Image Retrieval

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Abstract

This project focuses on image retrieval, aiming to retrieve relevant images given an image query. Leveraging both Histogram of Oriented Gradients (HoG) and Convolutional Neural Network (CNN) features extracted through provided implementations, various methodologies are explored, including classification and clustering-based techniques. The CIFAR-10 dataset serves as the foundation for this study, offering a diverse collection of images for training and evaluation purposes. Through systematic experimentation and analysis, this project seeks to enhance image retrieval systems, contributing to advancements in image recognition and retrieval technologies..

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1 Introduction

In the domain of computer vision, image retrieval poses a crucial challenge with diverse applications like content-based retrieval, organization, and visual search. The objective is to match a query image with relevant ones from a database, but this task is complex due to variations in appearance, semantics, and scale.

This project focuses on image retrieval, particularly using the CIFAR-10 dataset, comprising 60,000 32x32 color images across 10 classes. Its complexity makes it ideal for evaluating techniques. The goal is to develop robust methods for accurate retrieval. Techniques like Histogram of Oriented Gradients (HoG) and Convolutional Neural Networks (CNN) are employed to capture intricate details and patterns. HoG captures shape and texture, while CNNs learn hierarchical visual features.

Innovative classification and clustering approaches refine retrieval by categorizing images into classes or clusters based on feature representations. This process efficiently narrows the search space, enhancing accuracy.

Systematic experimentation and analysis on CIFAR-10 push the boundaries of retrieval capabilities, providing insights into technique performance and applicability to real-world scenarios. Ultimately, this

research contributes to advancements in computer vision, benefiting image recognition, retrieval, and understanding.

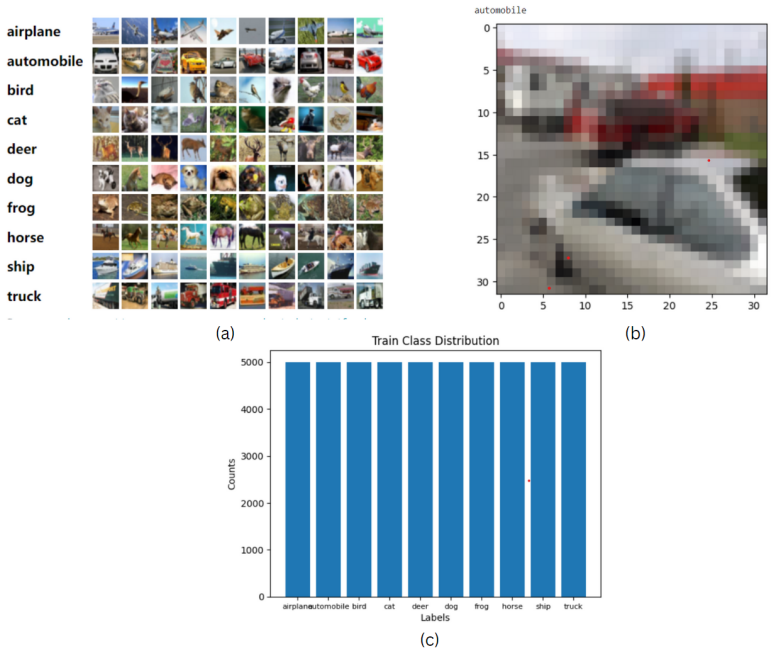

Figure 1: (a) CIFAR-10 (b) Sample Image of Automobile class (c) Data Distribution of few classes in CIFAR-10

2 Approaches Tried

1. KNN:

– Utilizes similarity of feature vectors for classification.

– Without additional feature extraction techniques, KNN operates directly on raw pixel values or basic features.

– The relatively low accuracy of 20.48 highlights the limitations of using KNN alone for image retrieval, emphasizing the importance of feature engineering.

2. PCA + KNN:

– Principal Component Analysis (PCA) reduces dimensionality to capture significant variations.

– By reducing the dimensionality of the feature space, PCA aims to capture the most significant variations in the data.

– Despite dimensionality reduction, combining PCA with KNN yields only a marginal improvement in accuracy (20.17), indicating that the reduced feature space may not fully capture the discriminative information required for accurate retrieval.

3. HOG + KNN:

– HOG captures object shape and appearance.

– Combined with KNN for similarity matching.

– Achieves 40.28 accuracy, indicating effectiveness with potential for improvement.

4. PCA + HOG + KNN:

– Combines PCA dimensionality reduction with HOG's object shape capturing.

– PCA reduces the dimensionality of the feature space, while HOG descriptors capture object shapes and appearances.

– Notable accuracy enhancement (39.47) over PCA + KNN, showcasing synergy of PCA and HOG.

3 Experiments and Results

While applying PCA to CIFAR-10 dataset , we observed various results which depicted dimensionality reduction. One of the those examples haven been shown in Fig 2.

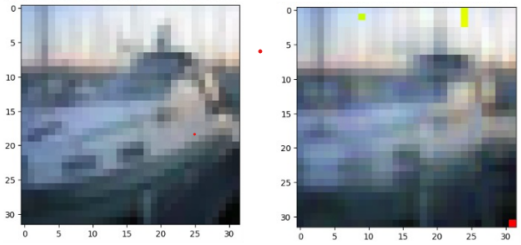

Figure 2: Left image shows the original image while the right one shows the same image after applying PCA (number of components = 5).

We tried the approaches that have been listed above on CIFAR-10 dataset and the accuracies obtained have been been mentioned in Fig3.

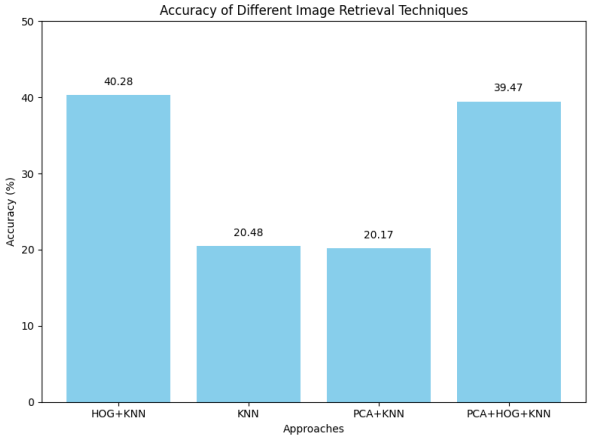

Figure 3: Accuracies on Various Methods

4 Future Approaches

In near future , we'll be trying the following techniques for this task -

- CNN (Convolutional Neural Networks): Utilize deep learning models specialized for image analysis, leveraging hierarchical feature extraction to capture complex patterns and structures within images.
- ANN (Artificial Neural Networks): Employ neural network architectures to learn relationships between input data and target outputs, enabling flexible modeling of complex image retrieval tasks.
- K-Means: Apply unsupervised learning algorithm to partition image feature space into clusters, facilitating efficient organization and retrieval of similar images based on their feature representations.