

ENPM703- Assignment-1

Part5: Neural Network on Image Features

Feature Extraction

Feature extraction is the process of converting raw image data into a format that can be easily interpreted by machine learning models. In context of image classification, features represent distinctive characteristics like edges, textures, shapes, or colors that help training process to be more efficient.

It makes model performance by reducing noise and irrelevant data, and allows algorithms to focus on the most relevant parts of the image.

Methods

Histogram of Oriented Gradients (HOG): Captures the structure and shape of objects by calculating the gradient orientation in localized portions of the image. Since, HOG captures texture of the image, it is robust to change in pose and color of the image contents.

Color Histogram (HSV): Represents the distribution of colors in an image using the Hue, Saturation, and Value (brightness) components, which helps in distinguishing objects based on their colors.

Overview of SVM and Neural Networks

SVM is a classification method that takes input data, which may not be linearly separable, and projects it into a higher-dimensional space to make it linearly separable. An optimal separating hyperplane is then determined by adjusting the weights of various parameters.

In a 2-layer NN, there are two layers of weights: one connecting the input layer to a hidden layer, and another linking the hidden layer with the output layer. The network learns by modifying these weights to reduce the error between the predicted values and the actual ground truth data.

SVM vs NN

- SVM performs well on smaller datasets with clear class boundaries, while neural networks are better suited for larger datasets with complex patterns and SVM is faster for training on smaller datasets.
- SVM is less prone to overfitting while there are many features, whereas neural networks need careful tuning to avoid overfitting by adjusting different hyperparameters.
- Neural networks scale effectively with large datasets and benefit from GPU acceleration, whereas SVM may struggle with larger datasets due to higher time complexity.

Raw Image Data vs Feature Extracted Data

Raw image data consists of pixel values that represent the image in its original form but it is too large and complex for efficient model training. Feature extracted data simplifies the raw image by focusing on important characteristics like edges, textures, or colors, reducing its complexity. Using feature extracted data helps models like SVM or neural networks to learn faster and perform better by removing irrelevant and redundant information. While raw data

might contain more detailed information, feature extraction makes it easier for ML models to focus on patterns relevant to the task.

Both validation and test accuracies are higher with feature data when compared with the raw image data. Thus, preprocessing data by extracting features is a reliable method to increase the efficiency of the model.