

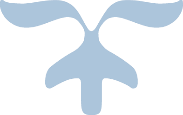
Credit Hours System

CMPN 450 – Pattern Recognition

Cairo University Faculty of Engineering



PATTERN RECOGNITION PROJECT DELIVERY



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# Project Pipeline

Performance Analysis

Model Selection and Training

Data Extraction and Selection

Data Preprocessing

Data Loading

# Data Loading Module

## Data loading

Dataset is loaded from we work with Hand Gesture of the Colombian sign language dataset, we consider the digit classes (from 0 to 5) for both men and women. The dataset can be downloaded from

<https://drive.google.com/drive/u/2/folders/1o9wzwaJVfrbpCFJ0rIyed1QvARh0JAtn>.

We split the dataset into:

Training Set to train the model.

Validation set to run the parameters of our model.

Test set to report the results of our models.

The splitting is done on each directory in a way that each set has all the classes (0 to 5) and (men/women). Then we shuffle the training set so that the images are not ordered by class while training the model

## Image resizing

The images are resized to 640\*640. The resizing takes into consideration the aspect ratio of the image and always the shorter side is resized to 640 then we resize the other side respecting the aspect ratio. Finally, we add padding with white pixels (same as the background) to end up with a resized image of 640\*640.

# Data Preprocessing Module

## Clustering Segmentation

* Apply SLIC algorithm to get superpixels.
* Calculate the color features of each superpixel.
* Cluster the superpixels based on their color, these can be done using Kmeans or FCM.
* Create an image with each superpixel labeled by its cluster.
* Post-process the labeled image

## Edge Detection

* Sobel
* Prewitt
* Roberts
* Laplace
* Canny

## Shadow and lighting reflection elimination

* Retinex algorithm

## Image aligner

Rotate all the images so that they are aligned in the same orientation:

* Detect the lines in the image using the Hough Transform
* Count the number of lines with each angle.
* Find the angle with the highest count.
* Rotate the image to align with the median angle.
* Make the image down to up oriented.

## Image restoration

For noise and blur removal and image enhancement:

* Mean filter using the rectangular disk.
* Mean filter using the circular disk.
* Median filter.
* Gaussian filter.
* Adaptive filter.
* Wiener filter.

## Contrast enhancement and transformations

* HE (histogram equalization)
* AHE (adaptive histogram equalization)
* CLAHE (Contrast limited adaptive histogram equalization)
* Logarithmic transformation

## Region Segmentation

* Region splitting
* Region growing
* Region merging

## Threshold Segmentation

* Global
* Otsu
* Local
* Multi-Level

# Feature Extraction and Selection Module

* PCA
* Hog
* LBP
* SIFT
* Daisy
* FD (Fourier Descriptor)
* Orb
* RI HOG
* Hu moment
* Convex-Hull
* Elliptical Fourier Descriptor
* Efds features.

# Model Selection and Training Module

* KNN
* ANN (2 hidden layers)
* SVM
* HMM
* Random Forest
* Adaboost
* XGBoost

# Performance Analysis Module

After training the model, we calculate the following parameters for the training and validation dataset to check overfitting and for hyperparameters tuning.

* Micro Average Precision
* Micro Average recall
* Micro Average F1
* Macro Average Precision
* Macro Average Recall
* Macro Average F1
* Weighted Macro Average Precision
* Weighted Macro Average Recall
* Accuracy

# Enhancements and Future work

We can work more on Data preprocessing, There are some techniques for shadow removal and light reflection that we did not have the time to try

Also, other combinations of feature extraction techniques along with image preprocessing and model selection may achieve better results.

# Trials and accuracies

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| Trial (1): Preprocessing: Illumination Processing  Edge Detection: Canny  Feature Extraction: Hog Features + PCA  Normalization: Z-Score Normalization  ============================  Model: SVM - Dataset: Train  Accuracy: 97.59%  Model: SVM - Dataset: Validation  Accuracy: 65.76%  ===============================  Model: KNN - Dataset: Train  Accuracy: 81.28%  Model: KNN - Dataset: Validation  Accuracy: 60.87%  ===============================  Model: Ensemble - Dataset: Train  Accuracy: 100.0%  Model: Ensemble - Dataset: Validation  Accuracy: 51.36%  ===============================  Model: AdaBoost - Dataset: Train  Accuracy: 51.14%  Model: AdaBoost - Dataset: Validation  Accuracy: 42.12%  ===============================  Model: ANN - Dataset: Train  Accuracy: 97.45%  Model: ANN - Dataset: Validation  Accuracy: 65.76% | Trial (2): Preprocessing: Illumination Processing + Alignment  Feature Extraction: Hog Features + SIFT + PCA  Normalization: Z-Score Normalization  =================================  Model: SVM - Dataset: Train  Accuracy: 27.94%  Model: SVM - Dataset: Validation  Accuracy: 20.11%  ==================================  Model: KNN - Dataset: Train  Accuracy: 38.2%  Model: KNN - Dataset: Validation  Accuracy: 16.58%  =================================  Model: Ensemble - Dataset: Train  Accuracy: 100.0%  Model: Ensemble - Dataset: Validation  Accuracy: 30.43%  =================================  Model: AdaBoost - Dataset: Train  Accuracy: 38.68%  Model: AdaBoost - Dataset: Validation  Accuracy: 24.46%  =================================  Model: ANN - Dataset: Train  Accuracy: 66.14%  Model: ANN - Dataset: Validation  Accuracy: 24.18% |

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| Trial (3): Preprocessing: Illumination Processing + Alignment  Feature Extraction: LBP Features + PCA  Normalization: Z-Score Normalization  ===========================  Model: SVM - Dataset: Train  Accuracy: 100.0%  Model: SVM - Dataset: Validation  Accuracy: 57.07%  ==============================  Model: KNN - Dataset: Train  Accuracy: 60.22%  Model: KNN - Dataset: Validation  Accuracy: 18.21%  ===============================  Model: Ensemble - Dataset: Train  Accuracy: 100.0%  Model: Ensemble - Dataset: Validation  Accuracy: 49.46%  ===============================  Model: AdaBoost - Dataset: Train  Accuracy: 50.72%  Model: AdaBoost - Dataset: Validation  Accuracy: 48.91%  ==============================  Model: ANN - Dataset: Train  Accuracy: 100.0%  Model: ANN - Dataset: Validation  Accuracy: 55.43% | Trial (4): Preprocessing: Illumination Processing + Image Alignment  Feature Extraction: ORB Features + PCA  Normalization: Z-Score Normalization  ==============================  Model: SVM - Dataset: Train  Accuracy: 100.0%  Model: SVM - Dataset: Validation  Accuracy: 41.85%  ==============================  Model: KNN - Dataset: Train  Accuracy: 38.61%  Model: KNN - Dataset: Validation  Accuracy: 19.02%  ==============================  Model: Ensemble - Dataset: Train  Accuracy: 100.0%  Model: Ensemble - Dataset: Validation  Accuracy: 34.78%  ==============================  Model: AdaBoost - Dataset: Train  Accuracy: 40.47%  Model: AdaBoost - Dataset: Validation  Accuracy: 29.62%  ==============================  Model: ANN - Dataset: Train  Accuracy: 99.86%  Model: ANN - Dataset: Validation  Accuracy: 41.03% |

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| Trial (5): Preprocessing: Illumination Processing + Image Alignment  Feature Extraction: RI Hog features + PCA  Normalization: Z-Score Normalization  ==================================  Model: SVM - Dataset: Train  Accuracy: 100.0%  Model: SVM - Dataset: Validation  Accuracy: 42.12%  ===================================  Model: KNN - Dataset: Train  Accuracy: 23.81%  Model: KNN - Dataset: Validation  Accuracy: 15.76%  ==================================  Model: Ensemble - Dataset: Train  Accuracy: 100.0%  Model: Ensemble - Dataset: Validation  Accuracy: 22.01%  ===================================  Model: AdaBoost - Dataset: Train  Accuracy: 42.95%  Model: AdaBoost - Dataset: Validation  Accuracy: 20.65%  ===================================  Model: ANN - Dataset: Train  Accuracy: 100.0%  Model: ANN - Dataset: Validation  Accuracy: 40.49% | Trial (6): Preprocessing: Illumination Processing + Image Alignment  Feature Extraction: Hu Moments Features+ PCA  Normalization: Z-Score Normalization  ============================  Model: SVM - Dataset: Train  Accuracy: 25.6%  Model: SVM - Dataset: Validation  Accuracy: 25.27%  ============================  Model: KNN - Dataset: Train  Accuracy: 64.42%  Model: KNN - Dataset: Validation  Accuracy: 40.22%  ============================  Model: Ensemble - Dataset: Train  Accuracy: 100.0%  Model: Ensemble - Dataset: Validation  Accuracy: 44.29%  ============================  Model: AdaBoost - Dataset: Train  Accuracy: 42.12%  Model: AdaBoost - Dataset: Validation  Accuracy: 33.42%  ============================  Model: ANN - Dataset: Train  Accuracy: 40.67%  Model: ANN - Dataset: Validation  Accuracy: 38.86% |

## Trial (7):

Preprocessing: Illumination Processing + Image Alignment

Feature Extraction: Convex Hull + PCA

Normalization: Z-Score Normalization

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Model: SVM - Dataset: Train

Accuracy: 57.05%

Model: SVM - Dataset: Validation

Accuracy: 47.83%

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Model: KNN - Dataset: Train

Accuracy: 68.2%

Model: KNN - Dataset: Validation

Accuracy: 45.11%

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Model: Ensemble - Dataset: Train

Accuracy: 100.0%

Model: Ensemble - Dataset: Validation

Accuracy: 53.26%

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Model: AdaBoost - Dataset: Train

Accuracy: 46.59%

Model: AdaBoost - Dataset: Validation

Accuracy: 35.87%

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Model: ANN - Dataset: Train

Accuracy: 87.47%

Model: ANN - Dataset: Validation

Accuracy: 53.53%

# Final Model

# Workload distribution

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| Ahmed Ihab | 25% |
| Mostafa Ashraf | 25% |
| Mousa Mohamed | 25% |
| Nader Youhanna Khalil | 25% |