Electro-Oculogram (EOG) Classification Report

SC_15

Level 3	**SC**	**2022170206**	شهد سامح عبد العزيزالسيد
Level 3	**SC**	**2022170148**	رحمه احمد احمد عزت
Level 3	**SC**	**2022170151**	رشا عبد الخالق عبد الحميد
Level 3	**SC**	**2022170141**	دارين حسام الدين علاء الدين

Project Objective

The aim of this project is to classify eye movements (Right or Left) based on horizontal EOG signals.

Dataset Description

The dataset consists of horizontal EOG signals sampled at 176 Hz. Each sample corresponds to an eye movement classified as either "Right" or "Left."

- **Input:** EOG Signal
- **Output:** One label ("Right" or "Left")

Preprocessing Steps

To enhance the quality of the raw signals and extract meaningful features, several preprocessing steps were applied:

1- **Mean Removal :**
   - **Goal:** To remove the DC offset and center the signal around zero.
   - **Implementation:** Subtracted the mean value of each signal from itself.

2- **Bandpass Filtering (Butterworth Filter):**
   - **Goal:** To isolate relevant frequency components **(0.5–20 Hz)** and remove noise.
   - **Filter Design:** Fourth-order Butterworth filter with cutoff frequencies normalized to the Nyquist rate.
     i. **Order 4:** Sharper cutoff, better for isolating specific frequency ranges.

3- **Normalization:**
   - **Goal:** To scale signals to a range of **0 to 1** for consistency to avoid outliers and scattered data . help to compare between signals.
   - **Implementation:** Min-max normalization applied to each signal.

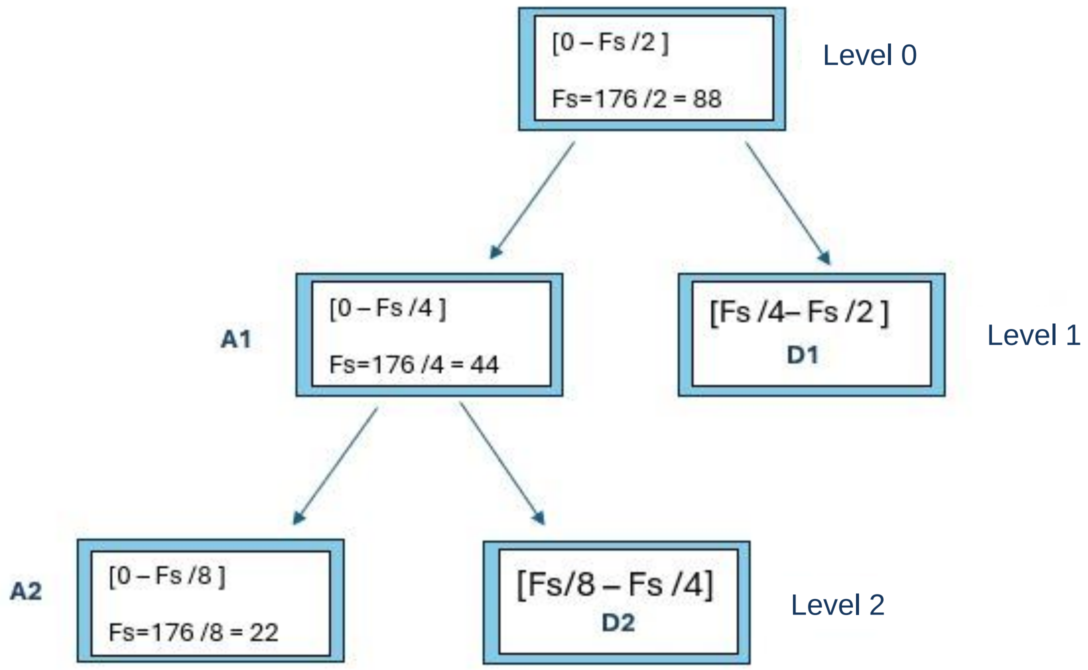
4- **Resampling:**

- **Goal:** To reduce the computational complexity by down-sampling the signal by reducing dataset size .
- **Implementation:** Down-sampled signals by a factor of 4.
    i. Factor 4: because our sampling frequency (Fs) = 176 so after down-sampling will be (176 / 4 = 44) 44 > **2* Fmax** (which 20) **Nyquist Frequency**.

5- Wavelet Feature Extraction:

- **Goal:** To capture time-frequency information using wavelet decomposition.
- **Wavelet Type:** Daubechies family **(d2)** like the input signal**.**
- **Level:** Decomposition performed at **level 2** . Only approximation coefficients were retained.

Level Decomposition :



Classification models : Two classification algorithms were tested

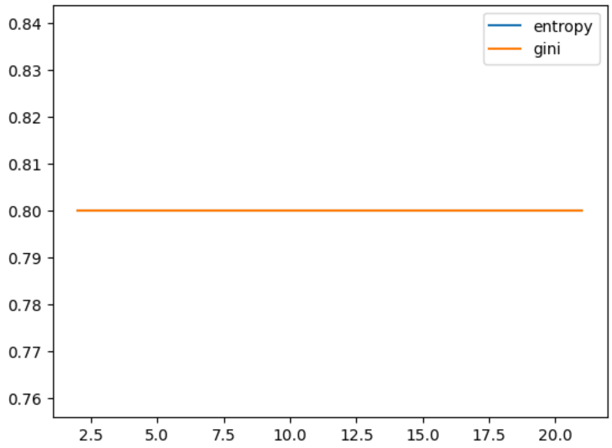
1-**K-Nearest Neighbors (KNN):**

Best Accuracy Achieved: **80%** with hyperparameter n--neighbors=**3**

2-Random Forest:

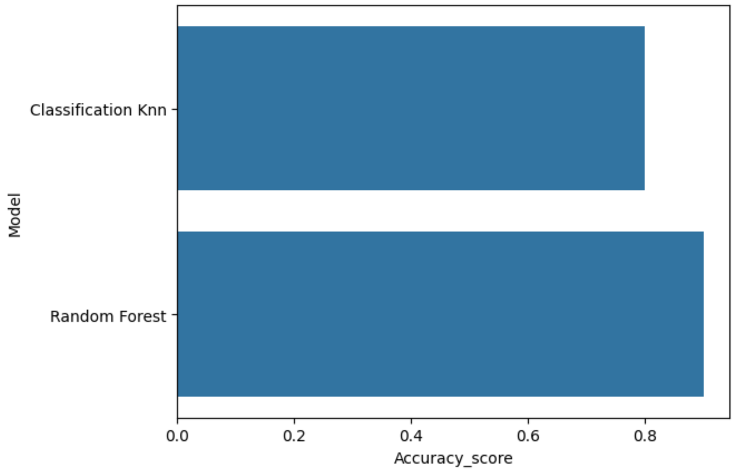
max_depth from **2 to 22** with criterion: "**entropy"** or **"gini"** and random state = **40**

Best Accuracy Achieved: **90%** with max_depth=**19** using criterion=**gini.**

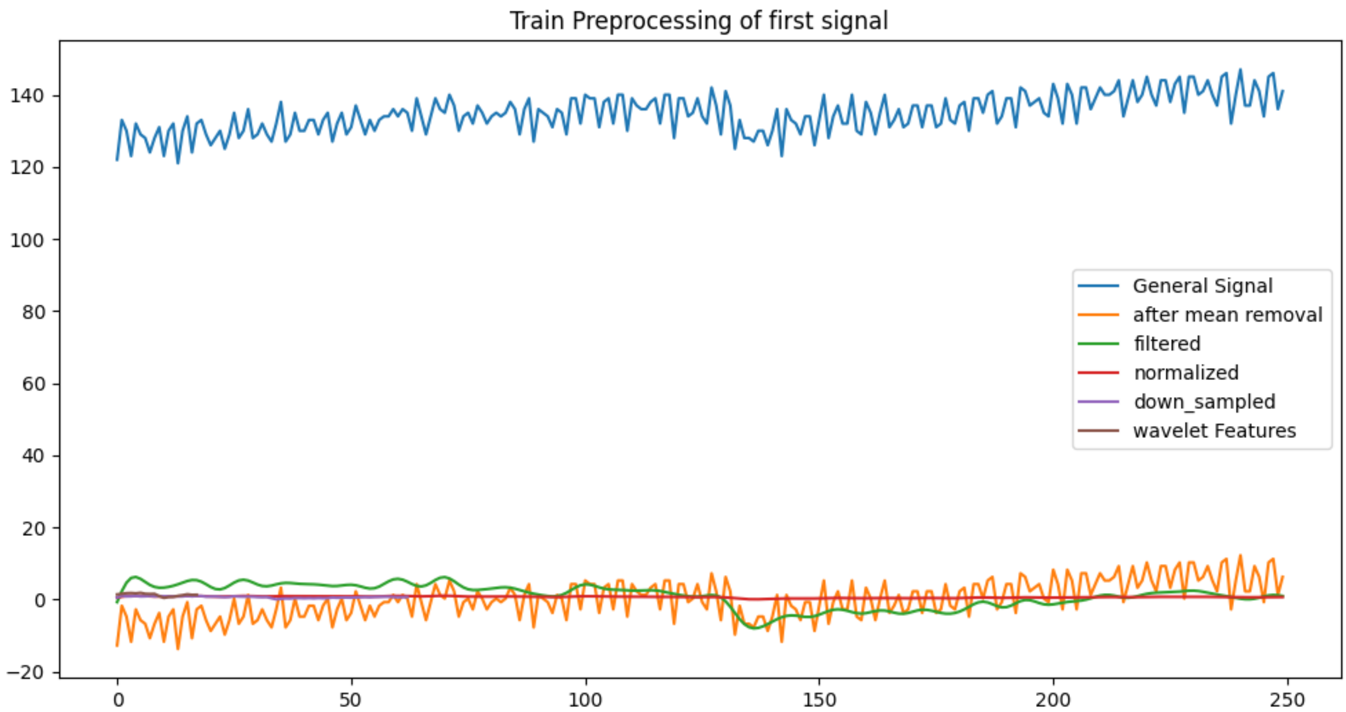


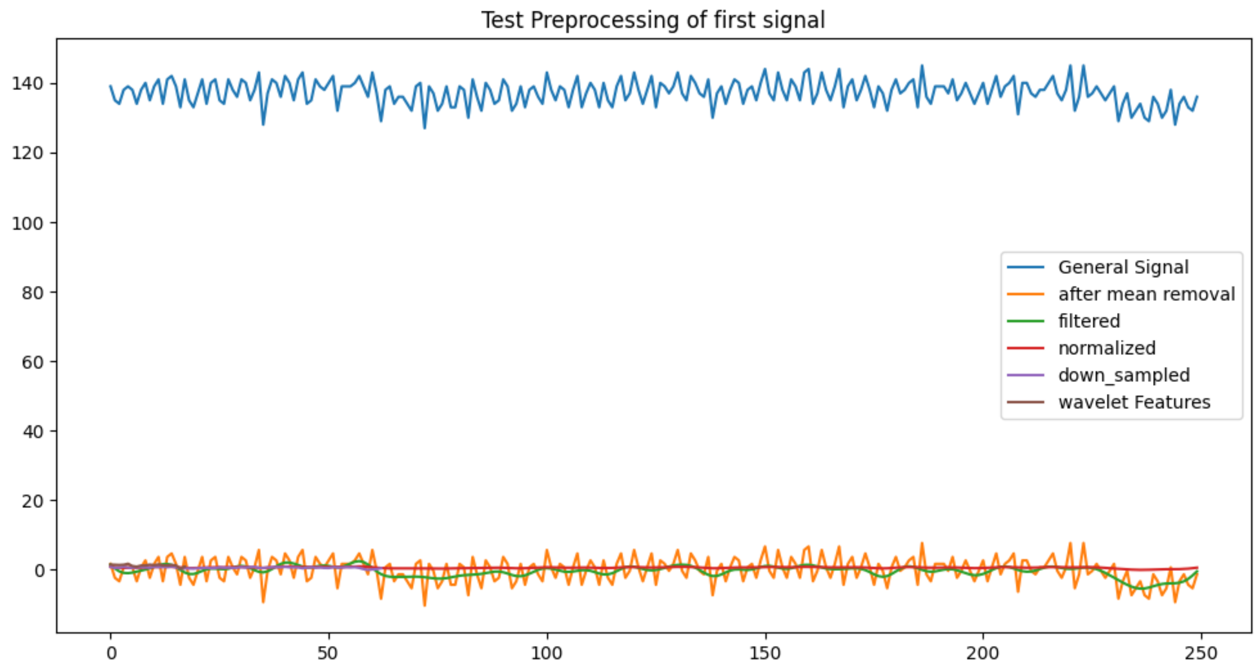
Accuracy Visualization:

The Random Forest classifier performed better than KNN, achieving the highest accuracy of **90%.**



Visualization:





Conclusion:

This project highlights the efficacy of a comprehensive preprocessing pipeline for EOG signal classification, incorporating mean removal, normalization, bandpass filtering, and down-sampling. By leveraging advanced feature extraction through wavelet decomposition, we successfully captured essential characteristics of the signals. The Random Forest classifier, trained on these features, achieved a high accuracy of **90%,** demonstrating its robustness and suitability for this task. These results underscore the potential of combining meticulous preprocessing techniques with advanced feature engineering to enhance the performance of machine learning models in EOG signal analysis.