Feature survey results

Here's why the features you’ve already chosen (RMS, variance, mean, crest factor, energy, entropy, and dominant frequency) are useful for your project "Acoustic Signal Analysis for Fault Detection and Fault Localization in Electrical Motors":

1. Root Mean Square (RMS)

- Purpose: The RMS value represents the overall power or energy content of the signal.

- Relevance to Your Project: In motor fault detection, RMS is commonly used to measure the vibration energy or signal amplitude. A faulty motor will often exhibit higher or fluctuating RMS values due to increased vibrations or abnormal noise levels.

2. Variance

- Purpose: Variance measures the signal’s spread or how much the signal varies from its mean.

- Relevance to Your Project: A motor running smoothly will have consistent vibrations, leading to low variance. Faults, such as mechanical wear or misalignment, can cause unpredictable variations in the signal, resulting in higher variance. Monitoring the variance over time helps in identifying irregularities.

3. Mean

- Purpose: The mean provides the average value of the signal over a time period.

- Relevance to Your Project: In the context of motor signals, changes in the mean can reflect a shift in the motor's operational baseline. A significant deviation from the normal mean value can indicate an ongoing issue, such as a fault or misconfiguration.

4. Crest Factor

- Purpose: Crest factor is the ratio of the peak amplitude to the RMS value. It captures the peaks relative to the overall signal energy.

- Relevance to Your Project: Motors with sudden impacts (due to faults like bearing wear or loose components) tend to produce higher peak values. These peaks, combined with the RMS, can help detect transient faults that are not visible through RMS alone. Crest factor can provide early fault detection before significant damage occurs.

5. Energy

- Purpose: Energy measures the total signal strength or the sum of the squares of the signal values over time.

- Relevance to Your Project: Energy is directly related to the motor’s overall vibration intensity. As faults develop, the energy in the acoustic or vibration signal tends to increase. A significant increase in energy could signal a deteriorating condition in the motor.

7. Dominant Frequency

- Purpose: Dominant frequency represents the most prominent frequency component in the signal.

- Relevance to Your Project: In a motor, the dominant frequency often corresponds to the rotational speed or harmonics related to specific faults (e.g., bearing defects, misalignment). Changes in the dominant frequency can provide early detection of mechanical or electrical faults. Monitoring the dominant frequency helps to pinpoint the type of fault and its severity.

Why These Features Are Helpful for Fault Detection

- Fault Characteristics: Each type of motor fault (such as bearing failure, misalignment, or rotor imbalance) manifests distinctively in the vibration and sound signals. For example:

- Mechanical wear may increase variance, energy, and RMS.

- Electrical noise or misalignment may introduce changes in the dominant frequency and crest factor.

- Random faults like loose components may increase entropy and variance.

- Multi-Faceted Approach: By using a combination of time-domain and frequency-domain features, you can capture both the steady-state behavior (mean, RMS, variance) and sudden or transient anomalies (crest factor, entropy, dominant frequency). This diversity allows for a more comprehensive analysis, improving fault detection and classification accuracy.

- Complementary Features: These features work together by highlighting different aspects of motor behavior. For instance:

- RMS and energy give a sense of overall intensity.

- Variance and entropy reveal irregularities and randomness.

- Dominant frequency and crest factor help detect specific fault-related events or harmonics.

Together, these features will help identify subtle and overt changes in motor operation, enabling efficient fault detection and localization.