

Deep Learning Approaches for Image Classification and Recognition

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Abstract

The rapid development of artificial intelligence has significantly advanced the field of computer vision, particularly in image classification and recognition. Deep learning techniques, especially Convolutional Neural Networks (CNNs), have demonstrated remarkable capabilities in automatically extracting complex features from images and achieving high classification accuracy. This paper presents an overview of deep learning approaches for image classification and recognition, focusing on the architecture, training process, performance evaluation, and practical applications of modern deep neural networks. The study examines the role of CNN-based architectures and transfer learning techniques in reducing feature-engineering requirements and improving model performance across diverse image datasets. Key factors influencing classification performance, including dataset quality, image preprocessing, model architecture, hyperparameter selection, data augmentation, and computational resources, are also discussed. Furthermore, the paper highlights applications of deep learning-based image recognition in healthcare, autonomous vehicles, security and surveillance, agriculture, industrial inspection, and biometric identification. Despite significant progress, challenges such as limited labelled datasets, class imbalance, computational complexity, model overfitting, and the interpretability of deep learning models remain important research concerns. The paper emphasizes the potential of transfer learning, attention mechanisms, and lightweight neural network architectures for developing efficient and scalable image recognition systems. Continued research in these areas can improve the accuracy, robustness, computational efficiency, and practical deployment of deep learning models for real-world computer vision applications.

Keywords: Deep Learning, Image Classification, Image Recognition, Convolutional Neural Networks, Computer Vision, Transfer Learning, Artificial Intelligence, Neural Networks