MDM Lab Asg2

Research Paper Details

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Title:

CIFAR-10 Image Classification Using Feature Ensembles by
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Objective

To classify images in the CIFAR-10 dataset by combining features from both manual (e.g., HOG, pixel intensities) and deep learning approaches (e.g., VGG16, Inception ResNet v2, CIFAR-VGG) to improve classification accuracy.

Methodology

1. **Datasets and Preprocessing:**
    - CIFAR-10 dataset with 10 classes (32×32 RGB images).
    - Data augmentation (horizontal flips) doubled the training data.
2. **Feature Extraction Approaches:**
    - HOG: Captures edge direction patterns.
    - Pixel Intensities: Raw flattened RGB values.
    - Transfer Learning Models:
        - TL-VGG16 (trained on ImageNet, fine-tuned on CIFAR-10).
        - TL-Inception ResNet v2 (fine-tuned on CIFAR-10).
    - CIFAR-VGG: Custom VGG-style CNN trained on CIFAR-10.
3. **Training Model:**
    - A fully connected neural network (FCNN) was trained using features from each method.
    - Early stopping and dropout were used to avoid overfitting.

Results:

Individual Feature Accuracies:

- HOG: 53%
- Pixel Intensities: 59%
- TL-VGG: 85%
- TL-Inception: 90.74%
- CIFAR-VGG: 93.43%

Feature Ensemble Performance:

- TL-VGG + HOG + Pixel (500 PCA components): **85%**
- TL-VGG + TL-Inception: **91.12%**
- **All 5 Features Combined (Top 1000 PCA components)**: **94.6%**
    - Slightly outperformed the benchmark CIFAR-VGG.

Observations:

- Different feature extractors (CNNs and manual) capture complementary information.
- Combining diverse feature sets leads to better classification than any single method.
- Even weak classifiers like HOG and raw pixels contribute when used in ensemble form.
- Transfer learning significantly boosts performance over using ImageNet weights directly.

Summary

The paper proposes improving CIFAR-10 image classification by combining features from manual methods (like HOG and pixel intensities) and deep learning models (VGG16, Inception ResNet v2, CIFAR-VGG).

Using transfer learning and PCA, features from each model were fused and classified using a neural network. This ensemble approach achieved **94.6% accuracy**, outperforming individual models, proving that **feature diversity boosts performance**.