-Based Moving Object Detection System” is designed to address these challenges by leveraging the precision of 3D LiDAR technology combined with a multi-sensor fusion approach. This system employs laser beams to create detailed three-dimensional representations of its surroundings, analyzing temporal fluctuations in data to detect and track moving objects. The integration of additional sensor inputs enhances the system’s accuracy and adaptability, enabling it to operate effectively under a wide range of environmental conditions.

This paper presents a groundbreaking system that surpasses conventional detection methods, providing an invaluable tool for autonomous vehicle navigation, surveillance, security, and robotics applications. By delivering unparalleled accuracy and reliability in moving object detection, the “3D LiDAR-Based Moving Object Detection System” not only improves the safety and efficiency of these technologies but also paves the way for new advancements in the field. This represents a significant leap forward in detection and tracking technology, marking a pivotal moment in its evolution.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-091113: A CAD-Driven Approach to Cutting Tool Geometry Design of Solid End Mills

Nikolaos Tapoglou and Charikleia Efstathiou

International Hellenic University, Department of Industrial Engineering and Management

Modern high-value manufacturing relies heavily on solid carbide end mills for finishing critical components. The intricate geometry of these cutting tools plays a crucial role in machining success. Optimizing end mill design requires the precise definition of various parameters to ensure efficient machining. This research presents a novel CAD-based framework that empowers designers with the ability to create and optimize solid end mills. Tool parameters such as tool diameter, rake angle, helix angle, and the number of teeth are used as input variables from the designer to influence the tool overall design.

The framework facilitates the design of variable helix angle tools, renowned for their stability during machining operations. It leverages the automation capabilities offered by the Application Programming Interface (API) within the selected CAD platform. The solid geometry produced through the framework would allow for the accurate representation of cutting tools that can be further exploited in FEA and CFD simulations of machining applications. The API-based approach enables users to define specific criteria and achieve a comprehensive optimization of tool geometries. The resulting geometries are then compared with established industry standards from leading vendors, providing valuable validation. Moreover, the effect of key design variables on the geometry of the cutting tool is investigated.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-088765: SCARAmouche: A 3D-Printed Low-Cost SCARA Robot

Fernando A. V. Figueiredo^{1,2,3} and **César M. A. Vasques**⁴

¹ Smile.Tech—Robótica, Vila Nova de Gaia, Portugal

² Instituto Superior Politécnico Gaya (ISPGaya), Vila Nova de Gaia, Portugal

³ proMetheus, Instituto Politécnico de Viana do Castelo, Viana do Castelo, Portugal

⁴ Department of Mechanical Engineering, University of Aveiro, Portugal

Robotics for manipulation has become essential in factory automation but has not yet been generalized in non-industrial settings. The Smile.Tech's Robótica Platform provides an assortment of robotic joints and controllers for the construction of different robot architectures with up to a 2 kg payload. This paper describes the development and testing of the SCARAmouche, a SCARA robot with most of its components 3D-printed. The robot was designed and engineered using Fusion360, and its load-bearing capacity was investigated through mechanical stress-strain analysis using finite element modeling. The 3D-printed components were manufactured with custom-built 3D printers operating at high temperatures and ABS polymer feedstock, using fused deposition modeling. The assembled robot was then tested and its repetition accuracy with different loads was investigated, referring to a low-cost 3D measuring device consisting of a fixture holding three digital indicators (plunger style), assembled with their axes orthogonal to each other and intersecting at one point. The newly developed SCARAmouche robot demonstrates the flexibility and capabilities of the Smile.Tech's robotic joint and controller technologies for the design and construction of accurate, reliable, highly performing, cost-effective, and safe SCARA robots, that can be used both for industrial and non-industrial handling applications and various operating scenarios.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Abstracts

Session 5. Turbomachinery

sciforum-091081: Improving Internal Combustion Engine Performance through Inlet Valve Geometry and Spray Angle Optimization: Computational Fluid Dynamics Study

Muhammad Ahsan and Mian Noman

School of Chemical and Materials Engineering, National University of Sciences and Technology, Islamabad 44000, Pakistan

This study aims to calculate the impact of the inlet valve geometry and spray angle on the performance of internal combustion engines using Computational Fluid Dynamics (CFD) analysis. CFD analysis was performed to explore the fuel flow dynamics within the combustion chamber at critical stages, considering factors such as swirl and tumble. The study investigates the role of the intake port's geometry and spray angles in creating squish and swirl, which is crucial for enhancing the combustion efficiency and overall engine performance. The analysis employs the Finite Volume Method (FVM), solved within the ANSYS Fluent software, utilizing the standard $k-\epsilon$ turbulence model. Design Modeler was used for the geometry design, and ANSYS Fluent facilitated the CFD analysis of the injection. Four distinct cases were explored to assess engine performance across various designs, examining parameters such as pressure, temperature, and velocity. These performance parameters were evaluated against the existing literature, enabling the identification of optimal configurations. The study identified optimal performance parameters based on the existing literature. The best design was further validated against existing designs under identical boundary conditions. The research demonstrates improved engine performance across all parameters compared to existing values in the literature. This suggests the efficacy of the proposed inlet valve geometry and spray angle configurations in increasing internal combustion engines' efficiency.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-091091: A Mechanism to Minimize the Noise in the Vehicle Interior

Indika Sandaruwan and Sam Niroshan Thayapararajah

Department of Engineering Technology, Faculty of Technology, University of Jaffna

The automotive industry is suffering due to interior noise propagation. These noise sources can be generated from roads, wind, and vehicle interiors. This study aims to develop a sound minimization panel for interiors using the concepts of sound reflection and sound absorption properties. In the methodology, a type of vehicle has been selected and studied for various noise-generating spots in its interiors. For analysis, a box model was built using an *eltoro* board with limited dimensions. A noise-level meter was inserted and the box was completely sealed to prevent the impacts of external noise. Two smartphones were connected to observe the reading inside the sealed box. To start, four different interior positions were selected, namely, the front left seat, the rear mid seat, the rear left seat, and the rear right seat. The readings were collected for the engine's idle speed with air-conditioning "ON", engine's idle speed with air-conditioning "OFF", first gear at 30 kmph, second gear at 45 kmph, and drive gear at 60 kmph in a standard road condition. With the gathered average readings for each case, a graphical plot was developed. As an improvement, rock wool and glass wool materials were superimposed in a zigzag approach. This developed material was applied inside the box model developed previously. A similar analysis was performed to identify the changes after the improvement. The results elucidated that the panel worked well, as expected. We concluded that 14.25%, 14.89%, 16.27%, 17.76%, and 17% of noise minimization, on average, could be achieved in first gear, in second gear, in drive gear, with air-conditioning "ON", and with air-conditioning "OFF", respectively. Though this conceptual model has limitations with the measurements, the results remained comparable. Indeed, this improvement suggested a better interior noise control mechanism for the selected vehicle.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-087723: Current Measurements for the Characterization of SiC Power Devices Used in Electric Traction Drives

Maria Giorgia Spitaleri, Giuseppe Scarcella, Mario Cacciato and Giacomo Scelba

Department of Electrical Electronics and Computer Science Engineering, University of Catania, 95125 Catania, Italy

Transient analyses of power devices used in traction motor drives are becoming increasingly challenging because of the use of WBG power switches. Hence, the selection of the sensing plays a key role, as it must be able to accurately measure the critical edges related to the fast transients. A classic method to evaluate the switching losses is the implementation of a double pulse test and computing the energy loss, starting from the measurements of current and voltage waveforms. For this reason, the measurement of the current and voltage should be as accurate as possible to provide good results in this kind of analysis. In this context, the selection of the most appropriate current measurement system can be extremely challenging, since the requirements that must be met are more stringent for SiC- and GaN-based power converters. Indeed, the current sensing system must be compact and non-intrusive to avoid introducing significant parasitic elements, which could influence the transient switching behavior. Furthermore, the current measurement system must guarantee a wide bandwidth, sufficient to capture the fast-switching transient. Moreover, in high power applications such as automotive, current sensing should be characterized by a relevant current range, and it should preferably be isolated to avoid issues in high voltage operations.

This paper aims to investigate the performances of different current measurement systems, considering all the aforementioned requirements. The current measurement achieved by a coaxial shunt resistor, current transformer and Rogowski coil are compared during the performance evaluation of SiC power switches through double pulse tests.

Experimental tests performed on a 1200 V—70A SiC power MOSFET are in progress, and the main goal is to quantify the differences among the current measurement methods under different load and driving conditions, emphasizing their pros and cons. The overall results will be presented in the final presentation.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-087741: Design and Analysis of Three-Phase 3L-ANPC Inverter for Electric Traction

Angelo Di Cataldo ¹, Giuseppe Aiello ² and Giacomo Scelba ³

¹ University of Catania, Department of Electrical electronic and computer engineering, Via Santa Sofia 95123, Catania, Italy

² STMicroelectronics, Stradale Primo Sole 50, 95121 Catania, Italy

³ University of Catania, Department of Electrical electronic and computer engineering, Via Santa Sofia 64, 95123 Catania, Italy

Long battery charging times is one of the main limits that are currently hindering the widespread adoption of EVs. This issue can be overcome by pursuing solutions with increased charging voltage involving 800 V DC buses. At the same time, traction electric drives are required to feature high efficiency, compactness, a high power density, high reliability and low weight. GaN technology presents a promising opportunity to achieve this target. The use of multilevel inverters is thus imperative to combine the exploitation of this technology with charging voltages above the breakdown voltages of GaN devices. Among multilevel converters topologies, Active Neutral Point Clamped (ANPC) offers the best distribution of switching and conduction devices' losses.

The main aim of this work is to present the design of a modular prototype for a 11 kW three-phase 3L-ANPC inverter based on 650 V GaN HEMT devices for electric traction applications. The design consists of a main board comprising the DC bus, DC sensor and the AC output connectors; a chip board with GaN devices, decoupling capacitors and RC snubbers to limit Drain-to-Source overvoltages; a chip board with the driving circuits; and two control boards with optical fiber receivers and STM32 microcontrollers, respectively. The design was carried out by considering a modular approach, which allowed us to choose different control device approaches (with optics or with microcontroller) and different GaN devices' packages. Moreover, the modularity allowed us to exploit the main board to realize other multilevel topologies by simply redesigning the chip boards.

A further analysis was carried out in such a way as to value the parasitics in the overall layout. Design and analysis results will be shown and explained in more detail in the presentation.

Low parasitics allow us to exploit the switching performances of GaN HEMTs, increasing the performance of the multilevel inverter in terms of output distortions and power losses.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-091082: Development of an Air Pressure-Sensing Unit for Domestic Applications

Saubhagya Kaluarachchi, Lakshan Ranasinghe, Punsara Perera and Sam Niroshan Thayapararajah

Department of Engineering Technology, Faculty of Technology, University of Jaffna

Air pressure sensors remain an expensive and dedicated brand of product. They are built in to some luxury vehicles, and the repairing process is also costly. The aim of this study is to develop a cost-effective air pressure sensor that can be used in domestic applications. The unit includes a pressure gauge, Light-Emitting Diode (LED), Light-Dependent Resistor (LDR), and a few circuit wires. The concept of a night sensor mode was used in the development. Three pressure levels were identified, namely, low, correct, and high, with values of 28 psi, 32 psi, and 35 psi, respectively. Based on the pressure variations, LED and LDR were installed and connected. The device was linked to the tire pressure measurements. In practice, air pressure is measured normally. When the air pressure is decreasing, the LED fixed on the 28 psi value by the pointer closes, the shadow created by the LDR is taken as the input, and the signal is given to the control panel that the tire pressure is low. Similarly, the other two pressures are also measured by the sensor unit. All the devices were fitted with heat sleeving at the required places to reduce the unit's errors. A power adapter is used to provide power to the system. The results obtained using the developed system can be used in automotive applications where tire pressure can be a major issue. An experimental setup was evaluated using an automatic tire inflation system. The temperature variation may lead to limitations, and accuracy issues may occur if the unit is not temperature-compensated or is not in a controlled environment. The further improvement would require the unit to be free of errors in terms of calibration and other extraneous factors.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-087582: WBG-based Current Source Inverter for Electric Traction Application

Gaetano Turrise, Luigi Danilo Tornello, Giuseppe Scarcella and Giacomo Scelba

¹ DIEEI—Dipartimento di Ingegneria Elettrica, Elettronica e Informatica Università degli Studi di Catania Viale Andrea Doria n°6
95125 Catania, Italy

² University of Catania

As it is well known in the literature, the use of wide bandgap power devices (WBG) in power conversion units allows to achieve higher switching frequency and lower conduction losses, improving their efficiency and power density. Drives used for the electric traction are fed by a two-level voltage source inverter (VSI) with switching frequency not exceeding 30 kHz, to limit overvoltages at the motor terminals, which can degrade the winding insulation and bearings. The main objective of this research activity is to investigate an alternative solution to the VSI-fed drive, by using the Current Source Inverter (CSI) based on WBG power devices. The CSI provides near-sinusoidal output voltage with significantly reduction of dv/dt , thus allowing to increase the motor drive reliability and improving electromagnetic interference (EMI) immunity. In particular, the working principle of a CSI for electric traction applications is analysed in this paper, and the main strengths and technical challenges are identified and supported by simulations based on Spice model devices and experimental tests. Preliminary simulation results underline that the CSI topology offers significant improvements at high switching frequencies compared to the VSI due to the filtering action provided by suitably combining the design of the dc-link inductor and filter capacitors. Furthermore, the final presentation will include the design analysis of passive elements. The experimental results obtained from tests conducted on a 2 kVA test bench will also be presented.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Abstracts

Session 7. Vehicle Dynamics and Control

sciforum-084879: Innovations in FCHEV Power Management: A Fusion of Machine Learning and Physics-Based Models

Djemai Nouredine ¹, Arif Ali¹, Guettaf Abderrazak ¹ and Berghout Tarek ²

¹ Department of Electrical Engineering, Laboratory of Modeling Energy Systems LMSE, University of Biskra, 07000 Biskra, Algeria

² Laboratory of automation and manufacturing engineering, Batna2 university, 05000 Batna, Algeria

In the green motor vehicle era, fuel cell hydrogen electric vehicles (FCHEVs) are becoming promising alternatives. Thus, ensuring the proper operation of FCHEVs solely depends on advanced energy management systems (EMS). In this light, this work looks deeply into how combining machine learning and physics-based models can make FCHEVs operate effectively through improved EMSs. This study extensively analyzes how machine learning and physics-based models operate together in FCHEV-EMS. It therefore breaks through existing research and identifies insights, challenges, and potential future directions. It also looks closely at how machine learning meets challenges in adapting to real-time and handling changing conditions. To gain a better understanding of these issues, this study further recommends innovative ways to integrate machine learning flexibility within the precision of physics-based modeling. It therefore reveals an intriguing potential for additional study in the world of FCHEV-EMS. It represents the integration of machine learning and physics-based models as a potent technique to deal with EMS difficulties and accelerate advances in FCHEV energy management. In the end, it outlines significant findings, addressing why this integrated strategy is crucial in making FCHEVs a world-leading sustainable means of transportation. Through its comprehensive review and strategic perspectives, this initiative aims at catalyzing innovations that actively contribute to the sustainable advancement of FCHEVs.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-090945: Modeling and Sensitivity Analysis of Anti-Roll Hydraulic Interconnected Suspension for Tri-Axle Mining Dump Trucks

Wanting Wang ¹, Gangfeng Wang ¹, Xuefeng Suo ¹ and Teng Du ²

¹ Key Laboratory of Road Construction Technology and Equipment of MOE, School of Construction Machinery, Chang'an University, Xi'an 710064, China

² Research and Development Center, Shaanxi Tonly Heavy Industries Co., Ltd., Xianyang 712000, China

Hydraulically interconnected suspensions have nonlinear stiffness and damping characteristics, which can provide excellent ride comfort. At the same time, a reasonable suspension connection form can improve the handling performance of a vehicle, and they are widely used in mining vehicles. The working environment of a mining dump truck is harsh, which puts forward higher requirements for the suspension system. In order to study the influence of structural parameters on the performance of hydraulic interconnected suspensions, this paper takes an anti-roll hydraulic interconnected suspension of a tri-axle mining truck as the research object and establishes a mechanical-hydraulic coupling model for the whole vehicle by means of the impedance matrix transfer method and system boundary conditions. The suspension performance evaluation functions are obtained by combining the random pavement input matrix, and the sensitive parameters affecting the suspension performance are found using the Morris analysis method. The results show that the vehicle bounce modal is the most sensitive to changes in the suspension structure parameters, followed by the roll modal, and the pitch modal is the least sensitive. The upper and lower cylinder area ratios, the precharge volume, and the pressure of the front axle accumulator have the greatest influence on the performance of the suspension. The results provide a reference for the optimal design of the hydraulic interconnected suspension of a tri-axle heavy vehicle.



© 2024 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

sciforum-084190: Nonlinear Spring Design of a Vibration Isolator Using a Geared Parallel Mechanism

Vu Linh Nguyen

VinUniversity

This paper presents the nonlinear spring design of a vibration isolator using a geared parallel mechanism. The proposed vibration isolator consists of six identical legs, each made of two straight links connected via two orthogonal springs. The main advantages of this vibration isolator are that it can provide a large stroke and a wide range of applied payloads, making it appropriate for most industrial applications. The link and spring parameters of the mechanism are determined through an analytical approach based on dynamic equations. In this work, the design concept, modeling, analysis, and numerical examples are presented in detail. Through the numerical investigation, it was found that the amplitude of an input signal can be nearly canceled with the spring design over a wide range of frequencies from zero to infinity. When the base is excited with acceleration, the moving platform of the vibration isolator obtains a much smaller value of acceleration as compared to that of the base. The obtained result demonstrates the effectiveness of the signal isolation of the proposed spring design. Moreover, this work also investigates the effect of the input parameters of the isolator, which allows us to find the optimal parameters for the vibration isolator to achieve the best performance.



© 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

Abstracts

Session 8. Friction and Tribology

sciforum-090822: A Fundamental Investigation of Bearing Cage Pocket Lubrication and Friction

Saeed Aamer

Mechanical Engineering, Purdue University

The focus of this study is to examine the effect of fundamental pocket geometries of a cylindrical roller bearing (CRB) cage on its lubrication and friction performance. Lubrication in bearings presents an interesting tradeoff with excessive lubrication resulting in high friction and fluid drag, while poor lubrication inherently results in wear and component damage. Three cage pockets of varying conformity with the roller were investigated to determine pocket friction due to fluid shear as well as lubricant availability within the pocket. A custom Bearing Cage Friction Test Rig (BCFTR) was utilized to isolate a single roller within a cage pocket geometry. The BCFTR was configured with a 6-axis load cell to accurately measure friction developed between the roller and pocket, while the roller speed was controlled through a precise servo motor. A lubricant sealing enclosure was installed around the roller to control the lubricant fill condition during testing. The enclosure was designed to include swappable, transparent cage inserts with adjustable roller pocket clearances. Testing was conducted for a range of roller speeds, pocket clearances, and lubricant fill conditions, and a high-speed camera was used to capture lubricant flow within the roller-pocket gap. A multiphase computational fluid dynamics (CFD) model was developed for an equivalent geometry, matching the range of test conditions. The robust model was able to accurately predict both experimentally measured pocket friction and the imaging of pocket lubrication state. Through the study, cage pocket conformity was determined to have a prominent effect. Reducing pocket conformity aids in minimizing pocket friction. However, the larger pocket inlet and outlet zones resulting from a low conformity design promote high recirculation which generates aeration within the lubricant. Furthermore, a low conformity pocket design faces challenges in retaining lubricant in the roller-pocket contact.



© 2024 by the author. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

MDPI AG
St. Alban-Anlage 66
4052 Basel
Switzerland
www.mdpi.com

Machines Editorial Office
E-mail: machines@mdpi.com
www.mdpi.com/journal/machines



Disclaimer/Publisher's Note: The title and front matter of this book are at the discretion of the Guest Editor. The publisher is not responsible for their content or any associated concerns. The statements, opinions and data contained in this book are solely those of the individual Editor and contributors and not of MDPI. MDPI disclaims responsibility for any injury to people or property resulting from any ideas, methods, instructions or products referred to in the content.



Academic Open Access Publishing
since 1996