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Editorial

Applied Artificial Intelligence for Sustainability

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1. Introduction

In the contemporary era, modern civilization is immersed in a technologically interconnected environment, where numerous applications within the digital ecosystem harness advanced artificial intelligence (AI) techniques. These applications address diverse challenges, ranging from refining search engines and integrating sophisticated facial recognition features on the web to deploying shape recognition algorithms in image processing. AI extends its influence into areas such as the application of pattern recognition methods in social networks and economic studies, as well as the utilization of complex behavioral engines that shape synthetic characters in computer-generated images for movies and video games.

The transformative potential of artificial intelligence resonates across a broad spectrum, influencing both corporate and domestic realms. This transformative power is underscored by predictions suggesting that AI will become a cornerstone of global economic contributions, exceeding the combined impact of economic powerhouses such as China and India. Forecasts also anticipate the widespread integration of AI across industries, with the expectation that, within the next decade, nearly every successful corporation will incorporate some form of AI to optimize and streamline their operations.

The unfolding narrative of AI presents a landscape in which technological advancements are poised to redefine and enhance various facets of human life, thus shaping the trajectory of industries and economies on a global scale. A recent study [1] has revealed that AI can be employed to conduct eco-friendly product sustainability analyses, providing designers and stakeholders with an innovative and comprehensive toolkit. This tool enhances sustainable design practices, paving the way for more informed and effective product development strategies in the realm of eco-friendliness.

This Special Issue was organized specifically to reflect upon the application of AI for sustainability and the latest research results achieved in these areas.

2. Special Issue Coverage

This Special Issue received 26 submissions, resulting in a 70% rejection rate and the acceptance of eight papers. Within these selected papers, diverse applications spanning image processing, indoor positioning systems, machinery health monitoring, solar panel detection, smart TV program recommendation, geological prediction, and logistics problem solving emerged. Noteworthy advancements include a teacher–assistant framework for enhancing the efficiency of an indoor positioning system, a novel group-sparse feature extraction method for machinery fault diagnosis, and a Multiscale Feature Attention Framework addressing challenges in geological prediction. Additionally, breakthroughs in emotion classification were achieved via the use of a hybrid feature extraction model, showcasing the multifaceted impact of applied artificial intelligence on sustainability across various

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domains. The comprehensive analysis of vehicle routing problems with time windows revealed current trends and methodologies, setting the stage for the evolution of solutions in sustainable logistics. These diverse contributions collectively emphasize the transformative potential of AI in addressing real-world challenges and fostering sustainability across multiple disciplines.

In an exploration of innovations in digital image processing, Pawar et al. [2] delve into the complexities of image contamination caused by various factors such as atmospheric conditions and device limitations. By employing advanced image processing techniques, these researchers emphasize the crucial significance of accurate noise detection for subsequent restoration. The narrative unfolds with the introduction of cutting-edge methods, including filtering techniques, fractional differential gradients, and machine learning, showcasing a reliance on image content and spatial domain information. Within the realm of deep learning, a Convolutional Neural Network (CNN) emerges as a key player; this is implemented within the Proposed System Architecture (PSA) to detect and classify noise with an impressive 99.25% accuracy. Beyond its technological advancements, this study extends its impact to mural art recovery, contributing significantly to the interdisciplinary field of applied artificial intelligence for sustainability.

In the domain of indoor positioning systems, which are crucial for precise object and user location, convolutional neural network-based technologies have emerged as pivotal devices, promising high accuracy albeit at the expense of computational demands. To address the challenge of deploying such systems on resource-constrained devices, knowledge distillation emerges as a viable solution. This innovative paper by Mazlan et al. [3] introduces the teacher–assistant framework, bridging the gap between powerful yet computationally demanding CNNs and simpler counterparts. By facilitating the transfer of knowledge through an intermediate network, the framework remarkably reduces positioning errors in smaller networks; this provides a significant leap toward sustainable and efficient indoor positioning solutions.

Regarding machinery health monitoring, the diagnosis of wind turbine faults necessitates the extraction of weak fault features from noisy measured signals. Addressing this challenge, a groundbreaking approach is introduced by He et al. [4]: a novel group-sparse feature extraction method employing an ensemble generalized minimax-concave (GMC) penalty. This method uniquely tackles the issue of isolating large useful magnitude values as features in the original GMC-based sparse feature extraction technique. Through the formulation of an effective unconstrained optimization problem and the incorporation of a group-sparse structure into non-convex regularization, the proposed method strives to accurately estimate fault features. The validation of its efficacy is demonstrated through both simulated and experimental fault diagnosis cases, showcasing its potential significance in advancing applied artificial intelligence for sustainability in the field of machinery health monitoring.

The focus shifts to enhancing the efficiency of snow-covered solar panel detection for optimal photovoltaic system restoration. The study by Al-Dulaimi et al. [5] employs five deep learning models, including VGG-16, VGG-19, RESNET-18, RESNET-50, and RESNET-101, to classify solar panel images under various conditions. Two classification cases, one on the original dataset and another simulating extreme climate conditions, are conducted to analyze the performance. Additionally, a region-based convolutional neural network (RCNN) detector is employed for the detection case, categorizing solar panels into all_snow, no_snow, and partial. The proposed blind image deblurring algorithm (BIDA) proves to be a significant preprocessing step, as the CNN-based BIDA-CNN model outperforms other evaluated models; this emphasizes the potential utilization of advanced AI applications in sustainable energy management.

The escalating adoption of smart home technology worldwide has led to a surge in the use of smart appliances, with smart television (TV) emerging as a prominent example embedded with advanced technology. While the interest of users in TV programs has garnered attention, the automatic recommendation of programs between users remains

an underexplored domain. The existing literature on recommendation systems for smart TV users lacks a comprehensive discussion on the leveraging of the smart TV camera module to capture and validate user images to personalize program recommendations. Dudekula et al. [6] introduce a novel approach: a convolutional neural network (CNN)-based personalized program recommendation system for smart TV users, trained on datasets for feature extraction and human face detection. The proposed hybrid filtering technique achieves approximately 85% and 81% accuracy from single-user and multi-user perspectives, respectively, thus outperforming conventional content-based and collaborative filtering methods and showcasing its potential impact on enhancing the user experience in the realm of applied artificial intelligence for sustainability.

In the evolving landscape of geological and metallogenic prediction, the integration of deep learning algorithms and image processing technology has emerged as a key frontier. However, challenges such as the scarcity of trainable image samples, small and irregular geological image features, and the complexity of calculating the influence of prospecting factors on ore mineralization persist. Addressing these issues, Gao et al. [7] introduce a Multiscale Feature Attention Framework (MFAF) based on geoimage data; this features the MFCA-Net module to alleviate the scarcity of mine label images and the SE-Net module to quantify the varying influence of different source factors on mineralization. The MFAF model, applied to identification and prediction of deposits in the southern section of the Qin-hang metallogenic belt, yields promising results, highlighting areas with significant metallogenic potential. This innovative approach not only outperforms existing methods in predicting prospecting target areas, but also enhances predictions in samples with known mines. The multi-scale feature fusion and attention mechanism presented herein offer a novel perspective for geologists interested in mineral exploration, providing the guarantee of resources and technical support for the sustainable exploitation of mineral resources and the enduring growth of society and the economy.

In the domain of logistics and transport, Vehicle Routing Problems with Time Windows (VRPTW) have emerged as focal points due to their crucial role in real-life scenarios. The study by Liu et al. [8] aims to tackle the intricacies of multi-constrained and multi-objective VRPTW-related problems in order to contribute to effective solutions. Following PRISMA guidelines, the study presents a comprehensive analysis of the literature published in the past five years (2018–2022). The findings reveal that approximately 86% of the algorithms in the literature are approximate methods, with a prevalence of meta-heuristics over heuristics. In addition, nearly 40% of the studies employ hybrid methods by combining two or more algorithms. This exploration not only sheds light on the current landscape of VRPTW problem-solving approaches, but also sets the stage for advancing applied artificial intelligence for sustainable logistics solutions.

The understanding of human emotions plays a crucial role in enhancing human–computer interaction systems, thus contributing to effective decision making within organizations. Ahanin et al. [9] address the challenges associated with emotion classification within natural language processing applications by introducing a hybrid feature extraction model. Unlike previous studies relying solely on deep learning models, this approach combines human-engineered features with deep learning features, leveraging Bidirectional Long Short-Term Memory (Bi-LSTM) and Bidirectional Encoder Representation and Transformer (BERT). By integrating data augmentation, capturing contextual information, and incorporating knowledge from lexical resources, the proposed model achieves the highest Jaccard accuracy on benchmark datasets, thus emphasizing the significance of hybrid features in improving the performance of baseline models and advancing the applicability of artificial intelligence in understanding and responding to human emotions.

3. Final Remarks

In conclusion, the exploration of innovations in digital image processing, indoor positioning systems, machinery health monitoring, solar panel detection, smart home tech-

nology, geological and metallogenic prediction, and logistics and transport presented in this collection of papers reflects the diverse applications of applied artificial intelligence for sustainability. Researchers have addressed challenges, proposed groundbreaking methods, and showcased the potential impact of advanced AI technologies in various domains. The curated papers are expected to benefit stakeholders, including researchers, practitioners, and industries, who are seeking to apply AI to sustainability. With the success of this Special Issue, we anticipate the opening of a second edition to facilitate the publication of recent findings regarding the utilization of generative AI for sustainability by the broader community.

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Conflicts of Interest: The authors declare no conflicts of interest.

List of Contributions

The following papers are included in our special issue and are listed based on their publication date in ascending order:

1. Deep Learning Approach for the Detection of Noise Type in Ancient Images [2]
2. Teacher-Assistant Knowledge Distillation Based Indoor Positioning System [3]
3. Group-Sparse Feature Extraction via Ensemble Generalized Minimax-Concave Penalty for Wind-Turbine-Fault Diagnosis [4]
4. Performance Analysis of Classification and Detection for PV Panel Motion Blur Images Based on Deblurring and Deep Learning Techniques [5]
5. Convolutional Neural Network-Based Personalized Program Recommendation System for Smart Television Users [6]
6. Intelligent Identification and Prediction Mineral Resources Deposit Based on Deep Learning [7]
7. A Systematic Literature Review of Vehicle Routing Problems with Time Windows [8]
8. Hybrid Feature Extraction for Multi-Label Emotion Classification in English Text Messages [9]

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