Algorithm 1: Multi-category Classification using HOG + PCA

Input: K,Number of principle components to retained

Data: $X_{Train}^{(j)}, X_{Test}, Y_{Train}$, where $j = 0, 1, ..., \#Class$

Result: Classification prediction forX_{Test}, $\hat{Y_{Test}}$

begin

foreach j **do**

Step 1 : HOG feature

Transform the raw data $X_{Train}^{(j)}$ into HOG feature matrix $H^{(j)} = \left[h_1^{(j)}\, h_2^{(j)}\, \cdots\, h_{n_j}^{(j)}\right]$

Step 2 : Apply PCA

Compute following: (Standardization procedure)

- $\bar{h_j} = \frac{1}{n_j} \sum_{i=1}^{n_j} h_i^{(j)}$
- $C_j = \frac{1}{n_j - 1} \sum_{i=1}^{n_j} \left(h_i^{(j)} - \bar{h_j}\right)\left(h_i^{(j)} - \bar{h_j}\right)^T$

Compute K eigenvectors

$\Longrightarrow T_K^{(j)} = \left[t_1^{(j)}\, t_2^{(j)}\, \cdots\, t_K^{(j)}\right]$

Step 3 : Test data classification

foreach $x \in X_{Test}$ **do**

Compute HOG feature h of x

foreach j **do**

Compute

- projection $z_j = T_K^{(j)}\left(h - \bar{h_j}\right)$
- approximation $\hat{h_j} = T_K^{(j)} z_j + \bar{h_j}$
- Euclidean distance $E_j = ||h - \hat{h_j}||_2$

Find $c \in j$ s.t. $E_c = \text{argmin} E_j$

Append c to $\hat{Y_{Test}}$

return $\hat{Y_{Test}}$