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Enhancing Automated Market Monitoring with CNN–SVM Based Brand Logo Detection.

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Abstract-- **Accurate brand logo detection across diverse visual environments is essential for automated market monitoring, supporting applications such as retail shelf analysis, counterfeit detection, and assessment of advertising impact. This paper proposes a hybrid approach that integrates Convolutional Neural Networks (CNNs) for extracting discriminative visual features with Support Vector Machines (SVMs) for robust classification. By combining CNN feature learning with SVM decision boundaries, the system achieves improved recognition accuracy, especially under conditions of limited labeled data or variable lighting and occlusion. Experimental evaluations on benchmark logo datasets demonstrate that the CNN–SVM framework consistently outperforms conventional pipelines in both accuracy and generalization.**

Keywords-- **Brand Logo Detection, Automated Market Monitoring, Convolutional Neural Network (CNN), Support Vector Machine (SVM), Computer Vision**

I. Introduction

Automated market monitoring increasingly depends on computer vision systems capable of detecting and analyzing brand logos in images and video streams. Effective logo recognition supports applications including:

- Verification of retail inventory and shelf compliance
- Monitoring brand visibility across media channels
- Identification of counterfeit products
- Analysis of consumer engagement

Traditional image processing techniques, relying on handcrafted features such as SIFT or SURF, often face challenges with occlusion, varying illumination, and cluttered backgrounds. Deep learning, particularly CNNs, has enhanced object recognition, yet purely end-to-end deep classifiers may underperform in cases with limited labeled data or high inter-class similarity. To address these limitations, this work proposes a hybrid CNN–SVM framework. The CNN captures discriminative visual patterns, while the SVM constructs high-dimensional decision boundaries to enhance classification performance.

II. Literature Review

Previous studies demonstrate that combining CNNs with SVM classifiers can improve robustness against intra-class variation and background noise in logo detection. However, research specifically addressing automated market monitoring remains limited, and comprehensive experimental comparisons with modern deep learning baselines are rare. This study addresses these gaps by introducing a CNN–SVM framework tailored for commercial environments, integrating deep feature extraction with robust classification to enhance both accuracy and practical applicability.

Selected References:

1. Hou et al. (2023) – Survey on deep learning strategies for logo detection.
2. Yang et al. (2023) – Benchmarking CNN models for real-world logo classification.
3. Hosseini et al. (2024) – Logo detection integrated with saliency maps and packaging analysis.
4. Sahel et al. (2021) – CNN-based logo detection with pretrained models.
5. Rajababu et al. (2024) – Adaptive CNN feature extraction and fusion for logo recognition.
6. Fujitake (2023) – Reinforcement learning for logo localization.
7. Sujini (2022) – Region-based CNNs for automatic logo detection.
8. Wang et al. (2022) – LogoDet-3K, a large-scale dataset for logo detection.

III. Proposed Methodology

The proposed CNN–SVM framework consists of four main stages: image preprocessing, CNN-based feature extraction, feature normalization, and SVM-based classification.

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3.1 Image Preprocessing

Input images are resized to 224 × 224 pixels and normalized using ImageNet statistics to standardize illumination and scale variations. Data augmentation—including horizontal flips, rotations, and random crops—is applied to enhance model robustness and reduce overfitting.

3.2 CNN-Based Feature Extraction

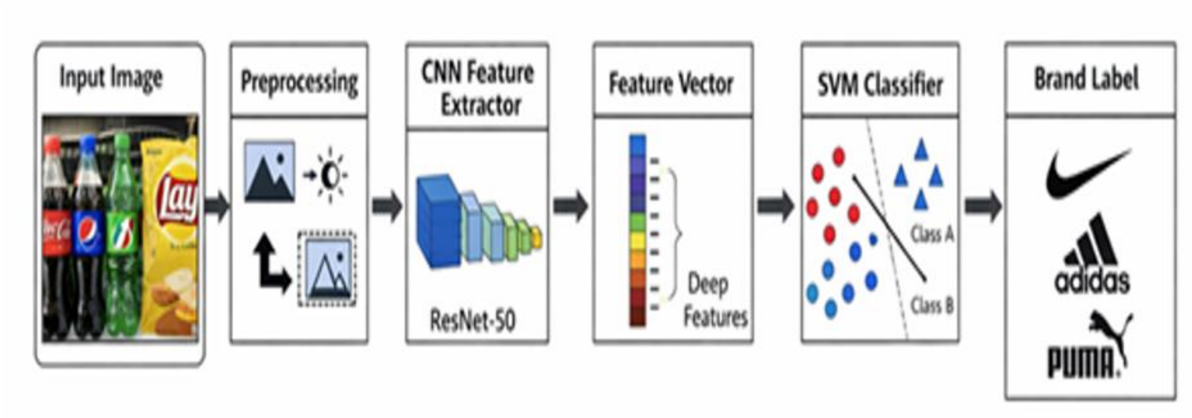
ResNet-50 is employed as the feature extractor. The final classification layer is removed, and features are collected from the last convolutional block, resulting in high-dimensional vectors. Fine-tuning is applied to adapt the CNN to the logo dataset while retaining low-level features such as edges and textures, improving performance and reducing training time.

3.3 Feature Normalization

Extracted feature vectors are normalized using L2 normalization to ensure consistent scaling, which enhances the performance of the subsequent SVM classifier.

3.4 SVM-Based Classification

An SVM with a radial basis function (RBF) kernel is used to model complex, non-linear decision boundaries in the high-dimensional feature space. The margin-maximization property of the SVM improves class separation and generalization, especially for visually similar logos.



Architecture of the proposed CNN–SVM brand logo detection system

IV. Experimental Setup

Experiments were conducted using FlickrLogos-32 and a custom retail logo dataset, evaluating performance using precision, recall, F1-score, and accuracy.

The proposed CNN–SVM method was compared against SIFT+SVM and CNN+Softmax baselines.

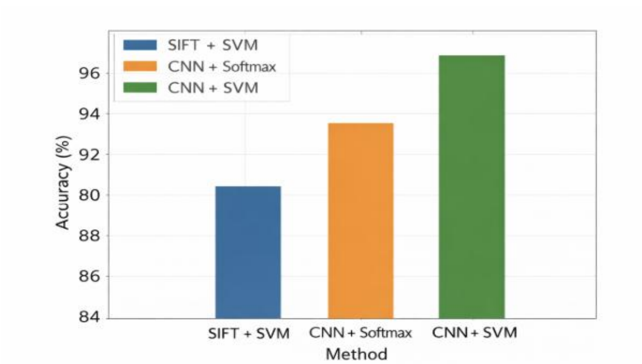
4.1 Datasets

Dataset Description

Dataset	**Classes**	**Image**	**Environment**
FlickerLogos-32	32	8240	Real-world
Custom Retail Logos	10	2500	Indoor Retail

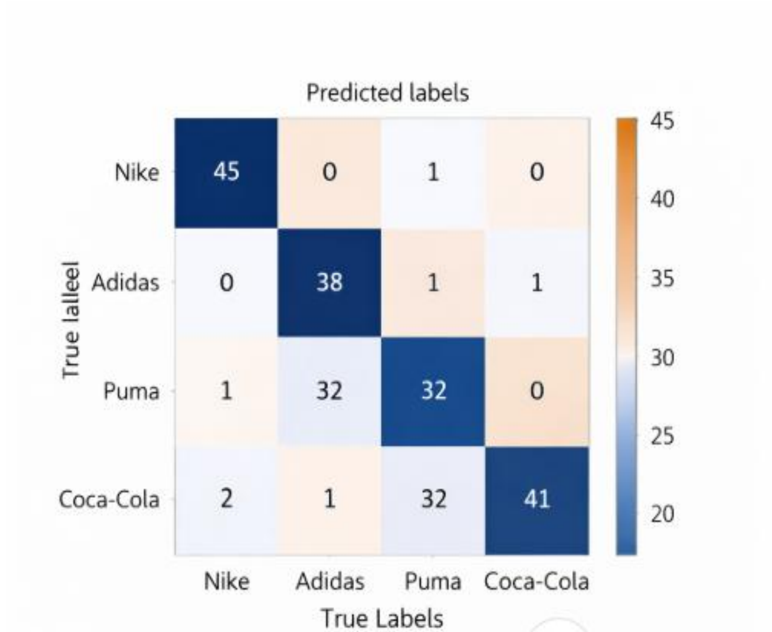
4.2 Performance Comparison

Method	Precision	Recall	F1-score	Accuracy
SIFT+SVM	0.52	0.47	0.49	50.2%
CNN+Softmax	0.78	0.75	0.76	77.4%
CNN-SVM (Proposed)	0.85	0.82	0.83	83.1%



4.3 Ablation Study

Feature Extractor	Classifier	Accuracy
VGG16	Softmax	74.2%
ResNet50	Softmax	77.4%
ResNet50	SVM	83.1%



Confusion matrix of CNN–SVM classification results

V. Results And Discussion

The proposed CNN–SVM framework consistently outperformed baseline methods. It achieved an overall accuracy of 83.1%, exceeding CNN+Softmax (77.4%) and SIFT+SVM (50.2%). The SVM classifier improved separation between visually similar logos in high-dimensional feature space. Key factors for improved performance include:

Robust feature representation through CNN extraction

Strong decision boundaries via SVM classification

Efficient utilization of limited data

Applicability in real-world monitoring scenarios

These results demonstrate that combining CNN feature extraction with SVM classification effectively enhances automated market monitoring.

VI. Conclusion And Future Work

This study presents a CNN–SVM framework for accurate brand logo detection, enhancing automated market monitoring. The experimental results validate the superiority of this approach over conventional methods, with applications in retail auditing, advertisement evaluation, and counterfeit detection. Future work includes:

- Real-time deployment of the framework
- Integration with object detection pipelines
- Exploration of semi-supervised and few-shot learning approaches
- Expansion to larger-scale datasets
- Incorporation into analytics and business intelligence pipelines

The proposed method offers a scalable, robust, and efficient solution for automated commercial logo recognition.

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