Motor Fault Diagnosis Using CNN and Spectrogram Feature Extraction

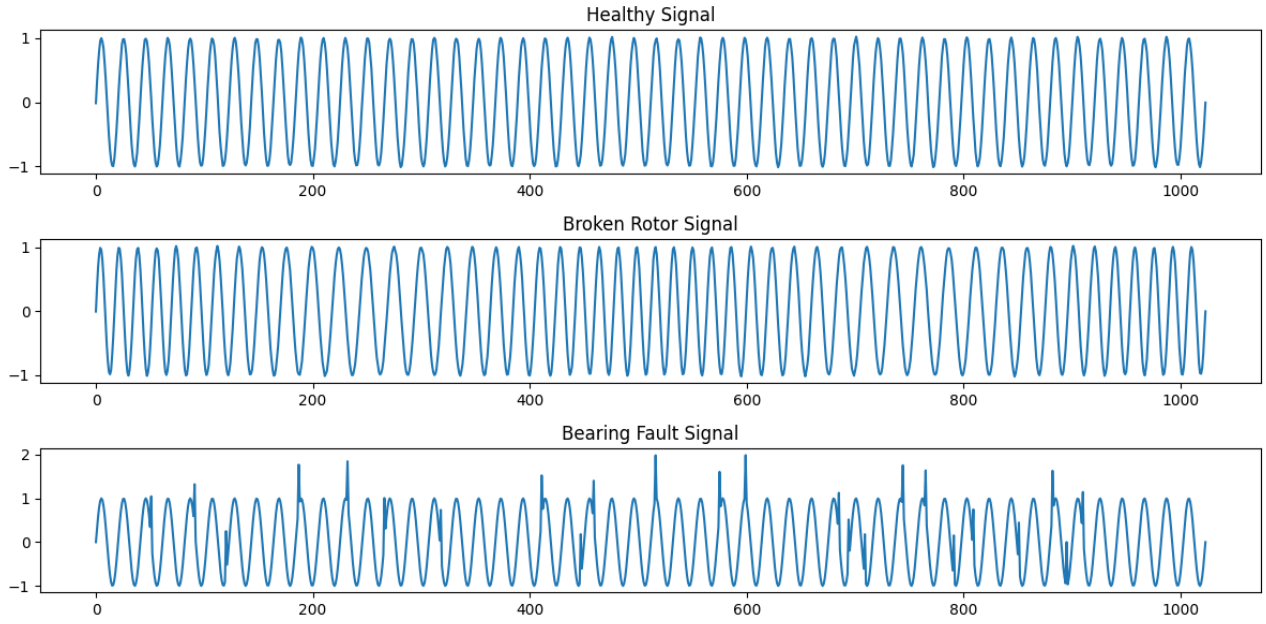
1. Abstract

In this study, we present a lightweight yet effective approach to fault classification in electric motors using synthetic vibration signals. Signals are generated for three operational conditions—Healthy, Broken Rotor, and Bearing Fault—and transformed into spectrograms to be used as input for a Convolutional Neural Network (CNN). The model achieved 100% test accuracy on a balanced dataset of 90 samples. This project demonstrates the power of image-based feature extraction combined with deep learning for industrial fault diagnosis.

2. Methodology

2.1. Signal Generation

30 signals per class were synthetically generated using sinusoidal waveforms with added distortions and noise. Each signal is 1024 samples long.



2.2. Feature Extraction

Each 1D signal was converted into a spectrogram using the Short-Time Fourier Transform (STFT). The spectrograms were resized to 64x64 grayscale images.

2.3. CNN Architecture

The CNN contains:

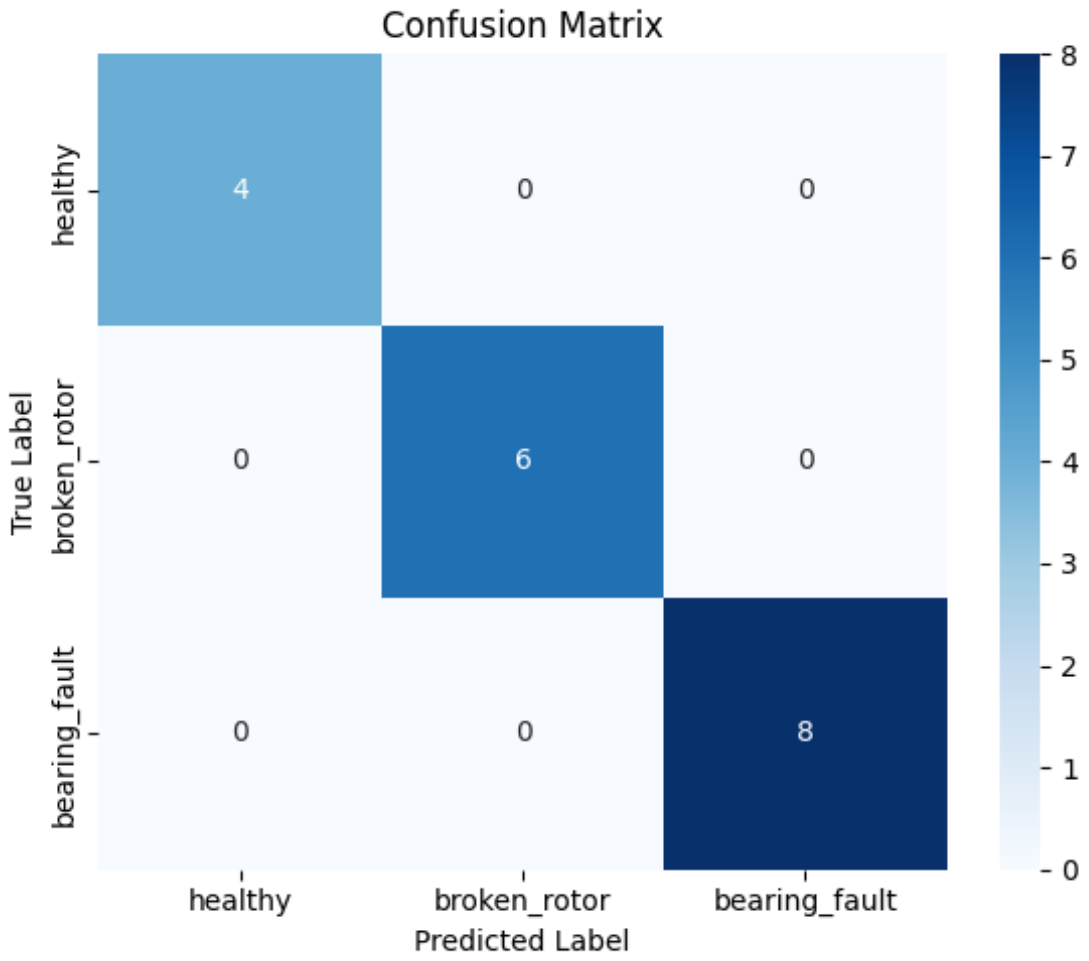
- Two convolutional layers (16 and 32 filters)
- Max-pooling layers
- A dense layer (64 units)
- Softmax output layer with 3 neurons (for 3 classes)

2.4. Training & Evaluation

- 10 epochs, batch size: 8
- Optimizer: Adam
- Loss function: Categorical Crossentropy
- Train/test split: 80/20
- Achieved test accuracy: 100%

3. Results

The model achieved perfect classification on the synthetic dataset. The confusion matrix shows zero misclassifications.



4. Future Work

- Test on real motor vibration data
- Apply wavelet transform for improved frequency resolution
- Compare performance with SVM and Random Forest classifiers

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