Team members	Student code	workload distribution
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Project pipeline:

1. **Data collection:** Use the large available dataset, which capture a diverse range of hand gestures [0:5] and in different lightning conditions.

2. **Data pre-processing:** Pre-process the data to remove noise and standardize the input format. This includes resizing the images, color segmentation, converting them to grayscale, gamma correction and normalizing the pixel values.

3. **Feature extraction:** Extract features from the pre-processed data to represent the hand gestures in a meaningful way. We used a histogram of oriented gradients (HOG) technique.

4. **Model selection:** Choose a suitable machine learning model that can classify the hand gestures based on the extracted features. We used random forest (FR), support vector machine (SVM) and k nearest neighbor (KNN) models for image classification.

5. **Model training:** Train the selected model on the pre-processed data and the extracted features. This involves splitting the data into training and validation sets and using grid search for fine-tuning the model parameters to optimize its performance.

6. **Model evaluation:** Evaluate the performance of the training model on a separate test set by calculating accuracy.

Preprocessing Module:

The preprocessing module in the project is responsible for preparing the raw input data for feature extraction and model training. Here are preprocessing techniques used in project:

1. **Resizing:** The input images are of varying sizes and aspect ratios. Resizing the images to a fixed size helps standardize the input format and reduce the computational complexity.

2. **Smoothing:** Applying Gaussian blur filter helps remove noise and smooth out the input data.

3. **Color segmentation:** segmentation is used to isolate the hand from background.

4. **Color conversion:** converting the input images to grayscale.

5. **Apply local contrast normalization:** This step helps to improve the robustness of the HOG descriptor to lighting variations. Adaptive histogram equalization technique is used.

6. **Gamma correction:** Gamma correction helps to improve the contrast and enhance the edges in the image.

Feature Extraction/Selection Module:

The feature extraction/selection module is responsible for extracting meaningful features from the preprocessed input data.

Histogram of Oriented Gradient(HOG) technique is used for feature extraction that computes the gradient magnitude and orientation of local image patches and aggregates them to form a global descriptor of the image.

Model Selection/Training Module:

The model selection/training module is responsible for selecting an appropriate machine learning model and training it on the extracted features to classify different hand gestures. Here's the pipeline for this module:

1. **Model Selection:** Choose a suitable machine learning model. We chose SVM, random forest, and KNN. We used them to build a voting model. We used grid search to tune hyperparameters of the model.

2. **Data Splitting:** Split the preprocessed and feature-extracted data into training, validation, and testing sets. The training set is used to train the model, while the validation set is used to tune the model's hyperparameters and avoid overfitting. The testing set is used to evaluate the performance of the trained model on unseen data.

3. **Model Training:** Train the selected model on the training set.

4. **Hyperparamter tuning:** Use the validation set to evaluate the performance of the trained model and select the best hyperparameters.

Performance Analysis Module:

The performance analysis module is responsible for evaluating the performance of the trained model on the testing set. This is done by calculating accuracy.

Trails

1- Try to improve HOG preprocessing :

1-without preprocessing: 69.04109589041096 %

2- old preprocessing: 71.5068493150685 %

3-new preprocessing with (color segmentation):77.08333333333334

4-new preprocessing with (color segmentation): 75.0

5-new preprocessing with (color segmentation and kmean k=4):72.91666666666666 %

6-new preprocessing with (color segmentation and histogram equalization first step):16.666666666666664 %

7- new preprocessing with (color segmentation and histogram equalization last step): 79.16666666666666%

8- new preprocessing with (color segmentation and histogram equalization first step and large closing(kernel size:11,itirations:15)):56.25 %

9- new preprocessing with (color segmentation and histogram equalization first step and large closing(kernel size:11,itirations:10)and k-mean):68.75 %

10- new preprocessing with (color segmentation and histogram equalization last step and (gamma (0.5,1.5)):78.125

11- new preprocessing with (color segmentation and histogram equalization last step and (gamma (2.5)):80.20833333333334

12- new preprocessing with (color segmentation and histogram equalization last step and (gamma (2.5)and canny):68.75

13- new preprocessing with (color segmentation and histogram equalization(local) last step and (gamma (2.5)):82.29166666666666 %

2-HOG with Random Data:

1- new preprocessing with (color segmentation and histogram equalization(local) last step:76.71232876712328

2- new preprocessing with (color segmentation and histogram equalization(global) last step and (gamma (2.5)):75.06849315068493

3- new preprocessing with (color segmentation and histogram equalization(local) last step and (gamma (2.5)) and closing:79.56204379562044

4- new preprocessing with (color segmentation and histogram equalization(local) last step and (gamma (2.5)) and without closing:78.1021897810219

5- new preprocessing with resize(460,259)==>80.2919708029197 %

6- new preprocessing with resize(700,700),(256,256)==>77.00729927007299

7-new preprocessing with resize(500,500),(256,256)==>78.1021897810219

8-new preprocessing with resize(600,600),(128,128)==>78.1021897810219

3-HOG Parameter

1-change cell size to (5,5): 75.91240875912408

2-change cell size to (10,10): 80.65693430656934 %

3-change Hog bins to (bins=12): 79.56204379562044 %

4-try to use Voting

Accuracy hard: 79.92700729927007 %

Accuracy soft: 81.38686131386861 %

4-LPB not has BIG Effect:

1-parameters:(radius :32, point: 32*8)

Accuracy hard: 80.65693430656934 %

Accuracy soft: 80.2919708029197 %