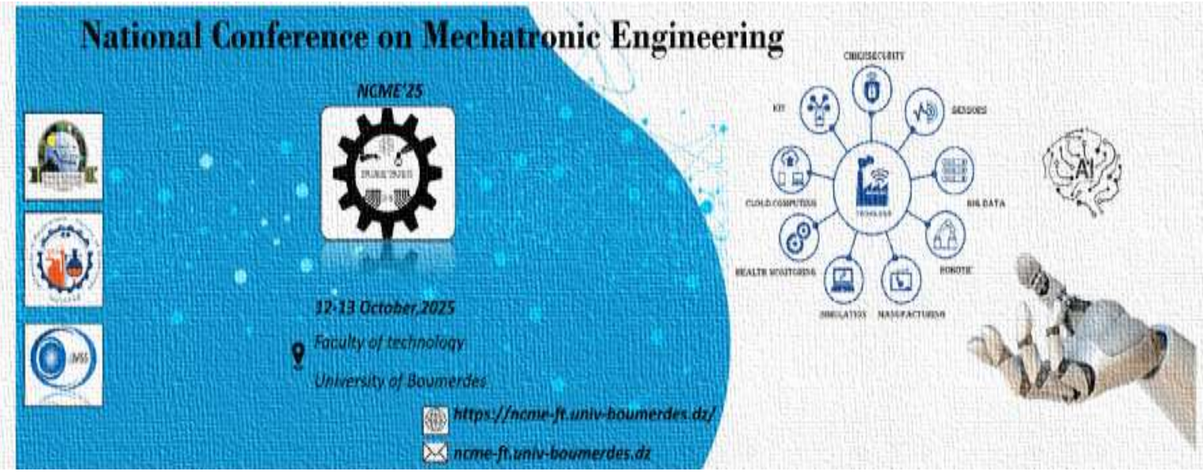

Proceeding

1st NATIONAL CONFERENCE ON MECHATRONIC ENGINEERING NCME'2025

12-13 October 2025

University of Boumerdes, Algeria

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Pr. Djamel BENAZZOUZ, University of Boumerdes

Conference General Co-Chair

Pr. Smail ADJERID, University of Boumerdes

Chair of Scientific Committee

Dr. Fawzi GOUGAM, University of Boumerdes

Preface:

This event is the 1th national Conference on ON MECHATRONIC ENGINEERING (NCME'2025) will be held for the first time from 12-13 October 2025 on hybrid mode at the University of Boumerdes, Algeria with a collaboration of the different research centers. The conference's main theme highlights all the fields of Mechatronic and electrical engineering and their applications, such as renewable and sustainable energy, Smart Grids and Energy Management in Industrial Automation, Applied AI Techniques in Health Monitoring and Autonomous Mobile Robots and Vehicle Applications.

We hope that this conference will support advanced technologies and create an environment where researchers and professionals can collaborate and exchange experience.

The scope of NCME'25 covers the following topics:

1. Advanced Technologies for Prognostics and Health Management
2. AI-Assistance for Mechanical Systems: Smart structures, Fluids, and defect Materials
3. Autonomous and Real-Time Systems
4. Embedded AI and Information Technology in Mechatronics
5. Power and Renewable Energy in Mechatronics Applications

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Paper ID : 1

Conception d'un système et revue critique des techniques par sondes de conductance pour la mesure de la rétention gazeuse avec perspectives d'analyse assistée par intelligence artificielle

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Abstract: Les écoulements diphasiques gaz-liquide sont omniprésents dans les procédés industriels notamment dans les secteurs de l'énergie, du pétrole et de la chimie. Parmi les paramètres essentiels à leur caractérisation, la rétention gazeuse joue un rôle clé dans l'évaluation des pertes de charge, des transferts thermiques et de l'efficacité globale des systèmes. Toutefois, sa mesure reste complexe en raison de la nature instable et multiparamétrique de ces écoulements. Face aux limites des techniques traditionnelles, cette étude s'intéresse à la conception d'un système de mesure basé sur des sondes de conductance multi-électrodes intégrées dans un montage coaxial. La problématique principale réside dans la capacité à effectuer des mesures précises et dynamiques dans des conditions variées sans recourir à des méthodes intrusives ou dépendantes de calibrations rigides. L'objectif est de développer une chaîne de mesure intelligente regroupant des capteurs performants, une électronique dédiée et un logiciel d'analyse en temps réel. Cette architecture modulable vise à intégrer à terme des techniques d'intelligence artificielle pour améliorer l'interprétation des signaux et l'estimation de la rétention gazeuse. Les résultats attendus permettront de proposer une solution fiable, flexible et évolutive pour la surveillance des écoulements diphasiques en environnements industriels avec des perspectives prometteuses pour l'optimisation des procédés et la transition vers des systèmes plus efficients.

Paper ID : 2

Motor Fault classification based on thermal images and Decision Tree Classifier

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Abstract: This study focuses on the classification of faults in an electric motor using artificial intelligence techniques applied to thermal images captured by an infrared camera. The goal is to exploit the thermal signature of the motor to automatically detect and classify eleven operating states of the electric motor. Four supervised learning algorithms were implemented for fault classification: Random Forest (RF), K-Nearest Neighbors (KNN), Support Vector Machine (SVM), and Decision Tree (DT). The thermal images were first preprocessed to extract relevant features, which were then used to train the classification models. Performance evaluation shows that the Decision Tree and Random Forest algorithms outperform the other techniques in terms of accuracy. However, in terms of stability, the Decision Tree proves to be the most reliable. The approach was experimentally validated on a dedicated test bench, which simulated eleven fault conditions of the electric motor. This work demonstrates the effectiveness of artificial intelligence methods specifically the Decision Tree for non-invasive and automated diagnostics of electrical machines based on their thermal signatures.

Paper ID : 3

Automated Design of Deep Neural Networks Using Combined Evolutionary Algorithms.

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Abstract: This paper presents a hybrid optimization algorithm, GAPSO-CNN, which combines the strengths of Particle Swarm Optimization (PSO) and Genetic Algorithm (GA) to automate the design of Convolutional Neural Network (CNN) architectures. GAPSO-CNN employs a variable-length encoding scheme and integrates genetic operations into the particle update process, enabling rapid convergence toward high-performing CNN structures. The method is evaluated on five benchmark datasets and demonstrates superior performance compared to existing approaches, achieving high classification accuracy with minimal human intervention. By reducing the reliance on expert knowledge, GAPSO-CNN offers an efficient and scalable solution for optimizing deep learning models.

Paper ID : 4

Effect of Creepage Distance on Flashover Voltage and Critical Length of Parallel Discharges of a uniform polluted glass insulator

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Abstract: the interest of this study is the importance of variation of the creepage distance on the flashover voltage of the glass insulator. In the case of clean and polluted insulating surface, we found that the higher of the leakage length, the greater of the insulation flashover voltage regardless of the configuration of the electrodes studied, which is logical since the flashover of a large area requires a longer duration than that of a small area, For a given contamination severity, it might be thought that flashover voltage would decrease indefinitely with increasing diameter of insulator because the overall resistance, which limits the arc current, would also decrease similarly and hence the creepage distance required for any profile has to be increased. However, an increase in diameter does not reduce the flashover voltage correspondingly. This may be due to the fact that more than one arc can initiate across a single dry band, causing a higher electrode voltage drop that partially compensates for the decrease in the flashover voltage.

Paper ID : 5

Impact of Internal Channel Geometry on the Thermal Performance of a Parabolic Trough Solar Collector with Phase Change Material in a Double-Pipe Thermal Energy Storage System

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Abstract: This study on renewable energy focuses on parabolic trough collectors (PTCs) that use phase change materials (PCMs) and features two tube designs: concentric and sinusoidal. The sinusoidal tube demonstrates superior heat absorption, achieving a liquid fraction of 90%-92%, compared to 85% for the concentric tube. It also achieves a 55.76% higher heat transfer fluid (HTF) outlet temperature and 72% thermal efficiency 10.8% higher than the 65% achieved by the concentric tube. However, the concentric design provides more stable thermal performance and reduced temperature gradients, thereby enhancing system durability. In summary, the sinusoidal tube offers higher efficiency, while the concentric tube ensures improved stability and longevity.

Keywords: parabolic trough collector ; Thermal energy storage ; Phase change materials; Heat Transfer Fluid; Receiver Tubes (Concentric and Sinusoidal); Thermal efficiency.

Paper ID : 6

An Efficient MLP Neural Network Algorithm for Diagnosis of Solar Panel Faults

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Abstract: Solar panel systems play an important role in the supply of energy to the world, yet their reliability and efficiency are often impaired by various faults, including mismatch faults, partial shading, and environmental degradation. It is essential that the faults be detected and categorized at an early phase to prevent performance loss, early system degradation, and fire risk. This paper discusses the use of artificial neural network (ANN) algorithm for fault detection and classification on solar panel system using a multilayer perceptron (MLP) type. The MLP was chosen because of its high computational power, generalization, and capacity to model complex, non-linear patterns in data. An MLP neural network is built and trained with current-voltage (I-V) and power-voltage (P-V) measurements to precisely detect and distinguish common PV faults. The system under consideration is good for classification, and the outcome shows a general fault detection accuracy of 95% at training for more than 30,000 iterations. The research comes out strongly in support of the feasibility of diagnosis of typical PV faults like series resistance mismatch, cell degradation, shunt faults, and partial shading by application of ANN. The results demonstrate the stability of ANN-based fault diagnosis to enhance the reliability and maintenance of solar PV systems and serve as a solid point of reference for further studies on intelligent PV monitoring and fault detection.

Paper ID : 7

Prognostics of Bearing Remaining Useful Life Using Machine Learning

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Abstract: In this study, a data-driven approach is proposed for the prediction of the Remaining Useful Life (RUL) of rolling bearings, based on vibration signal analysis and machine learning techniques. The methodology consists of several key stages. First, raw vibration signals collected from accelerated degradation tests are processed using Variational Mode Decomposition (VMD) to extract meaningful intrinsic mode functions. Next, a set of time-domain and statistical health indicators is constructed from the decomposed signals to form informative time series reflecting the degradation behavior of the bearing. Subsequently, a feature selection method based on monotonicity, trend, prognosability, and correlation is applied to identify meaningful features, reduce redundancy, and perform dimensionality reduction. These selected features are then used to train machine learning classifiers for RUL estimation. The model is validated on a complete bearing life cycle to assess its accuracy and robustness. Unlike deep learning methods that often suffer from distribution shifts under varying conditions, the proposed method emphasizes condition-specific degradation patterns without relying on transfer learning. The results demonstrate that the proposed framework can achieve accurate and stable RUL predictions, making it a reliable tool for predictive maintenance in rotating machinery.

Paper ID : 8

Smart Control for Stand-alone Photovoltaic Systems Using Fuzzy Logi

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Abstract: Artificial intelligence (AI) has become an indicator of progress and development in recent years. In this paper, artificial intelligence was relied upon to improve the performance of a power generation system based on solar energy. The system we propose consists of a photovoltaic system, an energy storage system, and electronic power converters. Artificial intelligence works to manage these converters smartly. We use the maximum power point tracking (MPPT)-based fuzzy logic controller (FLC) to regulate the boost converter in the PVS. We propose a controller based on fuzzy logic in order to regulate the DC/DC bidirectional converter of the storage system. The main goal of this regulator is to maintain voltage stability at the DC bus and manage the power flow of the system. This study was conducted and this work was simulated in a MATLAB\SIMULINK environment. The results of this paper demonstrated the superiority of AI-based MPPT over the P&O algorithm in terms of the quality of power produced and output yield. The proposed controller also showed satisfactory results in maintaining voltage stability at the DC bus and reducing deviations and oscillations, compared to the traditional PI controller. This research paper works to contribute to improving the performance of environmentally friendly systems.

Paper ID : 9

Smart Monitoring of Shear-Thickening Fluid Jets Using Adaptive Image Processing Techniques in MATLAB

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Abstract: This study introduces an advanced image-processing framework for the dynamic characterization of jets formed by discontinuous shear-thickening (DST) suspensions. Developed in a custom MATLAB environment, the system enables automated extraction of flow properties from high-speed video recordings (300 fps) of a suspension composed of calcium carbonate (CC) microparticles (68% vol.) and varying concentrations of polyamide (PA) microfibers. Through a user-interactive graphical interface, the program autonomously measures jet parameters such as width d(z), lateral deviation x(z), and break-up points. The use of adaptive techniques including Gaussian profile fitting, dynamic segmentation, and parallel computation (230 ms/frame on a 6-core processor) ensures efficient and accurate analysis across different flow regimes, ranging from continuous viscous threads to instabilities like coiling and periodic rupture caused by extensional stress. The system demonstrates responsive behavior to changing jet dynamics, reflecting the smart fluid nature of the material. Results reveal that increasing PA microfiber concentration improves jet stability, likely due to fiber alignment and enhanced extensional viscosity. Quantitative links between fiber content and instability features such as oscillation amplitude and wavelength are established.

This research highlights the potential of intelligent image-based tools for monitoring the behavior of complex fluids and soft materials. It offers new perspectives for integrating adaptive sensing and analysis into the study of smart fluid systems and their applications in mechanical systems and advanced materials.

Paper ID : 10

vLiDAR3D: An Optimized Vertical LiDAR Approach for SLAM and Remote Exploration of Hazardous Environments

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Abstract: Exploring hazardous and inaccessible environments remains a critical challenge in industrial inspection, disaster response, and historical site preservation. Conventional LiDAR systems are mostly designed for horizontal scanning, limiting their ability to capture dense and complete 3D data in complex environments. This paper presents vLiDAR3D, an optimized vertical LiDAR platform designed to enhance Simultaneous Localization and Mapping (SLAM) and remote 3D digitalization of hostile environments. The proposed system integrates a vertically mounted LiDAR with a dual-axis rotation mechanism, extending the scanning field of view beyond traditional planar sensors. It is embedded on a low-cost micro-robotic platform, leveraging ROS (Robot Operating System) for real-time data acquisition, SLAM processing, and wireless communication with a base station. The prototype was validated in simulated and real environments, demonstrating improved coverage, higher fidelity of point clouds, and reduced blind zones compared to conventional configurations. This approach offers a scalable and cost-effective solution for safe remote mapping in areas affected by radiation, structural instability, or natural disasters.

Paper ID : 11

Intelligent fault diagnosis of robotic cutting tools in industry 4.0 smart manufacturing

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Abstract: In the context of Industry 4.0 smart manufacturing, tool condition monitoring (TCM) plays a vital role in improving productivity and machine operating time by leveraging advanced sensors and intelligent data analysis to prevent tool failures. This paper presents a hybrid methodology for robotic cutting tool condition monitoring based on vibration sensor data. Four distinct tool states are considered: healthy, surface damage, flake damage and broken tooth. The proposed approach combines maximal overlap discrete wavelet packet transform (MODWPT) with the absolute value of the summation of exponential root (ASM) to produce feature matrices corresponding to each state. These features are then fed into Gaussian mixture model (GMM) for accurate tool state detection, identification and classification. Comparative results show that the proposed method achieves superior feature separability and consistent classification performance, with an average accuracy of 95.19% using ASM, compared to 86.86% for root mean square (RMS) and 86.54% for standard deviation (STD).

Paper ID : 15

Machine Learning and Smart Systems for Dynamic Environmental Modeling

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Abstract: Water is an essential element that sustaining life and shaping landscapes, is closely linked to the phenomenon of flooding, which has received increased attention in the context of climate change impacts augmentation. the aim of this study is to predict and produce flood susceptibility map using different machine learning models in the city of Meknes, Morocco. Therefore, Random Forest (RF), Decision Tree (DT) and Logistic Regression (LR) models for the flood susceptibility map and the Principal Component Analysis for the dimensionality reduction of the datasets were experienced. The algorithms were based on 106175 points (includes flood points and non-flood points) and some conditioning factors of flooding (Elevation, Slope, Flow accumulation, LULC and Rainfall amount) that were extracted from the DEM and the satellite image of the study area. The data was splitted into training datasets with 70% and testing datasets with 30%. The models were evaluated using different metrics such the recall and precision. The results demonstrate that RF performs well, with an accuracy of 0.87, a precision of 0.95 and a recall of 0.90, followed by DT (Precision =0.93, Recall = 0.89 and Accu+racy =85%) and LR (Precision=0.94, Recall = 0.80, Accuracy = 0.86). This method was very useful to minimize human loses and infrastructure damages in Meknes city.

Paper ID : 30

High efficient double perovskite solar cell type HTL/Cs2TiBr6/MASnBr3/ETL

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Abstract: This study introduces an innovative approach to enhance the performance of perovskite solar cells (PSCs) through a double active layer architecture comprising Cs2TiBr6 and MASnBr3 perovskites. A detailed simulation was conducted using the Solar Cell Capacitance Simulator-one Dimension (SCAPS-1D) software to optimize key cell parameters. Initially, the effect of layer thickness and defect densities on the cell's output parameters was explored. It was found that thicknesses of 700 nm for Cs2TiBr6 and 900 nm for MASnBr3, with a defect density of 1014 cm-3 for each layer, offer the best performance. Subsequently, the impact of defect densities at the interfaces between different layers, as well as the doping density in Cs2TiBr6 and MASnBr3, was investigated. Defect densities of 1014 cm-2 for each interface and a doping density of around 1018 cm-3 for each absorbing layer were identified as optimal. Finally, the effect of temperature, series resistance, and shunt resistance on cell performance was examined. The results demonstrate that the optimal cell parameters, such as Voc = 1.105 V, Jsc = 33.90 mA/cm2, FF = 88.01%, and PCE = 32.96%, are achieved under the specified conditions. In conclusion, this study shows that the use of Cs2TiBr6 and MASnBr3 as absorbers in a double active layer architecture is a promising strategy to significantly enhance the performance of PSCs. These findings pave the way for further advancements in the field of perovskite solar cells and may contribute to accelerating their widespread adoption.

Paper ID : 31

Fuzzy-Controlled Wind Power Supply for a Welding Station

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Abstract: This paper presents the design, modeling, and performance analysis of a standalone wind energy conversion system intended to supply an 8 kW welding station. The system is based on a Permanent Magnet Synchronous Generator (PMSG), combined with a fuzzy logic-based Maximum Power Point Tracking (MPPT) algorithm. A hybrid energy management strategy, incorporating a battery storage system, is implemented to ensure voltage stability and continuous power supply. The control system not only optimizes wind energy harvesting but also regulates the DC bus voltage and ensures reliable operation under varying wind and load conditions. The overall system performance has been validated through simulations, using the specific power requirements of the welding station as a reference.

Paper ID : 32

Autonomous Wind Power System for Agricultural Water Management

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Abstract: This article aims to determine the characteristics of a centrifugal pump intended to meet the water needs of a small village. To this end, vector control is applied to drive a submerged asynchronous motor-pump unit. The studied system consists of a wind turbine coupled to a permanent magnet synchronous machine (PMSG), followed by a rectifier, a DC bus, and a voltage inverter supplying an asynchronous machine that drives the pump. A Maximum Power Point Tracking (MPPT) device is integrated to optimize the use of wind energy by ensuring operation at optimal power.

Paper ID : 33

Multi-class Classification of Brain Tumor MRI Images Using a Hybrid CNN and SVM Approach

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Abstract: Brain tumors are a major threat to human health, the severity of which depends on both the type of tumor and its stage of development. Early detection of these tumors can considerably increase patients' chances of survival. Magnetic resonance imaging is one of the most effective techniques for visualizing brain tumors. In this study, we propose a method for automatically classifying brain MRI images into four categories: glioma, meningioma, pituitary and no-tumor. Our approach combines automatic feature extraction using a convolutional neural network, followed by dimension reduction using principal component analysis. The reduced features are then classified using a support vector machine classifier with different kernels (linear, quadratic, cubic, fine Gaussian, medium Gaussian, and coarse Gaussian). The best result was obtained with the cubic kernel, achieving a classification accuracy of 93.30%.

Paper ID : 35

Conventional Methods vs Artificial Intelligence for Battery Management Systems in Autonomous Systems

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Abstract: The integration of Artificial Intelligence (AI) into a Battery Management System (BMS) for autonomous systems offers numerous benefits, such as: real-time identification of battery Remaining Useful Life (RUL), State of Charge (SoC), fault detection and diagnostics, predictive maintenance, etc. Leveraging AI algorithms, the BMS can accurately determines the RUL and SoC of the battery by considering real-time measurements of voltage, current, and temperature, while also accounting for the battery's operational conditions and state of health (SoH). One approach involves employing Artificial Neural Networks (ANN) to validate the battery model based on a collected data. This paper presents two approaches for BMS. The first approach estimates SoC using two conventional methods: using Coulomb’s law with voltage, current, and usage time, and by using the Open Circuit Voltage (OCV) tests and lookup table. The second approach employs an ANN for RUL estimation, initially using only two inputs: voltage and current, and subsequently considering three inputs: current, voltage, and temperature. The RUL is considered the output of our regression model’s training and testing. The obtained results demonstrate that the ANN utilizing the inputs: voltage, current, and temperature provides superior accuracy compared to using only two inputs (voltage and current), therefore, considering the battery temperature has significant impact for BMS which is not provided by conventional methods. In addition, model evaluation is performed using the Mean-Squared Error (MSE) established from the error histogram graphs. Finally, the obtained results are thoroughly analyzed and discussed

Paper ID : 37

Comparative Study of Artificial Intelligence-Based Battery State of Charge (SoC) and Remaining Charging and Discharging Time Estimation

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Abstract: This paper presents a comprehensive comparative study of various Artificial Intelligence (AI)-based techniques for estimating Battery State of Charge (SoC) in battery discharging and charging modes. The evaluated techniques invovle: Linear regression (LR), Least Absolute Shrinkage and Selection Operator (LASSO), K-Nearest Neighbor Regressor (KNNR), Categorical Boosting Regressor (CatBoostR), Extra Trees Regressor (ETR), Random Forest Regressor (RFR), Extreme Gradient Boosting Regressor (XGBR), Decision Tree Regressor (DTR), and Gradient Boosting Regressor (GBR). Root Mean Squared Error (RMSE), Mean Squared Error (MSE), Mean Absolute Error (MAE), and R-squared (R2) are employed as evaluation metrics to assess the accuracy and performance of each technique. The ET-regressor model generates promising results in terms of the evaluation metrics and, according to state-of-the-art applications, makes it challenging for embedded machine learning and real-time monitoring.

The comparative analysis reveals nuanced differences in the predictive capabilities of the evaluated techniques. While some methods excel in certain aspects, others demonstrate strengths in different contexts. By quantifying RMSE, MAE, and R2, this study provides a comprehensive understanding of the predictive accuracy, precision, and reliability of each approach. Furthermore, the paper explores the implications of these findings for state-of-the-art applications in battery management, extending its relevance beyond performance evaluation. Insights from this comparative study offer valuable guidance for practitioners and researchers in selecting appropriate methodologies for Battery SoC. In conclusion, this research contributes to advancing the field of battery management by elucidating the strengths and limitations of various AI-based approaches, facilitating informed decision-making and fostering future advancements

Paper ID : 38

Bearing Fault Diagnosis Using Feature Engineering and SVM-based Classification

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Abstract: The accurate and timely diagnosis of rolling element bearing faults is paramount for ensuring the reliability and safety of industrial machinery. This paper presents a robust methodology for bearing fault diagnosis using a combination of advanced feature engineering and a Support Vector Machine (SVM) classifier. The proposed approach is validated using the Case Western Reserve University (CWRU) bearing dataset, a benchmark in the field. Vibration signals are initially segmented under varying rotational speed conditions. A comprehensive hybrid feature set is engineered, comprising nine statistical timedomain indicators and frequency-domain features derived from the normalized spectrum, specifically capturing the amplitudes of fundamental fault characteristic frequencies and their first harmonics. Sequential Backward Selection (SBS) is employed to identify the most discriminative subset of these features, which are then used to train a multi-class SVM classifier with an optimized polynomial kernel. A rigorous validation framework, including stratified hold-out for final testing and k-fold crossvalidation, ensures the model’s generalizability and prevents data leakage. The results demonstrate that the optimized SVM model achieves high classification accuracy, effectively distinguishing between different fault types (Inner Race, Outer Race, Ball) and healthy conditions. The study confirms that the synergistic use of a hybrid feature set and a methodologically sound machine learning pipeline provides a powerful and reliable solution for automated bearing fault diagnosis.

Paper ID : 39

Microgrid protection scheme using dual settings numerical protective relays

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Abstract: The goal of this research is to provide an optimum coordination mechanism for relay configurations in a distribution system. The proposed technique employs dual setting directional overcurrent relays (DS-DOCRs) where the protective relays can work in grid connected and islanded modes of operation and have two separate relay settings. The presented approach is used to test the distribution element of the IEEE 14-bus test system. An optimization algorithm was utilized to calculate the optimal settings using MATLAB, while the power system assessments are performed in DIgSILENT. The test results demonstrate the advantages of the suggested strategy. The coordination optimization problem (COP) using dual settings numerical relays shows that the miscoordination does not occur in both modes of operation when utilizing the suggested technique.

Paper ID : 40

Optimal coordination of DOCRs using Evaporation rate water cycle metaheuristic algorithm

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Abstract: The coordination of directed overcurrent relays is a crucial part of the protective system in electrical power systems (DOCRs). The coordination between these relays must be preserved at a correct scale to decrease the total operating period of all primary-relay failure scenarios in order to reduce and finally eliminate power losses. The coordinating of DOCR is a hard and fascinating issue in nonlinear optimization. The overall working duration of all necessary relays must be kept to a minimum in order to avoid too much breakdown and interference. In order to tackle the coordination problem of the DOCR, coordination is carried out utilizing the Evaporation rate water cycle algorithm (EWCA), IEEE 3-bus, 9-bus test systems are among the test systems to which the suggested method has been implemented. The Results collected demonstrate the suggested (EWCA) efficiency in reducing the relay operation time for the DOCRs' optimum cooperation.

Paper ID : 41

Observer-Based Sensorless Speed Control for Dual-Star Induction Motors in Solar Power Systems with Multi-Cell Inverter

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Abstract: This paper presents a photovoltaic power control system using Maximum Power Point Tracking (MPPT) with a boost converter. The MPPT-FLC/ANN controller extracts maximum available power from the PV array and delivers it to the load through a boost converter that increases the voltage to the required level. For three-phase load control, the system employs a series multicell converter controlled by the Artificial Bee Colony (ABC) algorithm. This approach provides two key advantages: first, it ensures balanced distribution of switching stresses across all power devices, and second, it maintains and enhances the quality of output voltage waveforms through optimized voltage level control.

Paper ID : 42

Artificial Bee Colony-Optimized Sensorless Drive for Dual-Star Induction Motors in Photovoltaic Systems with FLC-MPPT

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Abstract: This paper presents a photovoltaic power control system using Maximum Power Point Tracking (MPPT) with a boost converter. The MPPT-FLC controller extracts maximum available power from the PV array and delivers it to the load through a boost converter that increases the voltage to the required level. For three-phase load control, the system employs a series multicell converter controlled by the Artificial Bee Colony (ABC) algorithm. This approach provides two key advantages: first, it ensures balanced distribution of switching stresses across all power devices, and second, it maintains and enhances the quality of output voltage waveforms through optimized voltage level control.

Paper ID : 43

Quality Control of Cast Pump Impellers Using a Convolutional Neural Network

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Abstract: In high-precision manufacturing, early detection of surface defects is crucial for maintaining product quality and reducing waste. This study proposes a Convolutional Neural Network (CNN) model for automated classification of cast impeller images into defective and non-defective categories. Utilizing a custom grayscale dataset of 7,348 images captured under controlled conditions, the model achieved a classification accuracy of 99.44%, with precision and recall scores exceeding 98%. The system demonstrated strong generalization despite class imbalance, supported by effective data augmentation and normalization techniques. The findings highlight the model's potential to replace costly manual inspection, contributing to smarter, more efficient manufacturing pipelines.

Paper ID : 44

AI-based vibration signal analysis for milling tool health diagnosis

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Abstract: This study presents a machine learning-based approach for milling tool condition monitoring using vibration analysis. The proposed method combines the maximal overlap discrete wavelet packet transform (MODWPT) for signal decomposition with zero-crossing (ZC) and slope sign change (SSC) for feature extraction, and uses random forest (RF) classifier to distinguish between three tool wear conditions: break-in period, steady-state wear region, and failure region. Experimental validation is conducted on two tools from different manufacturers under consistent cutting conditions, using eight vibration sensors. The proposed methodology achieved classification accuracies of up to 97.5%, demonstrating high reliability and robustness across repeated trials. These results suggest that the approach can effectively support predictive maintenance strategies by enabling non intrusive, real-time monitoring of tool health

Paper ID : 45

Hybrid Renewable Energy System Sizing for Continuous Industrial Load Applications

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Abstract: Renewable energy sources are increasingly regarded as the primary solution for electricity generation due to their sustainability and environmental advantages. A significant application of these sources is in microgrid systems, where the integration of renewable technologies requires optimal sizing of components to ensure economic efficiency. This process involves calculating key indicators such as the Levelized Cost of Energy (LCOE), Net Present Cost (NPC), and the total electricity generated to meet a constant industrial demand of 24 MWh per day. Considering the need for long-term sustainability in the industrial sector, this study proposes an optimal microgrid design approach suitable for implementation in a desert region of Algeria. The country possesses substantial potential for renewable energy, particularly solar photovoltaic (PV) and wind turbine (WT) systems. The objective of this work is to assess the economic and technical feasibility of high-capacity microgrid systems through design optimization. Using HOMER Pro software, we analyze capital, replacement, maintenance, and operational costs over the system's lifetime. The design process includes estimating energy production from each component based on the characteristics of the installation site, such as energy resource availability and climatic conditions. The aim is to achieve a minimum Levelized Cost of Energy and reduced loss of power supply, ensuring both energy reliability and security.

Paper ID : 48

Performance Enhancement of a Solar Absorption Cooling System Using Hydrogen

Auxiliary Heating and Nanofluid Thermal

Storage with Autonomous Control

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Abstract: This study presents the modelling and simulation of a solar-powered absorption cooling system adapted for desert climates, with a case study in Adrar, Algeria. The proposed system integrates a parabolic trough solar collector, a thermal storage tank enhanced with a copper-based nanofluid, and an absorption chiller. To maintain cooling during periods of low solar radiation, a hydrogen auxiliary heater is introduced and activated automatically via a temperature-based control system when the storage temperature drops below the operational threshold. The model was developed using MATLAB and finite difference method to solve the governing energy balance equations. Simulation results reveal that the hydrogen heater significantly enhances system reliability and thermal stability, maintaining generator temperature and ensuring early-morning cooling availability. Furthermore, the use of copper based nanofluid led to improved heat transfer performance, resulting in a noticeable increase in the system's coefficient of performance (COP). This dual enhancement hydrogen-based stability and nanofluid enhanced thermal exchange demonstrates the system's suitability and efficiency under extreme Saharan conditions. The findings contribute to the development of more reliable andefficient solar cooling technologies for off-grid desert applications.

Keywords :Absorption cooling system, Nanofluid, Simulation,Hydrogen heater, Autonomous control.

Paper ID : 52

A low-cost acquisition system for a Piezoelectric accelerometer

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Abstract: This work presents the development and characterization of a low-cost dynamic acquisition system from a piezoelectric sensor and an Arduino Due board, which can be built at a fraction of the cost of commercial data acquisition systems. The first step is to build a safe and reliable signal conditioning system and the software to support the data acquisition. The most challenging task was to maximize the sampling frequency without affecting the signal quality. The optimized sampling frequency of 9kHz was achieved. The final step was to assess the quality of the measured signal which was done through the application of machine learning algorithms for classification which obtained significant successful classification rates up to 95% for most classifiers.

Paper ID : 53

Accelerating Face Recognition: Dlib on FPGA

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Abstract: While deep learning-based face recognition methods offer high accuracy, they are often complex and slow. Our paper aims to develop a facial recognition system that leverages deep learning algorithms and hardware acceleration provided by FPGA cards. We implemented the Dlib tool on a PYNQ-Z1 FPGA card, incorporating convolutional neural networks (CNN) and deep residual networks (ResNet) for real-time face recognition. Our system is designed to monitor student attendance using video captured at the entrance to the classroom. Our method achieves a precision rate of 98.494 %, and by integrating it into a PYNQ-Z1 FPGA card, we significantly enhance performance by accelerating key facial recognition functions, thereby reducing the overall program runtime by over 247%. By combining deep learning with hardware acceleration, our system improves efficiency, accuracy, and responsiveness, enabling real-time facial recognition.

Paper ID : 54

Classifying skin cancers using a new deep learning model

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Abstract: Skin cancer is one of the most common types of cancer worldwide, causing significant mortality. What distinguishes it from other types of cancer is that it is easy to treat if detected early. This disease is characterized by its diverse forms and many categories, making it difficult to determine its exact type. The human role in detecting and identifying skin cancer is a difficult, costly, and slow task. Therefore, it is necessary to identify skin cancer automatically to detect it quickly and accurately. There are many contributions in this field, but some still need improvements to increase their efficiency. Artificial intelligence is currently assisting people in various fields, especially in the medical field, detecting and classifying medical images, providing accurate results across various classifications and uses. In this paper, we presented a deep learning-based model for skin cancer detection. In the first stage, we extracted important features from images by combining the XcelNet17 network with the Spatial Attention Module. At the end of this step, we obtained a set of important and deep features. We classified these features using XgBoost as a final, multiple classification. The accuracy value obtained was 95.4%, which allows doctors to rely on our model to diagnose this type of disease.

Paper ID : 55

Neuro-CORONA: A Fuzzy-Neural Routing Protocol for Embedded Nano-Networks Mesh in Smart Structures

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Abstract: Nano-networks, composed of ultra-miniaturized sensing and communicating devices, are rapidly emerging as the foundation for intelligent materials in next-generation infrastructures. Among their most promising applications are smart structural materials capable of real-time sensing and responding to stress, deformation, impact, or environmental changes. However, enabling scalable and reliable communication across dense, embedded nano-sensor meshes remains a significant challenge due to severe energy constraints, a lack of unique identifiers, and no centralized control. This paper proposes Neuro-CORONA, the first lightweight, cluster-based, and learning-driven routing protocol tailored for static nano-network meshes embedded within smart materials such as concrete, flexible coatings, aerospace composites, and smart glass. Neuro-CORONA extends a coordinate-based clustering foundation with a three-tier fuzzy-neural decision architecture: cluster-head election, packet forwarding, and suppression control. Each node acts as a context-aware agent, using local fuzzy state variables and a compact Q-learning neural approximator to prioritize urgent packets, reduce redundancy, and adapt to energy and traffic fluctuations, without requiring global knowledge or neighbor tables. Simulation results across various event types and network densities via the nano-sim tool demonstrate that Neuro-CORONA consistently outperforms baseline protocols in key metrics such as packet delivery ratio, average end-to-end delay, suppression efficiency, and cluster resiliency.

Paper ID : 57

Robust Diagnosis of Bearing Faults under Variable Operating Conditions Using Dynamic Mode Decomposition of Electrical Signals

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Abstract: In the realm of industrial machinery, where the operational environment is often characterized by variable working conditions, the efficient prognostic and health management (PHM) of critical components, particularly bearings, is crucial. This paper presents an innovative methodology tailored for diagnosis under variable working conditions and the PHM of bearings in machinery. The approach utilizes electrical signals acquired from a three-phase motor and applies Dynamic Mode Decomposition (DMD) to extract spatiotemporal features from the non-stationary signals. DMD decomposes the input signals into a set of dynamic modes, each associated with a specific frequency and growth/decay rate, capturing the underlying system dynamics under diverse operating conditions. Subsequently, the Hilbert Envelope Spectrum (HES) is computed for the reconstructed signals corresponding to dominant DMD modes, and the Power Spectral Density (PSD) is determined within a specified frequency range corresponding to fault frequencies associated with bearing defects. The mode exhibiting the highest energy contribution is selected for further analysis, and three indicators—Hoyer index, L2-to-L1 ratio, and Geometric Mean Improved Gini Index—are computed to quantify the statistical and sparsity characteristics of the mode. To enhance the robustness of the methodology for bearing prognosis under varying working conditions, the indicators are standardized by dividing them by the standard deviation of the original signal. These standardized indicators are then used as input features for a machine learning classifier, achieving an impressive 99.67% accuracy in bearing fault diagnosis. This integrated approach provides a robust and interpretable framework specifically designed for bearing health assessment, contributing significantly to the reliability and performance optimization of industrial machinery across a spectrum of operational scenarios.

Paper ID : 58

Artificial Bee Colony optimization in tandem with Empirical wavelet decomposition and Decision Tree Classifier for Automatic condition monitoring of Grid-Connected PV system

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Abstract: In electrical energy production field, the early detection of Grid-connected PV system faults is crucial to avoid any failure in the system components, which can lead to unexpected breakdowns that causes high repair costs and enormous economic and commercial losses. During PPT modes operation, the system faults remain undetectable for longer periods introducing many threats to the system. This work presents A novel intelligent method based on signal processing techniques using Empirical wavelet decomposition (EWT), optimization algorithm by an artificial bee colony, and Machine Learning using a decision tree for faults detection and classification in (GPV) system under Maximum Power Point Tracking (MPPT) mode during large variations of environmental conditions. The EWT was applied to decompose the signal to extract the AM-FM modes. Each mode derived from EWT were statistically evaluated using the statistical feature. Then, the artificial bee colony (ABC) is proposed to optimize the selection of input feature subset and the number of relevant features faults to improve the performance of faults classification further. Finally, an ensemble learning algorithm Decision tree (DT) is applied to train a model able to classify the fault based on the selected features. The performance of the proposed controller has been validated in different scenarios by real-time simulation including seven faults: open circuit in PV array, grid anomaly, inverter fault, feedback sensor, MPPT controller, and boost converter faults. The obtained results indicate the ability of our proposed method to handle GPV fault detection and classification with high efficiency.

Paper ID : 63

ab-initio study of CdTe/ZnTe heterojunctions and their applications in photovoltaics

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Abstract: Abstract – In light of the global trend toward developing and diversifying more efficient and sustainable renewable energy sources, researchers are working to develop innovative technologies that combine advanced nanomaterial engineering and energy production. This research focuses on improving the performance of photovoltaic cells by introducing innovative strategies, including the use of CdTe/ZnTe heterojunction semiconductors as thin layers in photovoltaic cells. These layers are directly manufactured using the sol-gel method.To design the upper layers of cells to reduce light reflection and increase absorption, leading to increased cell efficiency, this work presents a multidisciplinary approach that combines materials engineering and renewable energy technology, with the goal of achieving more efficient, environmentally friendly, and low-cost solar cells.

Keywords – CdTe/ZnTe ; photovoltaic ; solar cells ; heterojunction ; semiconductors

Paper ID : 64

Predictive modeling of gas turbine exhaust temperature using ML techniques

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Abstract: This paper investigates the application of machine learning (ML) models to predict the exhaust gas temperature (G2.TTXD) of a gas turbine at the Hassi R'mel gas field using real-time data. Linear Regression, Support Vector Regression (SVR), and Random Forest were evaluated using MSE, MAE, and R^2 metrics. SVR outperformed the others, achieving an R^2 of 0.91 and MAE of 3.8 °C. The results highlight the potential of ML for predictive maintenance and real-time monitoring in line with Industry 4.0 goals.

Paper ID : 65

Study and Analysis of the Magneto-Mechanical Behavior of Smart Composite Sandwich Beam

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Abstract: The purpose of this work is to analyze the nonlin-ear magneto-mechanical behavior of smart sandwich structures with a magnetorheological elastomer (MRE) core subject-ed to a permanent magnetic field. A detailed study is first carried out to characterize the mechanical behavior of these structures. The tests were carried out in three-point bending on beams of these complex materials for several distances between supports. An experimental study of the static response, is realized using a Zwick 2.5 kN machine, allows to measure displacements as a function of force. The results deduced from the numerical simulation by the Abaqus software are compared with those obtained from the theoretical analysis. This study made it possible to show that these structures exhibit a non-linear behavior even at small deformations due to the rheological parame-ters which are more sensitive by the application of a magnetic field.

Paper ID : 66

: Numerical Investigation of Dimethyl Ether Blending Effects on Biogas laminar Diffusion Flame Characteristics and Emission Formation.

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Abstract: This study explores the potential of blending biogas with dimethyl ether (DME) to reduce greenhouse gas emissions, particularly nitrogen oxides (NOx) and carbon monoxide (CO). As an environmentally friendly fuel, DME is a suitable candidate for blending. The study examines the combustion behavior of a biogas/DME blend in a laminar diffusion flame within a counter-flow configuration. Simulations were conducted using CHEMKIN software to quantitatively analyze NO and CO formation from different reaction pathways. The chemical kinetics of combustion were modeled using the Aramco 1.3 mechanism combined with the NO sub-mechanism, which has been validated for its accuracy in simulating chemical kinetics based on experimental results. Additionally, the study identifies key reactions responsible for NO and CO formation under combustion conditions using rate of production analysis (ROPA). The (50:50) DME/biogas blend offers the best emission trade-off.

Paper ID : 67

Designing a Federated Learning-Based IoMT Architecture: Enhancing Privacy, Security, and Scalability in Healthcare IoT

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Abstract: Current Internet of Medical Things (IoMT) architectures are increasingly challenged by privacy concerns, scalability limitations, and inefficient data management practices. Predominantly relying on centralized cloud-based processing, these systems often struggle to comply with data protection regulations and face performance bottlenecks in dynamic healthcare environments. This paper presents a novel IoMT architecture that integrates Federated Learning (FL) as a foundational component to decentralize data processing while preserving data privacy and enhancing scalability. The proposed architecture is structured around three fundamental units: Physical Devices, Healthcare Application Systems, and Network Infrastructure. These units are interconnected through vertical layers that incorporate Federated Learning, Cloud Computing, 5G communication, and Security mechanisms. Key contributions of this work include: (i) a systematic analysis of existing IoMT architectures, differentiating between general concept-based and attribute-based frameworks; (ii) the design of a multi-layered architecture that enables privacy-preserving collaborative learning across heterogeneous IoMT devices; and (iii) a comparative assessment that demonstrates the architectural improvements in terms of privacy, scalability, and operational efficiency. By integrating Federated Learning into the architectural design of IoMT systems, this research proposes a comprehensive framework that addresses critical limitations of current models, contributing to the development of secure, scalable, and privacy-aware medical IoT solutions.

Paper ID : 68

Experimental Characterization and Numerical Validation of Terminal Velocities in Falling Droplets

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Abstract: The analysis of falling liquid droplets in a continuous fluid medium is a crucial step toward understanding two-phase flow behavior. This phenomenon plays an important role in various industrial applications, particularly in the pharmaceutical industry, liquid-liquid extraction processes, and atmospheric dust removal by raindrops. This study presents an experimental investigation conducted in our laboratory, focusing on the fall of different liquid droplets in water. For each droplet, the following parameters were measured: instantaneous velocity Uinst terminal velocity UT, and equivalent spherical diameter deq. In addition to the experimental approach, a numerical study was carried out to compare the terminal velocities corresponding to different droplet diameters.

The experimental results were compared with data from the literature concerning terminal velocities and equivalent diameters. A good agreement was also observed between the experimental findings and the numerical simulations.

Paper ID : 70

Formation of Nitric Oxide and Nitrogen Dioxide in Propane Diffusion Flames

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Abstract: It is true that biogas and syngas are alternative fuels, but their low calorific value makes them difficult to exploit because of the fragility of their flamelet. The aim of this study is to reduce as much as possible the

polluting emissions, especially NO, considered as the current challenge. To this end, a propane mixture and synthesis gas are blended. The reaction mechanism, namely: GRI-Mech 3.0, is used to numerically simulate C3H8/CO/H2 air non-premixed combustion (counter-flow laminar diffusion flame), by using CHEMKIN-PRO software. In a counter-flow laminar diffusion flame at atmospheric pressure, the influence of the fuel composition and radiation heat losses on the flame temperature and NOx emission has been studied. The results seem to be consistent with those found in the literature.

Paper ID : 71

Development of a Cost-Effective Precision Platform for Satellite Solar Sensor testing

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Abstract: Reliable performance of solar sensors is crucial for the Attitude and Orbit Control System (AOCS) of satellites. To ensure accuracy before deployment, these sensors require rigorous testing under controlled conditions. This work presents the design, modeling, and implementation of a low-cost precision rotary platform tailored for satellite solar sensor evaluation. The proposed system enables the simulation of orbital motion and illumination variations, allowing for comprehensive calibration and performance verification. The design process integrates mechanical optimization, numerical simulation, and automated control for enhanced positioning accuracy. Experimental validation demonstrates that the platform provides stable, repeatable motion suitable for both laboratory calibration and long-term sensor characterization, contributing to improved satellite operational reliability.

Paper ID : 72

Combined fault detection of an electric vehicle PMSM

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Abstract: Electric Vehicle (EV) traction systems demand high reliability, making early fault detection in Permanent Magnet Synchronous Motors (PMSMs) essential for preventing unexpected failures and reducing maintenance costs. This study proposes a fault detection framework for PMSMs under two critical fault scenarios: stator voltage unbalance and inter-turn short-circuit faults. The approach uses simulated electrical data generated from a PMSM model to represent healthy and faulty operating conditions. Discrete Wavelet Transform (DWT) is employed to decompose the motor's phase current signals, enabling time–frequency domain analysis and extraction of discriminative fault-sensitive measurements. These measurements are then analyzed to identify fault-specific patterns. The proposed method demonstrates accurate differentiation between fault types, as well as reliable detection in incipient fault stages. The results highlight the effectiveness of combining simulation-based data generation with DWT-based analysis for the development of efficient, non-intrusive, and cost-effective PMSM fault detection strategies tailored to EV applications.

Paper ID : 73

Robust Control of an Autonomous PV-Wind Hybrid Energy System Using H? Strategy

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Abstract: This study investigates an autonomous hybrid renewable energy system that combines photovoltaic (PV) and wind turbine (WT) technologies, both connected through a common AC bus. Designed to operate independently of the main utility grid, this hybrid system not only ensures local energy supply but also supports frequency regulation, a critical requirement in isolated power networks. The architecture enables coordinated interaction between the PV and WT sources, allowing for more stable and efficient energy management in the absence of conventional generation. To address the challenges of system instability caused by the intermittent nature of renewable energy sources and varying load conditions, an advanced H? robust controller is proposed. This control strategy is selected for its ability to manage system uncertainties, reject external disturbances, and maintain desired dynamic performance. It is responsible for stabilizing power exchange between sources and load while ensuring frequency deviations remain within acceptable limits.

Comprehensive simulation tests are conducted under different operating scenarios, including variations in wind speed, solar irradiance, and grid impedance. The results demonstrate that the H? controller significantly enhances system robustness and dynamic stability. Even under harsh and unpredictable conditions, the controller ensures effective frequency control and stable operation of the autonomous system. Overall, the study highlights the potential of combining hybrid renewable generation with advanced robust control strategies to develop autonomous energy systems capable of providing reliable power and grid-support functionalities in remote or off-grid areas.

Paper ID : 74

Time-frequency Analysis for Robust Motor defects Diagnosis

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Abstract: This paper looks at a robust approach for identifying various failures affecting components in an induction motor using motor current signature analysis (MCSA), which combines the discrete wavelet transform (DWT) and the energy analysis method to diagnose and monitor failures affecting rotating machinery. This process is applied to improve precision diagnosis of motor malfunctions through detecting three main types of defects: bearing faults, misaligned rotors and combined faults between both. By leveraging the discrete wavelet transform decomposition levels and the extraction feature of energy, experimental results validate and highlight the effectiveness of this combined approach and its potential for real-time monitoring and diagnostic fault systems for improving machinery performance.

Paper ID : 75

A Virtual-Capacitor Feed-Forward for Faster DC-Link Regulation in PV-HESS Microgrids

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Abstract: This paper proposes an enhanced Dual-PI control strategy augmented with a virtual-capacitor feed-forward mechanism for a standalone photovoltaic system integrated with a hybrid energy storage system composed of a lithium-ion battery and a supercapacitor. The PV array, battery, and SC are interfaced to a common 48 V DC bus via bidirectional converters,enabling flexible power management. The proposed controller ensures precise DC-link voltage regulation while effectively coordinating low-frequency and high-frequency power sharing between the battery and SC. The virtual-capacitor feed-forward term improves transient response by reducing overshoot, accelerating settling, and enhancing damping compared to conventional Dual-PI control. System modeling equations for the PV, battery, supercapacitor, and DC-link dynamics are derived,and the proposed scheme is validated in MATLAB/Simulink under varying irradiance and load conditions. Simulation results demonstrate that the proposed controller achieves stable operation, maintains energy balance, and significantly relieves the battery from transient stress by allocating HF fluctuations to the supercapacitor, thus enhancing overall system reliability.

Paper ID : 78

Securing Edge Computing for AI-Driven Mechatronic Systems: A Survey on Challenges, Threats, and Mitigation Strategies

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Abstract: Abstract: Edge computing (EC) is a distributed model that processes data at the edge of a network. It has benefits like faster insights, lower latency and better use of bandwidth, which are all important for real-time mechatronic applications [1]. But because it is distributed, has limited resources and is made up of many different types of computers it is very vulnerable to data breaches and different types of attacks [1]. This paper comprehensively examines the security challenges associated with EC, with a particular focus on its integration with Artificial Intelligence (AI) and the Internet of Things (IoT) in mechatronic systems. We classify common threats and carefully look at the most advanced ways to deal with them, such as AI/Machine Learning (ML) for advanced threat detection, Physical Unclonable Functions (PUFs) for hardware-based security, and Blockchain for decentralized trust management [1]. The integration of Federated Learning (FL) is examined for its potential to safeguard privacy in distributed AI contexts [2][3]. This paper aims to provide a comprehensive overview for researchers and practitioners by highlighting the benefits and limitations of existing solutions, thereby identifying critical research gaps and future directions for enhancing security and privacy in AI-enabled edge computing within mechatronic and autonomous systems.

Keywords: Edge Computing, Artificial Intelligence Cybersecurity, Physical Unclonable Functions, Blockchain, Federated Learning, Internet of Things, Mechatronic Systems.

Paper ID : 79

Simulation and Analysis of a Thermosyphon System Integrated with Membrane Distillation Using TRNSYS

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Abstract: Membrane distillation (MD) is a thermal separation process driven by a vapor pressure gradient, requiring a reliable thermal source. This study investigates a solar thermosyphon water heating system designed to support a membrane distillation unit for freshwater production. The system includes a 4 m² flat plate collector and two 1.6 m² photovoltaic (PV) panels coupled with a battery storage system. The PV system provides energy to auxiliary components, thereby lowering operational costs. The system was modeled using TRNSYS simulation software and analyzed under climatic conditions in Ain-Temouchent, Algeria. Simulation results show that the thermal storage tank reaches temperatures of up to 60 °C, with a daily water consumption of 600 L. The auxiliary energy requirement was estimated at 1208 W. This study confirms the potential of the solar thermal systems for sustainable and cost-effective membrane distillation in semi-arid regions.

Paper ID : 80

Fault Detection Strategy Using Black-Box Modeling and Statistical Distance: Example Of Distillation Column

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Abstract: This paper presents a comparative study of two linear models, CARARMA and Box Jenkins, identified using extended least squares algorithms. The models were evaluated based on statistical performance criteria, namely Root Mean Square Error (RMSE), and Nash-Sutcliffe Efficiency (NSE) and Akaike's Information Criterion (AIC), to determine their accuracy in parameter estimation and prediction capability. The results highlighted CARARMA as the superior reference model, providing more reliable predictions of system outputs. To demonstrate the practical relevance of the approach, a distillation column case study was conducted, where the selected model was applied for fault detection. The fault diagnosis process was discussed in detail, starting from model identification and residual generation to fault detection using statistical distance measures.

Paper ID : 81

Data Analysis, Networking, and Cloud Computing Using a Raspberry Pi Zero and BME680 Sensor A Personalized Indoor Air Quality

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Abstract: This study introduces AirMIND, a smart system for monitoring indoor air quality that aims to improve mental well-being by providing personalized and immediate feedback. The system integrates low-cost sensors with cloud computing and machine learning to continuously monitor environmental parameters such as temperature, humidity, pressure, and volatile organic compounds (VOCs). A Random Forest regression model trained on synchronized IAQ data and self-reported mood scores achieves a robust predictive performance with an average root mean squared error (RMSE) of 0.15 on a normalized mood scale. User evaluations with 10 participants demonstrate that 80% found the personalized alerts useful in improving awareness of their indoor environment's impact on mood. Designed for scalable deployment, AirMIND offers a practical solution for schools, offices, and homes to proactively manage indoor environmental quality and promote mental well-being.

Paper ID : 82

Embedded Machine Learning and AI for Mechatronic Systems: Adaptive PID Control via TinyML on Xiao ESP32-S3

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Abstract: This paper presents a novel adaptive control strategy for mechatronic systems by integrating TinyML-based machine learning on the Xiao ESP32-S3 microcontroller. Traditional PID controllers, while widely used, suffer from performance degradation under changing mechanical or environmental conditions due to their fixed gain parameters. To overcome this limitation, we develop a lightweight neural network model that dynamically adjusts PID gains in real time based on sensor data, including position, velocity, torque, temperature, and control error metrics. The model is pre-trained offline and deployed using TensorFlow Lite Micro, enabling efficient inference on the resource-constrained ESP32-S3. The control system operates entirely on-device, with no reliance on external computation, ensuring fast response and low power consumption. Experimental simulations conducted under different load and thermal conditions show that the adaptive controller greatly enhances performance by reducing settling time, overshoot, and steady-state error. It also maintains real-time responsiveness with minimal computational load. The architecture is designed to be scalable and robust, making it a strong candidate for intelligent control in embedded mechatronic systems.

Paper ID : 83

Non-Invasive Acoustic Monitoring of Pneumatic Systems in Mechatronics Using Edge Data Analysis and Cloud Integration

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Abstract: This paper presents a cloud-integrated, non-invasive monitoring system for pneumatic components in mechatronic applications. Acoustic and ultrasonic sensors capture leak-related emissions without physical modification to the system. A Raspberry Pi edge device performs real-time signal acquisition, filtering, and feature extraction, while minimizing bandwidth by transmitting only summarized feature data. Using an MQTT-based protocol, the system sends anomaly alerts and diagnostic features to a cloud platform, where advanced machine learning models perform anomaly classification and predictive maintenance analytics. Experimental validation confirms the system’s ability to detect leaks with low latency and significantly reduced network load, demonstrating the effectiveness of combining edge processing with cloud-based intelligence for scalable, real-time fault detection in pneumatic systems.

Paper ID : 84

Analysis of various load values affecting the efficacy of a self-excited induction generator

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Abstract: This study analyzes various load values for self-excited induction generators (SEIG) using a detailed finite-element model of the wind turbine conversion system. After identifying the minimum self-excitation capacitance, we connect different loads.to the SEIG and assess the generator's performance under varying operational conditions. The analysis includes a thorough evaluation of voltage stability and frequency response, critical factors that influence the overall efficiency of the wind turbine system. Additionally, the study examines the transient response of the SEIG system when subjected to sudden load changes, offering insights into the resilience and adaptability of the system in real-world scenarios. By adjusting the capacitance in conjunction with the load, we aim to maintain voltage levels within acceptable limits, The results demonstrate that a well-calibrated capacitive bank considerably improves self-excitation reliability, making the SEIG a viable option for renewable energy applications. this study underscores the significance of capacitance optimization and load management in the operational success of self-excited induction generators. Future work will focus on developing automated control systems that can efficiently adapt to real-time changes in both wind conditions and load demands, thereby enhancing the utility and sustainability of wind energy systems.

Paper ID : 85

A Hybrid ResNet–Vision Transformer Approach for Industrial Defect Classification

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Abstract: Industrial anomaly detection has become a crucial step, particularly in the metal domain, since metal is an essential component in most industries, and even a single defect can lead to significant economic consequences. In this work, we proposed a hybrid model for metallic defect classification by combining the first two blocks of ResNet50 with a Vision Transformer. ResNet50 is leveraged for extracting local features, while the Vision Transformer is specifically used to capture global representations through the modeling of long-range dependencies. Our approach achieved significant improvements over ResNet50, with a gain of 1.79% on NEU-DET and 3.68% on GC10-DET in terms of precision, demonstrating the effectiveness of the proposed model

Paper ID : 86

Application of the AMDEC Method on an Air Cooler

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Abstract: New the Mega train of GL.1K Skikda (Gas Liquefaction Complex) is equipped with cooling system dries made up of approximately of 360 Air-cooled which plays a very important part in the processor of the gas liquefaction, considering the importance to maintain under good performance the system with optimization of the costs of maintenance and in full safety by applying the policy of maintenance more. One adapts proposes, to apply the approach Maintenance Based on reliability, or MBF; and as the AMDEC method is a very important step in the MBF it must be applied to the Air-cooled.

Paper ID : 88

Multifault Isolability in Li-ion Batteries combining Model-Based Residual Generation and Hardware Redundancy

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Abstract: The complexity of battery packs and the limited sensor coverage make accurate fault detection and isolation (FDI) difficult, especially when faults show similar symptoms. This study presents a model-based diagnostic approach for series-connected lithium-ion (Li-ion) batteries, combining structural analysis with observer-based residuals. Hardware redundancy through additional voltage sensors improves the isolability of sensor, short circuit, and connection faults. Residuals are evaluated using adaptive thresholds to enhance robustness to modeling errors and noise. The proposed method enables multifault detection within a single diagnostic framework, isolating faults robustly and without added complexity.

Paper ID : 89

Systematic Design of a Passive Damped LCL Filter for Grid-Tied Voltage Source Inverters

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Abstract: This paper presents a systematic modeling and design approach for an LCL filter with series passive damping, aimed at improving the power quality of grid-connected voltage source inverters (VSIs) in compliance with IEEE 519-1992 harmonic standards. The proposed step-by-step design algorithm determines filter parameters based on system specifications, ensuring effective suppression of switching harmonics while maintaining system stability and minimizing voltage drop. The designed filter is implemented in a MATLAB/Simulink model of a 300 kW two-level grid-tied VSI, and its performance is evaluated through frequency-domain analysis and time-domain simulations. Results demonstrate that the introduction of passive damping effectively mitigates resonance, reduces total harmonic distortion (THD) in both voltage and current to within IEEE limits, and delivers nearly sinusoidal waveforms at the point of common coupling (PCC).

Paper ID : 91

Réalisation d'un systéme mécatronique marchée par énergie solaire

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Abstract: Réalisation un systéme mécatronic marchée par énergie solaire de systéme de stockage. Haute eau à l'intérieur de la terre par machiné électrique.

Paper ID : 92

Deep Perception for Autonomous Driving: A Robust 3D Tracking Framework

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Abstract: This paper presents a robust 3D multi-object tracking (MOT) framework for autonomous driving applications, based on the tracking-by-detection paradigm. The system integrates a high-precision PointRCNN detector to generate 3D bounding boxes directly from raw LiDAR point clouds. For temporal association, a 3D Kalman Filter predicts object dynamics, and the Hungarian algorithm ensures optimal data association between predictions and new detections. The proposed framework is extensively evaluated on the KITTI tracking benchmark across Car, Pedestrian, and Cyclist categories. Results demonstrate state-of-the-art or highly competitive performance, achieving a MOTA of 84.81% for Cars, 68.19% for Pedestrians, and 83.38% for Cyclists. The system proves effective in complex urban environments, handling challenges such as occlusions and illumination changes, confirming its potential for real-world autonomous driving systems.

Paper ID : 95

automated pneumonia classification using a customized CNN

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Abstract: The need for automatic identification of thoracic and pulmonary diseases through X-ray radiography has become urgent and can be achieved through artificial intelligence, especially recently with the emergence of the pneumonia disease. Pneumonia is an infection of the lower respiratory tract that is one of the leading causes of morbidity and mortality worldwide. In this work, we constitute an efficacy diagnosis tool to classify pneumonia vs. normal subject. We propose a novel 2D Convolutional Neural Networks (CNN) architecture to performed a binary classification. The proposed method demonstrates superior performance with an accuracy of 95.16% using the X-rays chest database.

Paper ID : 97

Modeling and Control of an Intelligent Flywheel Energy Storage System for an isolated wind Turbine

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Abstract: Flywheel energy storage systems (FESSs) help wind turbines deliver higher-quality electricity and assist them in providing auxiliary services. Currently, FESSs with an IM (induction machine) that is flux-oriented controlled (FOC) are mainly considered to account for this kind of application. Flywheels have attributes of a high cycle life, long operational life, high round-trip efficiency, high power density, and low environmental impact, and can store megajoule (MJ) levels of energy with no upper limit when configured in banks. The main of applications FESS with FOC controlled is to minimize wind power fluctuations and to maintain the equilibrium between production and the grid. The suggested FOC control algorithm has shown its validity and effectiveness under a variety of operating conditions, according to simulation results

Paper ID : 98

Wall-following behaviour in a differential mobile robot by using sonar sensors, FSM, and a PID controller.

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Abstract: The use of a Finite State Machine (FSM) controller to control the actions of a robot exploring a controlled indoor environment is described in this work. Planning a secure and reliable path for wall-following tasks is our primary goal. In our work, we describe the Python implementation of an FSM controller and show how it improves task precision. We built our controlled environment and controlled the Pioneer 3DX mobile robot's sensors and motors using remote Python API functions in conjunction with the CoppeliaSim Simulator. The entire experiment was carried out in a simulated environment with barriers and enclosing walls. A collection of sensors located these obstacles, and thereafter the robot then followed them. Our robot successfully adhered to the pre-established path and adeptly navigated around obstacles within this environment. Furthermore, we conducted a comparative analysis of the results achieved with an alternative controller known as the Proportional Integration Derivation (PID), with the aim of identifying the most effective algorithm for this task.

Paper ID : 100

Dynamic modeling and analysis of a spur gear transmission with crack fault considering temperature effects

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Abstract: Dynamic modeling is a crucial tool for rotating machinery fault diagnosis. It provides a better understanding of vibration responses associated with the system degradations and allows identifying characteristic signatures that facilitate the diagnosis of faults. In this context, the present paper aims to develop a dynamic model of a cracked spur gear that takes into consideration the effect of temperature on the system dynamic behavior. The present approach incorporates a linear model of variation of mesh stiffness as function of temperature. The equations of motion of the system are obtained using Lagrange formulation and solved by the Newmark method. By integrating the temperature effects into the model, a more realistic representation of the meshing process is achieved, providing valuable insights for accurate prediction of dynamic responses and fault diagnosis in rotating machinery.

Paper ID : 101

Capacitor Fault Detection in Modular Multilevel Converters based on Discrete Wavelet Transform and Neural Networks

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Abstract: Modular multilevel converters (MMCs) have become a key technology in modern power systems thanks to their high efficiency and scalability. Despite these advantages, their complex structure makes them susceptible to a range of faults, with capacitor degradations or failures being among the most detrimental, as they directly impair output quality and system stability. This paper introduces a fault detection and diagnosis strategy aimed at capacitor failures in MMCs. The method combines Discrete Wavelet Transform (DWT) for feature extraction from submodule capacitor voltages with an Artificial Neural Network (ANN) for fault classification. The wavelet-based analysis captures transient variations in the capacitor voltage signals, while the trained ANN provides fast and accurate fault identification. Simulation studies carried out in MATLAB/Simulink confirm the effectiveness of the approach, demonstrating its capability to enhance the reliability of MMC operation

Paper ID : 102

Advances in Medical Image Segmentation for Early Diagnosis: From Traditional Methods to Deep Learning

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Abstract: Medical image segmentation plays a vital role in computer-aided diagnosis (CAD) by enabling the accurate identification of anatomical structures and abnormalities. It is particularly important for the early detection of diseases such as cancer and infectious conditions, where precise delineation directly supports clinical decision-making. Segmentation methods have evolved significantly, beginning with traditional image processing techniques like thresholding, region growing, and edge detection. While these methods established the foundation for automated analysis, they often struggled with noise and generalization. Machine Learning (ML) approaches introduced data-driven models that improved performance but still relied on handcrafted features. More recently, Deep Learning (DL), especially Convolutional Neural Networks (CNNs) and U-Net-based architectures, has transformed segmentation by enabling automatic feature extraction and achieving state-of-the-art accuracy across diverse medical applications. This review examines the progression of segmentation methods, compares classical and DL approaches, and discusses persistent challenges, including dataset limitations, annotation complexity, and clinical interpretability.

Paper ID : 103

A Mechatronic GSM-Based Car Alarm System for Real-Time Intrusion Detection Using Phone Call Alerts

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Abstract: Vehicle security remains a growing concern in both urban and rural environments, especially in regions where continuous internet connectivity is not guaranteed. This paper presents the design and implementation of a smart, real-time intrusion detection system for vehicles using GSM-based phone call alerts. The proposed solution integrates mechanical sensors (vibration and motion), a microcontroller, and a GSM module to form an autonomous mechatronic system. Upon detecting unauthorized access or abnormal motion, the system initiates an automated phone call to a predefined number, ensuring immediate notification regardless of internet availability. The architecture emphasizes low-cost hardware, reliable operation under real-world conditions, and minimal power consumption suitable for automotive environments. Experimental results demonstrate the system's responsiveness, robustness, and practical viability. This work contributes to the development of accessible, embedded vehicle security systems and serves as a foundation for future enhancements including location tracking and intelligent threat classification.

Paper ID : 104

Optimization of a Graphene-Based Alkaline Electrolyzer for Renewable Hydrogen Production: Toward Energy-Efficient Mechatronic Systems

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Abstract: This study presents the development and optimization of an alkaline water electrolysis system for renewable hydrogen production. NiCoP/graphene electrodes were deposited on nickel foam using an electrochemical technique, and a full factorial design (2^3) was applied to evaluate the influence of stirring speed, particle size, and electrolyte concentration. Comprehensive electrochemical characterization confirmed that the optimized system significantly enhanced hydrogen evolution and overall energy efficiency. These results demonstrate the potential of integrating advanced electrode materials with process optimization into smart mechatronic energy platforms, highlighting the synergy between material design, system control, and sustainable hydrogen technologies.

Paper ID : 105

AI-Assisted Statistical Analysis of Cutting Parameters' Influence on Tool Life in Hard Turning

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Abstract: In hard machining, tool wear is a critical factor that directly compromises tool life, process performance, and product quality. The present study investigates the influence of cutting parameters on tool life during hard turning by adopting a statistical approach enhanced with artificial intelligence. The workpiece material used is hardened 100Cr6 steel, while the cutting tool consists of a CC650 ceramic insert. A full factorial 23 experimental design was implemented to systematically evaluate the effects of the main cutting parameters. Tool life (T) was assessed based on the allowable value of flank wear (VB). The experimental data were statistically processed using the R programming language to develop a predictive model based on Artificial Neural Networks (ANN). This AI-driven model effectively captures the complex and nonlinear relationships between cutting parameters and tool life, thereby providing deeper insights into tool wear mechanisms in hard turning. The findings of this study aim to optimize machining conditions to extend tool life, enhance productivity, and reduce manufacturing costs in hard turning applications.

Paper ID : 107

Robust Trajectory Tracking Control of a robotic Manipulator Using Fractional Order PID Controller

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Abstract: The present research examines the efficacy of Fractional-Order Proportional-Integral-Derivative (FOPID) control for precise trajectory tracking in a 2-degree-of-freedom (2-DOF) robotic manipulator, a critical task for autonomous mechatronic systems. While the ubiquitous PID controller provides a baseline for performance, its integer-order structure often struggles to compensate for the inherent nonlinearities and dynamic coupling present in multi-joint manipulators operating in real-time. The FOPID controller, incorporating fractional order calculus, introduces additional tuning parameters that significantly expand the optimization space for control design. The analysis provides a comparative analysis, evaluating both controllers under dynamic tracking scenarios and simulated disturbances. The findings suggest that the enhanced flexibility of the FOPID structure facilitates a more robust and optimized control solution, implicitly leading to superior tracking accuracy and improved disturbance rejection capabilities. The outcomes demonstrate the practical value of advanced control strategies in achieving the high-performance standards required by next generation autonomous systems. A detailed description of the simulation framework is presented, optimization methodology, and comprehensive quantitative results.

Paper ID : 108

Design and Implementation of a Parallel Kinematic Delta Rob

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Abstract: This paper presents the design and the implementation of a delta parallel robot. In fact, the design involves two main parts including the mechanical and the electronic parts. For the software part and in order to control the built robot and perform the different postures, micro-Python and ESP8266EX have been used. In addition, in order to give mobility for the control of the robot, a mobile application as well as desktop interface have been developed based on python and Flutter

Paper ID : 109

structural characteristics of hydrogenated amorphous silicon crystallized by nickel-induced crystallization

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Abstract: Abstract— In order to obtain a-Si:H thin films, the plasma enhanced chemical vapor deposition (PECVD) technique has been used. The a-Si:H layers were deposited in a radio frequency (13.56 MHz) PECVD reactor. The temperature for the cell fabricating processes was around 200°C. The a-Si:H precursor gases were semiconductor-grade silane (SiH_4). Subsequently, thin layers of nickel are deposited on the a-Si: H films using DC magnetron sputtering. The resulting structures (Ni/a-Si: H/glass) are then subjected to annealing at 570 °C under an N_2 atmosphere. Two annealing processes are compared: one involving a prior dehydrogenation step and the other without dehydrogenation. The crystallinity of the samples is confirmed by X-ray diffraction and Raman spectroscopy.

Keywords—hydrogenated amorphous silicon, nickel.

Paper ID : 110

Experimental Comparison of Classical and Neural Controllers for the Rotary Inverted Pendulum

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Abstract: This paper presents a comprehensive experimental study on the stabilization of a Rotary Inverted Pendulum using both conventional and neural-based control strategies. Two con-ventional approaches: Second-Order Sliding Mode Control and a hybrid Swing-Up + Linear Quadratic Regulator are compared against three neural-based controllers: Multi-Layer Perceptron, Adaptive Neuro-Fuzzy Inference System, and Deep Deterministic Policy Gradient. Experimental validation is carried out on the physical setup to evaluate performance in terms of settling time, trajectory tracking accuracy, control effort, and energy efficiency. Comparative analysis highlights trade-offs between speed, and control energy, providing practical insights for the selection of RIP controllers in real-time applications.

Paper ID : 111

Automatic Alzheimer disease classification using bag of feature and SVM

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Abstract: Alzheimer's disease (AD) is a neurodegenerative disorder and the first cause of dementia. The detection of this disease early on is a challenge for researchers. In this study, we developed a novel approach that combines a bag of features (BoF) and a support vector machine (SVM) to classify AD stages. Three experiences are applied using structural MRI images collected from the ADNI dataset. The proposed method achieves an accuracy of 91.54% to classify CN vs. mild cognitive impairment (MCI) vs. CN.

Paper ID : 112

Impact of Air-Side Partial Premixing of DME Fuel on the Structure and Emissions of Biogas/Air Laminar Diffusion Flame

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Abstract: Our study numerically examines the effects of air-side DME premixing on structural characteristics and emission of biogas/air non-premixed flames. This effects be evaluated by analyzing: the heat release, NO and CO production, Chemical interaction between methane, CO2, and DME radicals. DME vapor was added to the oxidizer gases of biogas/air flame, which created partially premixed flame PPF. We found that air-side DME premixing prompted the formation of a dual-zone reaction in the flame (lean premixed and the non-premixed reactions zones), the interactions between them expand flame thickness, increase the flame temperature peak and enhances flame speed and radical production (OH, CH). consequently resulting in more robust flame power. The profile of the NO production rate was broadened by increasing equivalence ratio and the peak NO production rate decreased. The reactivity of the premixed mixture significantly affected total NO formation.

Paper ID : 113

Modified Super Twisting Sliding Mode Controller for Gun Launched Coaxial Rotor UAVs

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Abstract: In this paper, we present a nonlinear controller based on second order sliding mode control to solve the path tracking problem for a Gun Launched Coaxial Rotor unmanned aerial vehicle (UAV) in the presence of parameter uncertainties and aerodynamic disturbance. For autonomous rotorcraft flight, it is important to separate the flight control problem into an internal-loop that controls the attitude and an external-loop that controls the translational trajectory of the rotorcraft UAV. The proposed controller is designed to ensure the convergence of the translation positions and yaw angle to the reference trajectories in finite-time and stabilize the pitch and the roll angles simultaneously. A formal proof of closed-loop stability and finite-time convergence of tracking errors is derived using the Lyapunov function technique. Simulation results are presented to corroborate the effectiveness and the robustness of the proposed control method.

Paper ID : 114

Reliability Analysis of Polyvinyl Chloride Insulation Subjected to Sinusoidal Electrical Stress

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Abstract: This study investigates the electrical ageing of polyvinyl chloride (PVC) insulation sheaths subjected to alternating sinusoidal voltages. Samples were tested under twelve stress levels ranging from 15.5 to 40 kV, with more than 600 breakdown time measurements collected. The statistical analysis relied on the two-parameter Weibull model, with validation by chi-square goodness-of-fit at 90% confidence intervals. Results reveal a three-zone endurance curve, consistent with the inverse power model, reflecting early defects, intrinsic dispersion of flaws, and long-term ageing. The estimated service lifetime under AC stress suggests safe operation below 10 kV. These findings contribute to a deeper understanding of PVC reliability in power engineering applications, providing guidelines for cable design and maintenance.

Paper ID : 115

CFD Study on the Impact of Tip Cavity Geometry and Shroud Motion on Leakage Flow and Thermal Loading in Transonic Turbine Blades.

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Abstract: This paper presents a numerical study on the aerothermal performance of modern turbine blade tip configurations, including flat, squealer, vertical shelf, and inclined shelf designs. Simulations were conducted under both design and off-design conditions, with and without casing motion. Results show that the vertical shelf tip minimizes leakage flow, while the inclined shelf yields the highest heat transfer coefficient. These findings provide insight into optimizing tip geometry for enhanced sealing effectiveness and thermal management in next-generation transonic turbine applications.

Paper ID : 116

Diagnosing and Locating Short-Circuit Faults in Power Transformers with Frequency Response Analysis (FRA)

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Abstract: Short-circuit faults in windings are among the most dangerous and common faults in power transformers. These faults originate from multiple factors, including transportation to the operating site, manufacturing faults, suboptimal operating conditions, and natural hazards such as heat and lightning. The signs of these faults begin to appear through changes in the drive point impedance (DPI), which in turn reflects a change in the parameters of the transformer file model.

Paper ID : 117

Artificial Intelligence-Based Approach for Predictive Maintenance of Bearings

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Abstract: The present research article focuses on the diagnosis of bearing faults in industrial environments. Classical vibration analysis methods, although widely used for a long time, show certain limitations in terms of automation and accuracy. To overcome these shortcomings, we investigate the contribution of Machine Learning techniques, such as Random Forest, SVM, and KNN, applied to vibration signals collected on a test bench. A comparison with conventional approaches (RMS, FFT) highlights the superior performance of intelligent models, thereby confirming the relevance of artificial intelligence for reliable and automated predictive maintenance.

Index Terms—Predictive Maintenance, Bearings, Vibration Analysis, Machine Learning, Fault Diagnosis, Artificial Intelligence.

Paper ID : 120

Modeling the Effect of Piston Motion Profiles on Wave Behavior and Porosity in High-Pressure Die Casting

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Abstract: High-pressure die casting (HPDC) conducted in a cold chamber remains vital in precision metal manufacturing due to its ability to produce high-quality components with superior surface finish. However, the injection process often leads to air entrapment, resulting in internal porosity. This study focuses on identifying a piston acceleration strategy that minimizes air inclusion during the slow shot phase. A two-dimensional, unsteady, turbulent simulation of molten metal flow is carried out using the Reynolds-Averaged Navier–Stokes (RANS) model within the Ansys Fluent environment. The Volume of Fluid (VOF) method is employed to capture the evolution of the free surface between the molten metal and entrapped air. Dynamic mesh adaptation is used to accommodate piston displacement during filling. The results demonstrate that appropriate piston acceleration laws can significantly reduce air retention by maintaining wave stability and preventing breakup near the discharge region. This highlights the potential of optimizing piston motion profiles to improve casting integrity.

Paper ID : 121

Particle Swarm Optimization for Blind Audio Source Separation

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Abstract: Blind Source Separation (BSS) is a fundamental technique for disentangling mixed signals of various types, including speech, biomedical, and telecommunication signals. Such signals are often subject to mixing processes, making separation essential to recover the original sources for effective exploitation. In this work, the BSS problem is formulated as an optimization task, where the Particle Swarm Optimization (PSO) algorithm is employed to minimize a fitness function constructed from mutual information and kurtosis. To evaluate the approach, speech signals of 5 and 10 seconds in both Arabic and English were randomly mixed using a predefined mixing matrix. Experimental results demonstrate that, by leveraging the ratio between kurtosis and mutual information, the PSO algorithm successfully separated the mixed signals, achieving a Signal-to-Noise Ratio (SNR) exceeding 38 dB for both languages.

Paper ID : 122

Motor Imagery Tasks Identification using SWLFCC Features with Different Electrodes Configurations

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Abstract: Motor imagery tasks identification play a central role in the brain computer interface (BCI) technology. The BCI technology aims to help disable people to perform some daily tasks without difficulty. Due to the nature of the electroencephalogram EEG signals (non-stationary, non-linear), the motor imagery tasks identification in term of accuracy is still challenging researchers. In this work, four motor imagery tasks, from the BCI Competition IV 2a dataset, are identified by the support vector machine (SVM) classifier using surface EEG signals. The EEG signals are monopolar signal detected using the 10-20 system. The SVM classifier is fed by the shifted and weighted linear frequency cepstral coefficients (SWLFCC). Before computing the SWLFCC features, signals resulting from different electrodes configuration are weighted in order to get more representative signals. Both weighting signals and the SWLFCC are optimized by Genetic Algorithm (GA). This study revealed the outperforming of the modified normal double difference (MNDD) configuration. Obtained results were satisfied compared to the existing methods.

Paper ID : 124

Face Recognition Enhancement through Triangle-Based Background Removal and Statistical Feature Analysis

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Abstract: Face recognition remains a challenging problem due to variations in background, illumination, and facial expressions. This paper presents a lightweight face recognition framework that combines triangle-based background removal, statistical feature extraction, and a compact two-layer artificial neural network (ANN) classifier. The triangle masking method effectively eliminates irrelevant background regions, ensuring that feature extraction emphasizes the most informative facial areas. Simple statistical descriptors—mean, variance, and entropy—are employed to provide computationally efficient yet discriminative features. The system is evaluated on two benchmark datasets, ORL and Yale, under multiple train-test splits for robust performance validation. Experimental results show recognition accuracies of 97.6% on ORL and 96.8% on Yale, outperforming classical methods such as PCA, LBP, and DCT-based techniques, while achieving competitive results compared to recent deep learning models with substantially lower computational cost. These findings demonstrate that the integration of background removal and statistical features with a lightweight ANN offers an efficient and effective solution for real-time face recognition applications.

Paper ID : 125

Smart Materials for Smart Machines :Exploring Silicene NanoRibbons with DFT for future AI Devices

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Abstract: In this work, utilizing the ab initio Density functional theory DFT, we aim to study the impacts hydrogen H edge atom passivation on the stability and electronic properties of planar bare (without H- edge passivation) Silicene NanoRibbon (PLSiNRs) with armchair (PLASiNRs) edges on both sides. The obtained results show that H- edge passivation is a new approach to stabilize and open the band gap in planar armchair SiNRs, (PLASiNRs). This passivation transforms the bare PLSiNRs from metallic states to a nonmagnetic semiconductors with a band gap depend on their width. The band gaps of PLASiNRs–H present oscillatory behavior and can be classified into three branches Eg(3n +1) > Eg(3n) > Eg(3n +2), where n is an integer. Our results provide that edge passivation is a key issue to integrate PLASiNR-H in electronic devices like short ASiNRs field-effect transistors (FETs), which are integrated with Artificial Intelligence (AI) for applications like high-sensitivity biosensing and neuromorphic computing. These FETs serve as AI-powered sensors for early disease detection and enable more efficient AI processing through neuromorphic applications. The optical parameters show that The most dominant absorption peaks centered at 5.17eV for 7-PLASiNR-H and systems, respectively, indicate a high absorbance in the UV range, making them prospective nanomaterials for photovoltaic devices which is necessary for clean energy to power AI systems

Paper ID : 126

Space Vector Modulation for Three Phase Cascaded H-Bridge Inverter

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Abstract: This paper presents the Space Vector Pulse Width Modulation technique (SVPWM) for Multilevel Cascaded H-Bridge Inverter (CHB Inverter) with a Resistive-Inductive Load (R-L Load) and an equal DC voltage source. Cascaded H-Bridge Inverter generate a large number of voltage vectors and redundant switching states, it create a problem of computational complexity in multilevel inverter. A simple space vector pulse width modulation strategy is proposed to approximate the reference vector, and the calculation of dwell time becomes very simple. Space Vector Modulation has a, numbers of features; good utilization of the DC-link voltage, low current ripple, low harmonic distortion (THD) and reduce switching losses. A three phase multilevel cascaded H-bridge Inverter has been constructed, and simulation results are presented to verify the theoretical study of the system model.

Paper ID : 127

Multi domain autoencoder based health indicators construction for bearing remaining useful life estimation using ANFIS

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Abstract: Within mechanical systems, rolling-element bearings are foundational components that are vital yet vulnerable in rotating machinery. Estimating how these components will degrade over time by determining their remaining useful life is therefore crucial for interventions scheduling and improving overall systems reliability. Traditional reactive and preventive based maintenance strategies are often inefficient, leading to unplanned failures and to costly maintenance interventions. For these reasons, remaining useful life estimation representes a promising solution for predictive maintenance paradigm. Therefore, the development of robust prognostic methodologies for early fault detection and remaining useful life prediction is paramount, which reduce downtime and lower maintenance costs. This work suggests a data driven approach, using an autoencoder to construct reliables health indicators that can describe bearing's degradation process and an adaptive neuro fuzzy inference system as a predicting model for remaining usful life prediction. The proposed approach is validated XJTU-SY bearing dataset obtained from a run-to-failure experiment. The results demonstrates that the suggested method is a promising solution for prognostic field.

Paper ID : 129

Accurate Parameter Estimation of Li-Ion Battery Models using Enhanced Runge-Kutta Optimization

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Abstract: This paper introduces a novel enhancement to the Runge-Kutta Opti-mization (RUN) algorithm by integrating Lévy flight dynamics, termed Lévy-RUN, for high-dimensional parameter identification in lithium-ion battery models. The proposed algorithm addresses the challenges of optimizing 27 parameters using real experimental data, demonstrating superior accuracy, convergence speed, and robustness compared to state-of-the-art algorithms such as Tunicate Swarm Optimization (TSO), Salp Swarm Algorithm (SAM), Jellyfish Search, and Information-Optimization (INFO). Results indicate that Lévy-RUN achieves higher accuracy in parameter estimation, faster convergence, and improved robustness by leveraging Lévy flight's ability to escape local optima and explore complex search spaces efficiently. This advancement establishes Lévy-RUN as a potent tool for solving high-dimensional, non-linear optimization problems in energy storage systems.

Paper ID : 130

Integration of A* and RRT Algorithms for Quadcopter Navigation in 3D Environment

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Abstract: The increasing demand for autonomous Unmanned Aerial Vehicles (UAVs) in complex environments necessitates advanced path planning and robust control strategies. This work addresses the problem of efficient path planning and precise trajectory tracking for quadcopters operating in static 3D environments. Two prominent path planning algorithms, A-Star and Rapidly-exploring Random Tree (RRT), are designed and simulated in order to generate feasible paths in static 3D spaces. The simulation results demonstrated that both A-Star and RRT algorithms effectively generated collision-free paths; with A-Star excelling in optimality and admissibility while RRT prevailing in handling complex and high-dimensional spaces. In addition, the simulation results have shown the effectiveness of the A-Star and RRT algorithms in 3D path planning and the robustness of nonlinear controllers in trajectory tracking, thereby contributing significantly to the advancement of autonomous UAV navigation in complex environments.

Paper ID : 131

UWB Pulse Optimization with Linear Combination waveforms and Firefly Algorithm

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Abstract: In this work, we investigate the design of UWB pulse shapes, motivated by their promising capabilities in terms of secure operation and efficient spectrum utilization. To ensure coexistence with existing communication systems, UWB pulses must strictly comply with the emission mask imposed by the Federal Communications Commission (FCC). Simultaneously, it is desirable to maximize the energy distribution within the allowed spectral band, while respecting the technical constraints of the mask. To address this dual challenge, we introduce an optimal design strategy that relies on the linear combination of Spectrum-Shifted Gaussian Waveforms (SSGW) and employs the Firefly Algorithm as an optimization technique.

Paper ID : 132

Solar Water Pumping System Performance Evaluation, Using Artificial Neural Network

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Abstract: The aim of the study was to employ mathematical modeling in the analysis of a photovoltaic (PV) water pumping system, using as a case study the region of Khemis Meliana in Algeria in northwest Africa. System performance was optimized by considering the variation in solar irradiance level, ambient temperature, generated PV power, pump flow rate and head, and water demand for irrigation. The maximum power point tracking (MPPT) of the PV module was estimated from the I-V curve model. The performance equation that expresses the flow rate of the pump as a function of input power and the total head was modeled basedon the manufacturer’s performance curves using A feed-forward backpropagation network which is a supervised learning architecture of artificial neural networks. Results showed that an increase in irradiance intensity increased the pump flow rate. A higher head gave a lower flow rate, regardless of the change in solar irradiance intensity. The power excess was predicted monthly. This power can be further utilized for secondary applications. The PV water pumping arrangement model enables advance estimation of system outputs and allows for optimization and improvement in the performance and reliability, accounting for variation in solar irradiance level, different pump operating parameters, and the water demand for irrigation

Paper ID : 133

ECG denoising using statistical thresholding

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Abstract: A straightforward and effective approach for eliminating artifacts and random noises from electrocardiogram signals is introduced. This method leverages fundamental digital signal processing techniques, including : moving average filtering, median filtering, baseline wandering rectification, and peak detection. Through extensive simulations, we demonstrate that the introduced technique is significantly better than the conventional cited filters, positioning it as a strong competitor to the standard wavelet-based approach.

Paper ID: 134

Study of the Factors Influencing CFRP Structures Using a Coupled Numerical Approach

A. Zara, N. Fahem, A. Oulad Brahim, S. Khatir, I. Belaidi, R. Capozucca

Abstract: Recent advancements in artificial intelligence have significantly improved the optimization of multilayer composite structures. The main objective of this study is to investigate how geometric parameters, such as fiber orientation and number of layers, on the mechanical properties of CFFP (Carbon Fiber Reinforced Polymer) laminated composites with epoxy resin. A numerical model based on the Hashin damage criterion will therefore beimplemented under the ABAQUS environment to simulate the behavior of CFRP composites under bending load, to generate training data for an improved artificial neural network (IANN). Then, a hybrid E-JAYA-ANN optimization technique will be used to predict these properties during bending tests, and its results will be compared with those of the hybrid JAYA-ANN technique. The objective is to better understand the influence of geometric parameters on mechanical properties in order to optimize a better architecture of unidirectional fiber-reinforced laminated composites during the development phase.

Keywords: composite laminate; number of layers; fiber orientations; Hashin damage; optimization; E-JAYA-ANN.

Paper ID: 135

Optimization-Based Structural Health Monitoring of Steel Pipelines Using XFEM and Balancing Composite Motion Algorithms

Abdelmoumin Oulad Brahim , Noureddine Fahem , Abdeldjebar ZARA ,Samir KHATIR , Idir BELAIDI

Abstract: In this study, the extended finite element method (XFEM) is employed to model the mechanical response of high-strength API X70 steel pipelines. The numerical simulations focus on stress concentration values, which are subsequently used as input and output datasets for optimization. By incorporating variations in the number of composite layers and their orientations, the collected data are utilized within a Balancing Composite Motion Optimization (BCMO) framework to predict stress concentration under different design scenarios. The ultimate aim of this work is to enhance the accuracy and reliability of composite patch design for damaged pipelines. Furthermore, the study evaluates multiple optimization methodologies to identify the most effective strategy for achieving improved structural integrity, providing valuable insights for pipeline rehabilitation and long-term structural health monitoring.

Keywords: Structural Health Monitoring (SHM); Extended Finite Element Method (XFEM); API X70 Steel Pipeline; Stress Concentration; Composite Patch Design.

Paper ID: 136

ANN prediction model for the behavior of composite plates Under low-velocity impact using a parametric finite element approach

Noureddine Fahem , Abdelmoumin Oulad Brahim, Abdeldjebar ZARA , Samir KHATIR , Idir BELAIDI

Abstract: This work presents the use of Artificial Neural Networks (ANN) to predict the reaction force and displacement of composite plates subjected to low-velocity impact. The impact response of a composite laminate depends on several parameters, including stacking sequence, type of reinforcement, number of layers, fiber orientation, and impactor velocity. A sensitivity analysis conducted in a previous study identified the most influential factors affecting impact resistance. The numerical model was developed in ABAQUS, incorporating the Hashin damage criterion. Material properties of the reinforcements were extracted from experimental studies reported in the literature. The simulations, carried out using the Finite Element Method (FEM), were first validated and then employed to generate several case studies. The simulation results were subsequently combined with ANN in order to fit a predictive function capable of estimating the overall response of composite plates under impact loading. The results show that the ANN, trained on FEM-based data, is able to predict with satisfactory accuracy the reaction force and displacement of composite plates for different configurations of input variables.

Keywords: Composite material; Finite Element Method (FEM); Artificial Neural Networks (ANN); Hashin damage criterion.