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Thematic Section:

Advances in Pattern Recognition

This thematic section of Computación y Sistemas (CYS) contains a selection of seven papers presenting advances in the field of Pattern Recognition (PR). Pattern recognition is a branch of computer science focused on the study of algorithms and methodologies for identifying patterns within data. It encompasses the development of computational models and techniques that enable machines to recognize regularities, structures, or trends in diverse datasets. This field plays a crucial role in applications such as image and speech recognition, natural language processing, and machine learning, contributing to advancements in automation, decision-making, and artificial intelligence systems.

The guest editors meticulously curated the seven papers featured in this thematic section. Each manuscript underwent thorough evaluation by a minimum of three members of the scientific committee. Reviewers assessed various aspects such as originality, contribution to the field, soundness, and technical quality in determining the acceptance of a paper. Subsequent paragraphs offer an overview of the papers comprising this volume.

Velázquez-Arreola et al. evaluate the information heat maps provide and how they relate to the morphological characteristics of blood components in acute lymphoblastic leukemia. After considering four convolutional neural network (CNN) models to classify unsegmented images, they generated the respective heat maps with the LRP (Layer-wise Relevance Propagation), Deep Taylor, Input*Gradient, and Grad-Cam methods. They got the best results with the GoogleNet model and the Grad-Cam method, which were the ones that best related the natural morphological characteristics of the cell with the heat maps, reaching a good percentage of relevant pixels within at least one cellular morphological feature present, locating the most critical pixels within the nucleus.

Fortuna-Cervantes et al. present an analysis of the performance of three different CNNs with transfer learning for Art Media Classification (AMC) to answer the question of what challenges arise in this application. The authors introduced the Art Media Dataset (ArtMD) to train the CNNs. ArtMD contains five classes of art: Drawing, Engraving, Iconography, Painting, and Sculpture. Their results demonstrate that all the tested CNNs exhibit similar behavior. However, Drawing, Engraving, and Painting had the highest relationship, showing a strong relationship between Drawing and Engraving. Then, they removed Drawing and Engraving. By eliminating Drawing, they got the best performance. The experiments allowed them to conclude that Drawing and Painting have the lowest accuracy, showing a solid misclassification with the other classes. They also discussed the degree of relationship between the three CNN models and detailed AMC's challenges.

Molefe et al. introduce a multi-stage graph embedding approach for road-type classification tasks. The methodology involved deriving road segment feature vectors by extracting relevant edge and node attributes from the road network graph. Graph embedding techniques were employed to acquire the embedded vector representation of a designated road segment. The proposed method demonstrated superior performance to existing state-of-the-art methodologies addressing the Linkoping Road network dataset tasks. The authors compared the proposed method against alternative approaches that use raw features and different graph embeddings as input, in contrast to the deep autoencoder representation in this paper. The results show that using the DAE embedding method to obtain compact road segment features significantly improves the performance of graph embedding methods for road-type classification tasks. This work contributes to advancing intelligent road network systems, offering potential applications.

Luna-Lozoya et al. propose a lightweight CNN for detecting MicroCalcifications Clusters (MCCs) in digital mammograms using a reduced number of parameters (only 8301), which helps radiologists to accurately detect MCCs that plays an important role in early identification of breast cancer. This proposal constitutes a practical, efficient and effective solution for MCCs detection, requiring low computational resources. The proposed lightweight CNN achieves competitive results with more complex models like LeNet-5 and MobileNetV2; reaching an accuracy of up to 99.3%, but requiring much less parameters than these models. Currently a software application implementing the proposed model to detect MCCs in digital mammograms is being evaluated by expert radiologists. This research contributes to facilitate the practical use of Artificial Intelligence techniques for medical applications.

Torres-Rodríguez et al. conduct a comparative evaluation of various averaging methods for evoked potential estimation using realistic simulations. Simulated signals are crucial for assessing pattern recognition algorithms in the absence of gold standard records. The simulations are deemed realistic by introducing variations in potential latency, width, and amplitude, while background noise is simulated using an 8th order Burg autoregressive model derived from real auditory evoked potentials data. The simulations also incorporate actual instrumentation and acquisition channel effects, along with power line interference. Three averaging methods—consistent average, weighted average, and reported average—are compared in scenarios with and without artifacts. Results indicate that the trimmed average strikes the best balance between estimated signal-to-noise ratio (SNR) value and bias, particularly in the presence of artifacts.

Arevalo-Ancona et al. introduce a zero-watermarking scheme for medical image authentication using a Context Encoder neural network model. This approach enhances image reconstruction and robustness by extracting unique features, employing a halftone image of the patient's face as a watermark for identification. Extensive experiments demonstrate the method's resilience against various attacks, including geometric transformations and image processing manipulations, with low bit error rates and high normalized cross-correlation values confirming reliable watermark retrieval. The use of a large watermark size (160 x 160 pixels) facilitates easy patient identification, contributing to quick and accurate verification in medical applications. The deep neural network further improves the robustness, efficiency, and versatility of the proposed zero-watermarking scheme, making it a practical and effective solution for securing and authenticating medical images.

Garibaldi-Márquez et al. propose a two-stage deep learning approach for early weed detection in agriculture, addressing the challenge of uncontrolled conditions. Using a UNet-like architecture for image segmentation and ResNet101, VGG16, Xception, and MobileNetV2 for classification, the method achieves robust results, with a Dice Similarity Coefficient (DSC) of 87.48% and a mean Intersection over Union (mIoU) of 78.17% when images are divided into patches. Xception demonstrates the best classification performance with 97.43% accuracy. Despite confusion in segmenting and classifying specific plant classes, the approach proves advantageous for practical use in natural field conditions.

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