Project Report: Feature Extraction from Noisy Motor Signals Using Wavelet Transform

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Introduction

In this step, we explore how wavelet transforms can extract meaningful features from motor signals even in the presence of noise. The objective is to assess the robustness of the wavelet-based approach under noisy conditions, which better simulates real-world scenarios.

Methodology

1. Synthetic Noisy Signal Generation:

Two types of signals were generated:

- A "normal" signal composed of 50Hz + 120Hz sinusoids with added Gaussian noise.
- A "faulty" signal with the same base frequencies plus an additional 200Hz component simulating a fault.

2. Wavelet Transform:

- We used the Daubechies 4 (db4) wavelet to decompose each signal up to 5 levels.
- For each decomposition level, two features were calculated:
  - Energy of the detail coefficients
  - Shannon entropy of the detail coefficients

Numerical Results

Wavelet Features for Normal (Noisy) Signal:

Level	Energy	Entropy
L0	65.57	-118.15
L1	8.31	6.20
L2	418.97	-915.22
L3	122.04	-47.66
L4	55.54	47.97
L5	119.93	82.92

Wavelet Features for Faulty (Noisy) Signal:

Level	Energy	Entropy
L0	196.47	-639.02
L1	11.50	4.42
L2	480.84	-1109.98
L3	433.22	-755.22
L4	283.27	-166.08
L5	124.34	83.20

Figures

Figure 1 – Noisy Normal vs Faulty Signal (Time Domain)

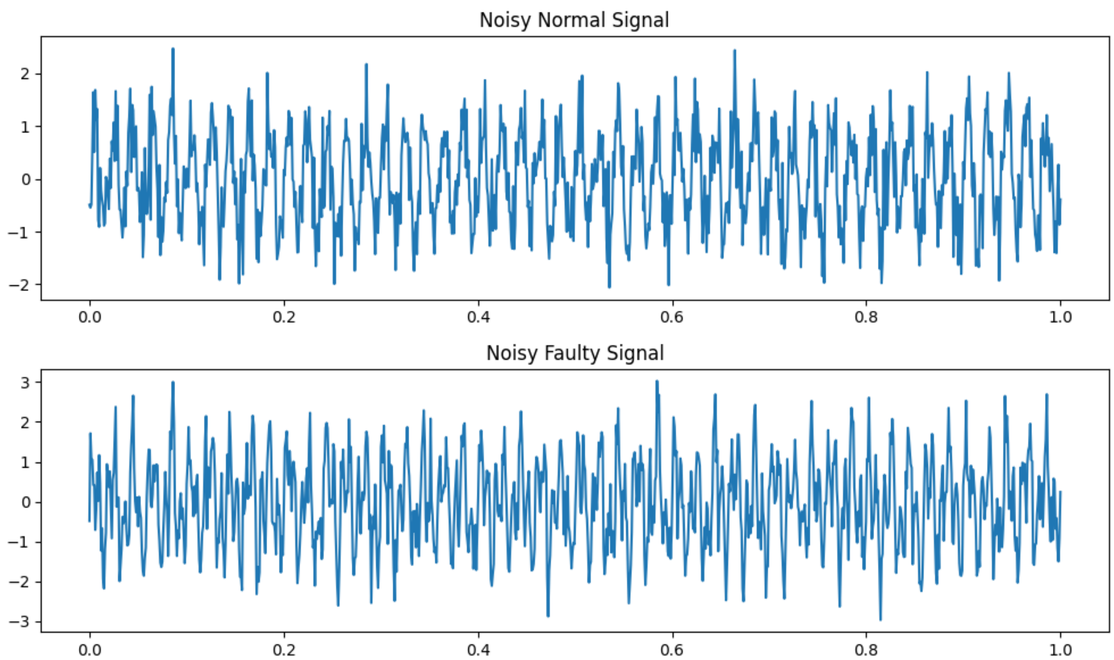
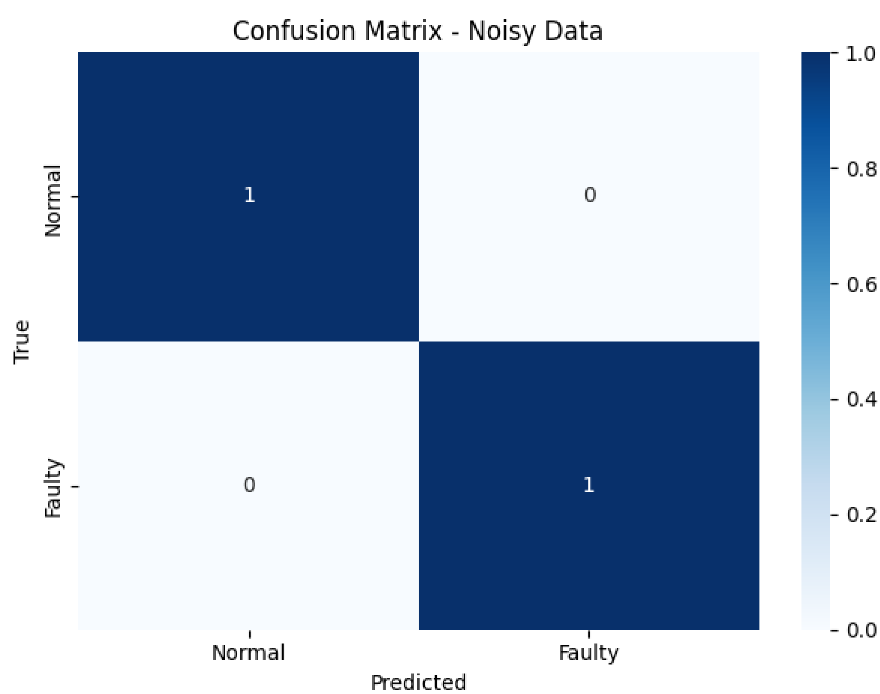


Figure 2 – Confusion Matrix (Random Forest on Noisy Data)



Conclusion

Despite the presence of noise, wavelet transform successfully extracted features that distinguish between normal and faulty motor signals. This confirms the robustness of wavelet-based methods for fault diagnosis in noisy environments.

Next Step

In the next phase, we plan to extend the dataset, include more signal variations, and evaluate generalization with proper train/test splits.