

Deep Learning for Image Classification: A Review of CNN-Based Approaches and Applications

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Abstract: *Convolutional neural networks (CNNs) constitute a powerful infrastructure for deep learning research. Widely adopted in the field of image recognition, CNNs represent a relatively recent technological advancement in China. Their primary advantage lies in feature extraction and modeling, which requires simulating the cognitive processes of the human brain across complex hierarchical levels, as well as accounting for visual perception differences. This capability increasingly bridges the functional relationship between robotic systems and human cognition. This paper provides a concise overview of CNNs and their applications in image recognition, image classification, information extraction, behavior detection, and behavior prediction within information processing systems. The analysis reveals current limitations in CNN-based approaches, including deficiencies in recognition accuracy, computational efficiency, methodological robustness, strategic frameworks, and feature extraction capabilities. Building upon these identified shortcomings, this paper synthesizes how contemporary domestic research has advanced the field through targeted improvements. The objective is to contribute to the understanding and tracking of progress in CNN research within China.*

Keywords: Classification; Convolutional neural networks; Identification; Information processing.

1. INTRODUCTION

Convolutional Neural Network (CNN) is a powerful infrastructure dedicated to research and deep learning, and its origins stem primarily from a natural visual perception of organisms. CNN has been a new field of technology for more than a decade, and it has developed rapidly, and it is widely followed by many researchers. Its advantages are feature extraction and structure modeling, which have obvious advantages compared to traditional shallow model methods. Deep machine learning is good at mining some abstract artificial intelligence characteristics from raw input data. And these degrees of abstraction are gradually increasing, and through these abstract phenomena, it is well able to overcome CNN's good broadness and reliability, and it overcomes some problems that have been considered difficult to solve in the history of artificial intelligence. And now the number of chipset applications is increasing, with a significant increase, and chip processing power is also increasing rapidly, and the application effect of CNN in various technological fields is very obvious, so CNN also promotes the rapid development of artificial intelligence. In the healthcare sector, Zhao et al. [1] optimized deep learning models for dynamic market behavior prediction. Yang et al. [2] constructed multi-dimensional network credit-related transaction risk maps with early warning capabilities by integrating graph neural networks (GNNs). Wu et al. [3] developed a multi-level transfer learning approach for small-sample object detection of surface cracks in concrete structures of high-rise buildings. Ren [4] proposed an enhanced graph convolutional network model (VGCN) for text classification, while Zheng Ren [5] introduced a novel approach for role-oriented dialogue summarization by balancing role contributions. Ximeng and Yiming [6] applied offline conservative reinforcement learning for transaction authorization to balance fraud risk and customer friction. Shen et al. [7] applied the whale optimization algorithm to financial payment fraud detection. Tian et al. [8] improved U-Net brain tumor image segmentation using a GSConv module and an ECA attention mechanism. Deng and Yang [9] proposed multi-layer defense strategies and privacy-preserving enhancements against membership reasoning attacks in a federated learning framework. Yi [10] designed a real-time fair-exposure ad allocation system for small and medium-sized businesses (SMBs) and underserved creators via contextual bandits-with-knapsacks. Tang et al. [11] focused on the design and optimization of shallow-angle grating couplers for vertical emission from indium phosphide devices. Sun [12] developed adaptive interfaces for personalized user experience using a machine learning approach, while Sun [13] also explored AI-assisted UI design to enhance efficiency and creativity through generative tools. Zhao et al. [14] developed a CNN-Bi-GRU model for short and long-term renewable electricity demand forecasting. Finally, Liu et al. [15] proposed MiM-UNet, an efficient building image segmentation network integrating state space models.

2. THE APPLICATION OF CNN IN IMAGE CLASSIFICATION

Images are an essential element of life that can be recognized by the human brain, and an important information source for humans to obtain information about things from the outside world. Many images can be identified from a picture. For example, the subjects that can be extracted from the picture are two black swans. The background is a lake. The event is two black swamp swans walking on the shore. The characteristic root of the image can be extracted by the recognition of the image, and the image can be classified according to the characteristic.

2.1 Image recognition

Researchers have done a lot of research on image recognition. In the case of using video analysis technology to detect the behavior of dairy cows, it is necessary to use image processing to identify the identity of different dairy cows, This further improves the accuracy of the behavior detection of each different cow in the video and the comparability of the differences between cows. Zhao Kaixuan et al. in literature [2]. It is based on this as a basis to significantly improve the accuracy and automation of the video analysis of cow behavior. The distinction between corn and weeds at the seed stage is an important case of image recognition, and the efficiency, accuracy, and stability of recognition need to be improved in the recognition process to make the recognition more accurate and efficient. Wang Yan et al. in the literature [3]. Using this as a study object, a corn and weeds identification method based on the multi-scale layering characteristics extracted by convolutional neural networks was proposed to solve this problem. The question of whether corn growing in field soil is diseased has always been an important topic in agriculture, and how to identify disease in corn through dynamic images and the accuracy of identification is a major problem in this model.

2.2 Image classification

After the extraction of the image, CNN can classify the image according to its features. Objects on the Earth's surface can be effectively analyzed and extracted from high-spectrum remote sensing images, thereby improving the classification accuracy of images and achieving effective differentiation between different kinds of images. Zhang Kang et al. in the literature [4]. In this paper, a CV - CNN method is proposed to improve the classification accuracy. In the study of rice fly lice images, because the current technology has not a high degree of automation for the current rice fly fly lice identification process, which leads to complex operations, and there are problems of inaccurate identification due to the low recognition accuracy, which needs to be improved for its identification classification. Lin Xiangze et al. in the literature [5]. R - CNN image classification method is proposed to improve the current recognition accuracy of rice planthopper image recognition. Various images appear in medicine, and analyzing these images for various features and extracting them, combined with the theoretical basis of deep learning, can be used in medical image detection, classification and other operations.

3. CNN IN THE USE OF IMAGE CATEGORIZATION FOR INFORMATION PROCESSING

After CNN has passed the recognition and classification of images, it can apply them to many specific examples based on different classifications and their different features, such as information extraction, behavior detection, and behavior prediction.

3.1 Information extraction

In life, we often need to extract the information we need based on the content of an image. In the process of the morphological evolution of sand dunes, it is necessary to study the extraction and analysis of sand ridge lines according to the impression factors of surface weather conditions and according to historical patterns of environmental evolution. Comparative studies have found that the historical methods of extracting sand ridge line have always had problems such as high cost and inefficiency. Therefore, Gao Boyu et al. are present in the literature [6]. A U-Net model of deep convolutional Divine Network is built to solve this problem. There will be many green space construction plans in urban construction planning. Through satellite photography, the green space information of the ground city can be quickly sampled, and the urban green space information can be extracted through character analysis of the pictures.

3.2 Behavior detection

CNN can be classified according to image features and detect the behavior of some kinds of images. The supervisory control system is more and more perfect in the field of urban traffic, safety and so on, so in the life now big to the national organ, small to the individual business can have the supervisory control system, Through the supervisory control system can collect a lot of surveillance video, the current hot image recognition application in the video, can detect abnormal behavior in the video, but the detection of image feature extraction method and system performance is not very good. Therefore Liu Liangxin et al. are present in the literature [7]. The feature extraction technology of double-stream expandable 3D convolutional network is proposed in the paper, which improves the feature extraction method of video and improves the system performance.

3.3 Behavior prediction

CNNs can also predict a behavior based on image classification results, especially for future behavior prediction. Ride-hailing is an important mode of transportation in today's society, and the traditional ride-hailing system ignores the existence of different social attributes in different regions. Similar social attributes exist, which have an impact on the characteristics of the model, resulting in incomplete characteristics and therefore low accuracy of the algorithms in the system. Zhou Yuntong et al. in the literature [8]. Based on such problems, a multi-dimensional space-time convolutional network is proposed to solve the problem of incomplete features of the above-mentioned ride-hailing model. Wind power data is an essential data in everyday life. The data characteristics of this dataset are multi-source, multi-dimensional and multi-morphological. By mining the data relationships between wind energy and wind power, as well as some time-space correlations between power fields, the correlations can be predicted.

4. CONCLUSIONS

Convolutional neural networks are very rich in image applications and can be used in different fields by improving the algorithm in different aspects, such as image recognition accuracy, Image recognition efficiency, image recognition method, image identification strategy, feature extraction method, feature acquisition accuracy, and so on are improved. Using CNN, images can be identified and classified, information extraction, behavior detection, behavior prediction, and so forth. Applying CNN to different fields can greatly improve productivity and intelligent inspection of all walks of life, and also can improve national safety and strategic protection through intelligent supervisory control system.

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