EE5024 PA3: Dimensionality reduction of HoG features for Bayesian classification

Aakash (ME16B001)
Department of Mechanical Engineering
Indian Institute of Technology Tirupati
me16b001@iittp.ac.in

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Aim

1. To develop Histogram of Oriented Gradients (HOG) descriptor based Human and non-human classification.
2. To apply dimensionality reduction to the HOG features using :
   - Principal Component Analysis (PCA)
   - Fischer Linear Discriminant (FLD)
3. To classify the images as human and non-human from the reduced dimensional data using Bayesian classification.

Procedure

1. Given dataset consists of human and horse classes.
2. Reshape the images in the datset uploaded to 256×256 and divide the images into 16×16 blocks.
3. Get the 9 bin HOG Descriptor (consider magnitude while binning) for all the blocks such that final HOG feature vector dimension will be 2304×1.
4. Visualize HoG and report one result per class
5. Applying PCA:
   - Select top k eigen values such that 95% energy is retained.
   - Note down the reduced dimension of HOG feature vector dimension.
6. Applying FLD:
   - Apply FLD to the HOG feature vector such that it's reduced to one dimension.
   - Plot the magnitude of data points with different colors for both classes.
7. Plot confusion matrix for the above and calculate the accuracy. LAB command)).

Results

The given image dataset consisting of human and horse classes was used to implement dimensionality reduction for bayes classification by using the HoG as the features. The original dataset consisted of images of dimension 300×300 which was reduced to 256×256 by center cropping the original image data. This data was then fed to a HoG feature descriptor consisting of the 9 bins and 16×16 blocks. The HoG thus results in a feature vector of length 2304 (i.e. $16 \times 16 \times 9$). The HoG has been visualised as shown in Figure 1.

Vector	HoG	PCA
Train data	(1027, 2304)	(1027, 530)
Train labels	(1027, 1)	(1027,1)
Test data	(256, 2304)	(256, 530)
Test labels	(256, 1)	(256, 1)

Table 1: Vector dimensions after applying HoG and PCA

The HoG feature vectors are then fed through PCA and FLD algorithms in order to reduce the feature vector dimension. The HoG results in a vector of dimension 2034×1 which is reduced to 530×1 after application of PCA dimensionality reduction algorithm by keeping the 95% energy (Table 1).

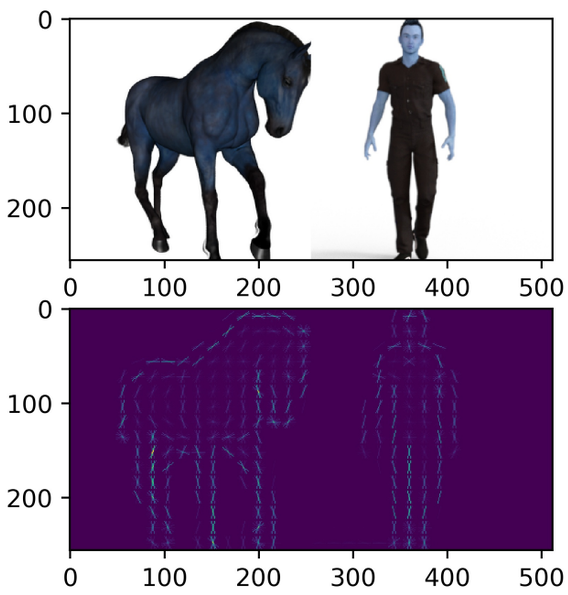

Figure 1: HoG visualization of Horse and Human class

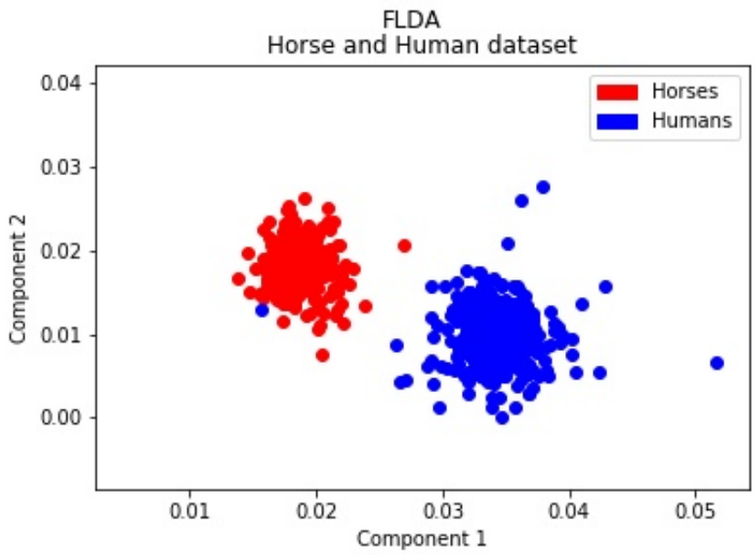

Figure 2: Data points of two classes after using FLD

The vectors with reduced dimension are then used for carrying out binary classification using Bayes method. The binary classification in PCA reduced data results in a 92.18% accuracy with confusion matrix as shown in Table 2. Similarly, FLD reduced data results in 57.03% accuracy with corresponding confusion matrix as shown in Table 3. The two classes are plotted in Figure 2 after reducing the dimension of their feature vectors.

Confusion matrix	Predicted as class 1	Predicted as class 2
Test data point belongs to class 1	116	12
Test data point belongs to class 2	8	120

Table 2: Confusion matrix for Bayes classification (PCA method)

Confusion matrix	Predicted as class 1	Predicted as class 2
Test data point belongs to class 1	92	36
Test data point belongs to class 2	74	54

Table 3: Confusion matrix for Bayes classification (FLD method)