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NETWORK CLASSIFIER FOR IMAGE RECOGNITION

Kashish Mirza
Graphic Era Hill University,
Bhimtal, India
kashishmirza99@gmail.com

ABSTRACT
Image recognition is a fundamental task in computer vision that entails mapping visual data to discrete labels. In this report, we survey different network classifiers for image recognition, evaluate several case studies, and discuss ethical considerations surrounding their deployment. We focus on convolutional neural networks (CNNs), traditional machine-learning classifiers such as support vector machines (SVMs) and random forests, and illustrate their strengths and weaknesses through empirical studies. We also highlight ethical issues—including bias, data privacy, transparency, autonomy,and accountability—that must be addressed when deploying these models.

INTRODUCTION

Image recognition is a field of vision that has proven to be very useful in many instances
such as recognizing handwriting and faces, diagnosing diseases, and making self-driving cars safe. The present methods are mostly dependent on neural networks that mimic the human brain, especially convolutional neural networks (CNNs), which are a type of deep neural network developed for data with a grid layout like images. CNNs automatically learn the spatial resolutions of their input; the first layers find edges and basic features, while the last layers determine more complex features like figures and objects. Some of the early CNNs are LeNet which was the first to do handwritten digit recognition with around 60000 parameters, AlexNet which used deep convolutional layers and non-saturating ReLU activations to win the ImageNet competition, and VGG-16 which uses 3×3 convolutions and 16 weight layers with a total of about 138 million parameters. Other machine-learning classifiers like support vector machines (SVMs) and random forests treat image classification as a problem of feature extraction and flattening, followed by the application of a decision boundary or ensemble of decision trees. SVMs work by finding a hyperplane that maximizes the margin between classes, while random forests create many decision trees from randomly selected data and features and then combine their votes to get higher accuracy and lower errors. Although these traditional classifiers are very good on small or tabular datasets, deep CNNs usually can do better on complicated image recognition tasks because of their capacity to use spatial hierarchies.
Below, Figure 1 presents a simplified CNN framework and the flow of images through convolution, pooling, flattening and fully connected layers to get an output.
Simplified CNN architecture

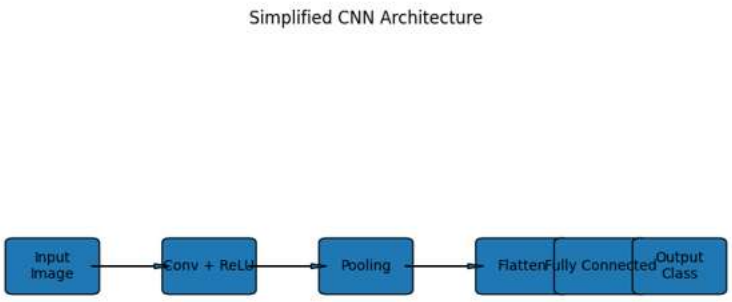

Figure 1: Simplified CNN architecture.

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Sources

To gain in-depth knowledge of the network classifiers landscape for image recognition, we have reviewed various recent journal articles. A paper published in *Soft Computing* in 2023 presented the convolutional neural network recognition algorithms and asserted that CNNs have been utilized for target detection, image recognition, and sound recognition. The article points out that single-machine implementations may experience lengthy training times and limited memory; thus, the solutions proposed are acceleration methods and real-time algorithms. An article by Atharva Hemant Patil provides instructive material on CNNs and mentions classic architectures such as LeNet, AlexNet, and VGG. Another *Medium* article points out the differences between SVMs and CNNs, describing SVMs as supervised classifiers that find optimal hyperplanes to separate classes, while CNNs consider the images as input to convolutional layers and learn spatial hierarchies. The comparison also states that SVMs thus achieve approximately 98% accuracy on handwritten digit recognition, while CNNs reach about 99.12%, thus representing the slight but significant improvement made by deep networks. A conference paper recently presented an experimental comparison where SVM achieved 93% accuracy on a limited image dataset but dropped to 81% after data augmentation; applying a CNN increased accuracy to 94.57%. According to the GeeksforGeeks tutorial, the random forest algorithm is an ensemble of decision trees where each tree is trained on random subsets of the data and features; predictions are combined by majority voting to improve accuracy and reduce errors. Ethical considerations were primarily based on a detailed blog post by Codefinity that outlines bias, data privacy, transparency, autonomy, and accountability as the main concerns in deep-learning systems. The blog got more insights from an article on ethical AI in medical image analysis that points out that mislabeling or poisoning of training data can drastically change the performance of neural networks and thus stresses the importance of detecting label corruption.

Case Studies

Case Study 1: Fashion-MNIST Classification with *Multiple CNNs*

Fashion-MNIST is a well-known dataset that contains 70,000 grayscale images (size 28×28) of 10 different types of clothing. A research study conducted in 2022 compared the performance of several CNN architectures, including LeNet, AlexNet, ResNet18, MobileNet, EfficientNet, Vision Transformers (ViT), and custom multiple CNN models (MCNN) in classifying fashion items. Table 1 and Figure 2 below illustrate that deeper CNN architectures generally achieve higher accuracy. The best-performing model was MCNN15 with an accuracy of 94.04%, while the classical LeNet achieved 90.16%. MobileNet and EfficientNet offered competitive performance around 93.96% and 93.64% respectively. The work compared these findings with those of other methods such as SVM plus histogram of oriented gradients (HOG), which only reached 86.53% accuracy. These research results demonstrate the advantage of deeper CNN architectures and the downside of using traditional machine learning pipelines for complex image datasets.

Model	Accuracy%
Lenet	90.16
Alexnet	92.74
Resnet18	93.20
Mobilenet	93.96
Efficientnet	93.64
VIT	90.98
MCNN15	94.04
SVM	98.00 (MNIST)
CNN	99.12 (MNIST)

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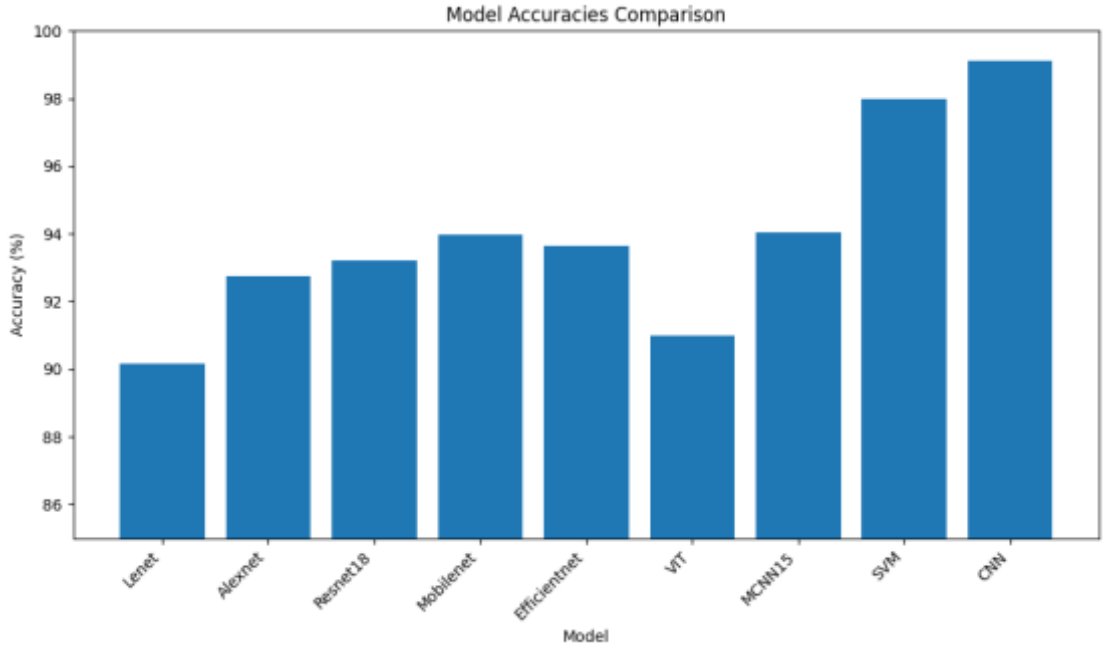

Model accuracies comparison

Figure 2: Comparison of model accuracies on the Fashion-MNIST dataset and related tasks.

Case Study 2: Handwritten Digit *Recognition — SVM vs CNN*

The MNIST dataset of handwritten digits (70,000 images of 28×28 pixels) has long been used as a standard benchmark for testing the performance of machine learning models. A recent tutorial on SVM classifier training using pixel value flattening demonstrated that the SVM achieved 98% accuracy and also showed high precision and recall for all digits. A deep convolutional neural network trained on the same set of data attained a slightly better accuracy of 99.12%, thereby proving the merit of spatial hierarchies. The difference is very small, but it is of great importance in areas where almost perfect recognition is required, such as postal sorting or bank check processing. The SVM algorithm can still be a strong competitor under circumstances involving limited data and when the main concern is training time or interpretability.

Case Study 3: Limited-Data Classification

Sumit Pandey and Priya Mishra (2025) performed experiments on a small image dataset with limitations in computational resources. Their initial SVM classifier managed to reach 93% accuracy; however, the accuracy dropped to 81% after data augmentation increased the training set size. They deployed a CNN to break the impasse, which resulted in a rise of accuracy to 94.57%, thus demonstrating the robustness of CNNs on a larger dataset. This research demonstrates how deep learning can facilitate better generalization when additional data are available, while traditional methods may have difficulties in scaling.

Ethical AI Considerations

The use of network classifiers in domains that are both sensitive and vital to human health, such as healthcare, finance, and public safety, calls for the consideration of ethical issues in their design and deployment. Bias and Fairness: Bias occurs when training data mirror past prejudices and are not sufficiently diversified, resulting in discriminatory decisions. For example, facial recognition systems may fail to accurately identify individuals from certain racial groups, or tools for predicting recidivism like the COMPAS algorithm may show racial bias. To alleviate bias, practitioners should build diverse datasets, use fairness-aware algorithms, and continuously monitor outputs. Data Privacy: Data of a personal nature collected for training AI models raise privacy concerns. Examples include healthcare AI systems that expose patient information or consumer data that leak private details. Ethical AI requires data anonymization, informed consent from data owners, and strict protocols for handling sensitive data. Transparency and Explainability: Many AI systems operate as “black boxes,” making it difficult for users to understand or trust their decisions. A lack of transparency in credit scoring or

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criminal justice applications can lead to biased or unfair outcomes. The adoption of interpretable models or post hoc explanations helps promote trust and accountability. Autonomy and Human Oversight: Ethical concerns arise when critical decision-making is handed over to AI without human supervision. For instance, autonomous drones or AI systems in healthcare may make life-and-death decisions. Human-in-the-loop oversight ensures that such decisions align with social and moral values. Accountability: Determining responsibility for AI-driven decisions is complex when multiple actors are involved. Self-driving car accidents, for example, raise questions about liability among manufacturers, developers, and owners. Clear legal frameworks and ethical guidelines are essential for assigning accountability. Scientists have identified ethical dilemmas directly related to image recognition. A 2025 paper on medical image analysis investigated the effects of mislabeled training data (label corruption) on different neural network architectures and found that each architecture responded differently to such corruption. Detecting and correcting label corruption is crucial to ensure trustworthy and fair performance.

CONCLUSION

The arrival of network classifiers has transformed the image recognition landscape by enabling machines to autonomously learn patterns and categorize visual data. Among them, convolutional neural networks can best explain and predict outcomes by capturing spatial hierarchies and achieving extremely high accuracies on various datasets, as shown in the case studies of Fashion-MNIST and MNIST. On the other hand, traditional classifiers like SVMs and random forests can still be useful for smaller or tabular datasets but generally fall short compared to deep neural networks when handling complex images. Factors such as data size, computational resources, and application requirements should be considered when choosing the appropriate architecture. Moreover, ethical issues—including bias, privacy, transparency, autonomy, and accountability—must be addressed to prevent negative outcomes and foster trust. Future research should focus on developing efficient architectures for resource-limited environments, reliable methods for detecting label corruption and adversarial attacks, and interdisciplinary strategies to embed ethical principles throughout the AI lifecycle.

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