

Two-dimensional Motor Vibration Sensor Based on a Fiber Bragg Grating for High-end Equipment

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Abstract

We propose a 2D contact-type FBG vibration sensor that identifies motor faults via strain-induced wavelength shifts along two orthogonal axes.

Introduction

The proposed two-dimensional FBG vibration sensor offers high sensitivity and immunity to electromagnetic interference. By converting motor vibrations into strain-induced wavelength shifts along two axes, it enables reliable monitoring of load variations and multiple motor fault signatures in high-end equipment.

Sensing principle

The operating principle is based on vibration-induced strain applied to the sensing grating, which causes a wavelength shift and leads to a variation in the overlapped optical power. In this process, motor vibrations deform the fiber Bragg grating (FBG) and change its grating period, producing a wavelength shift that alters the optical power returned through the circulator. The photodetector converts this power variation into electrical signals displayed on the oscilloscope, and a Fast Fourier Transform (FFT) is then applied to the acquired signals to analyze the vibration spectrum and identify the main frequency components.

Experimental setup and results

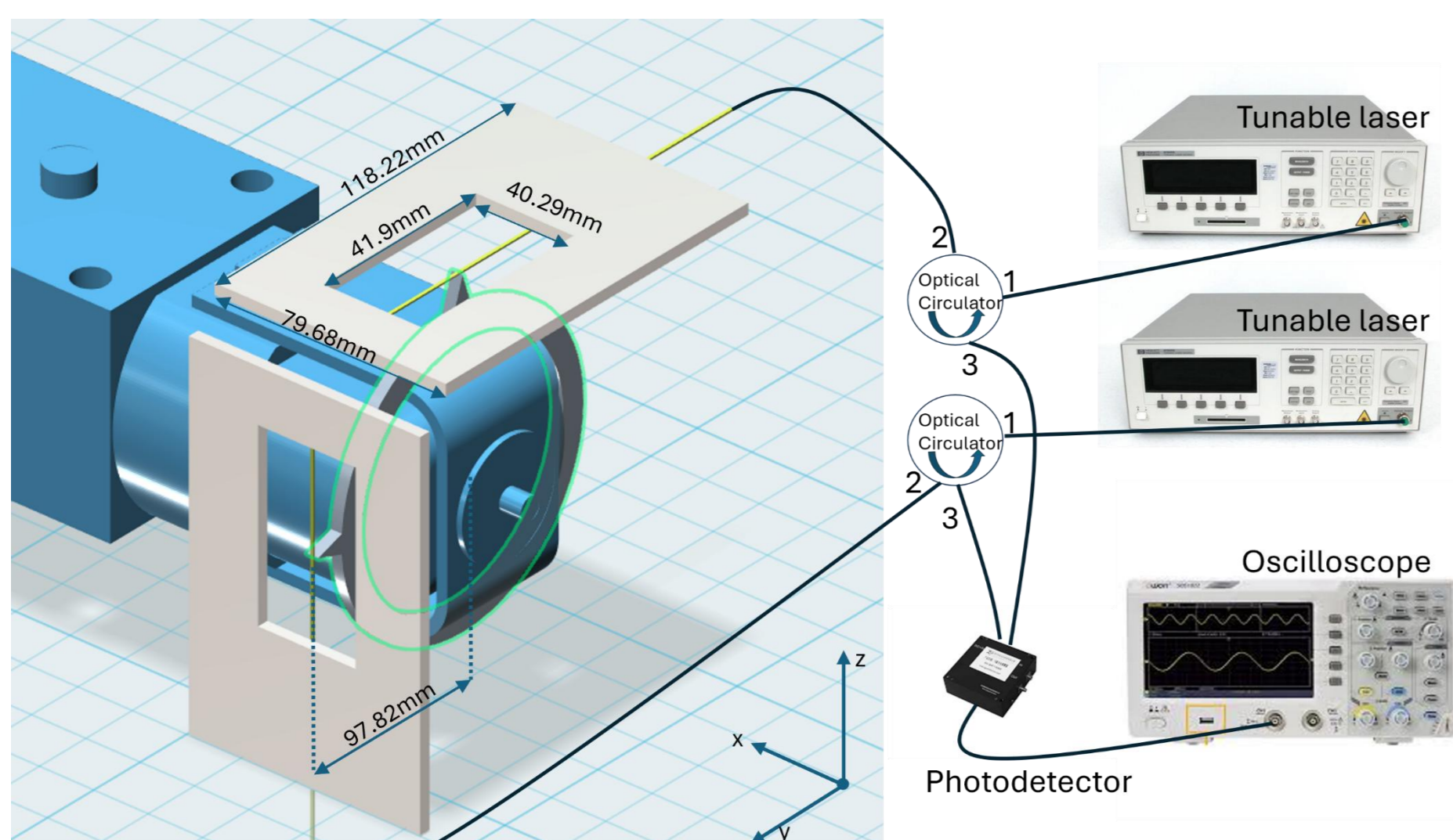


Fig. 1 Experimental setup

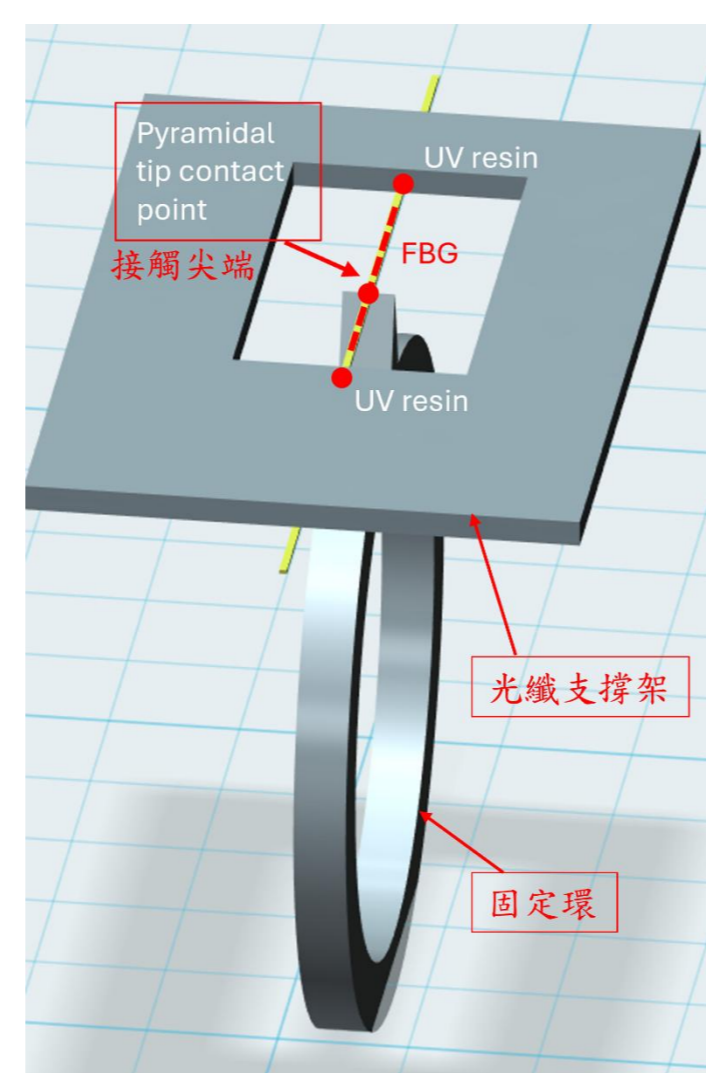


Fig. 2 Sensing head structure

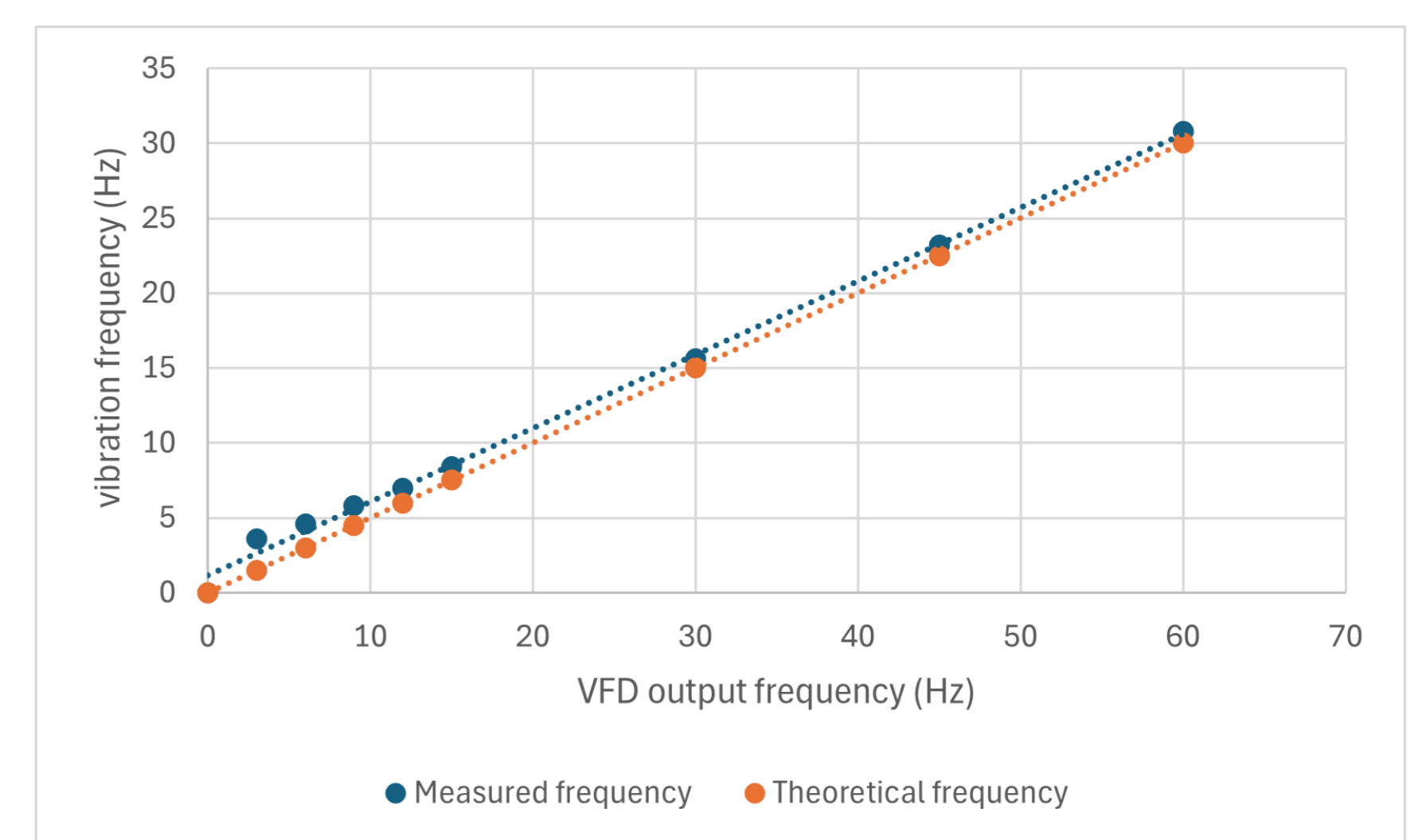


Fig. 3 Measured and Theoretical Frequencies under VFD Output Control

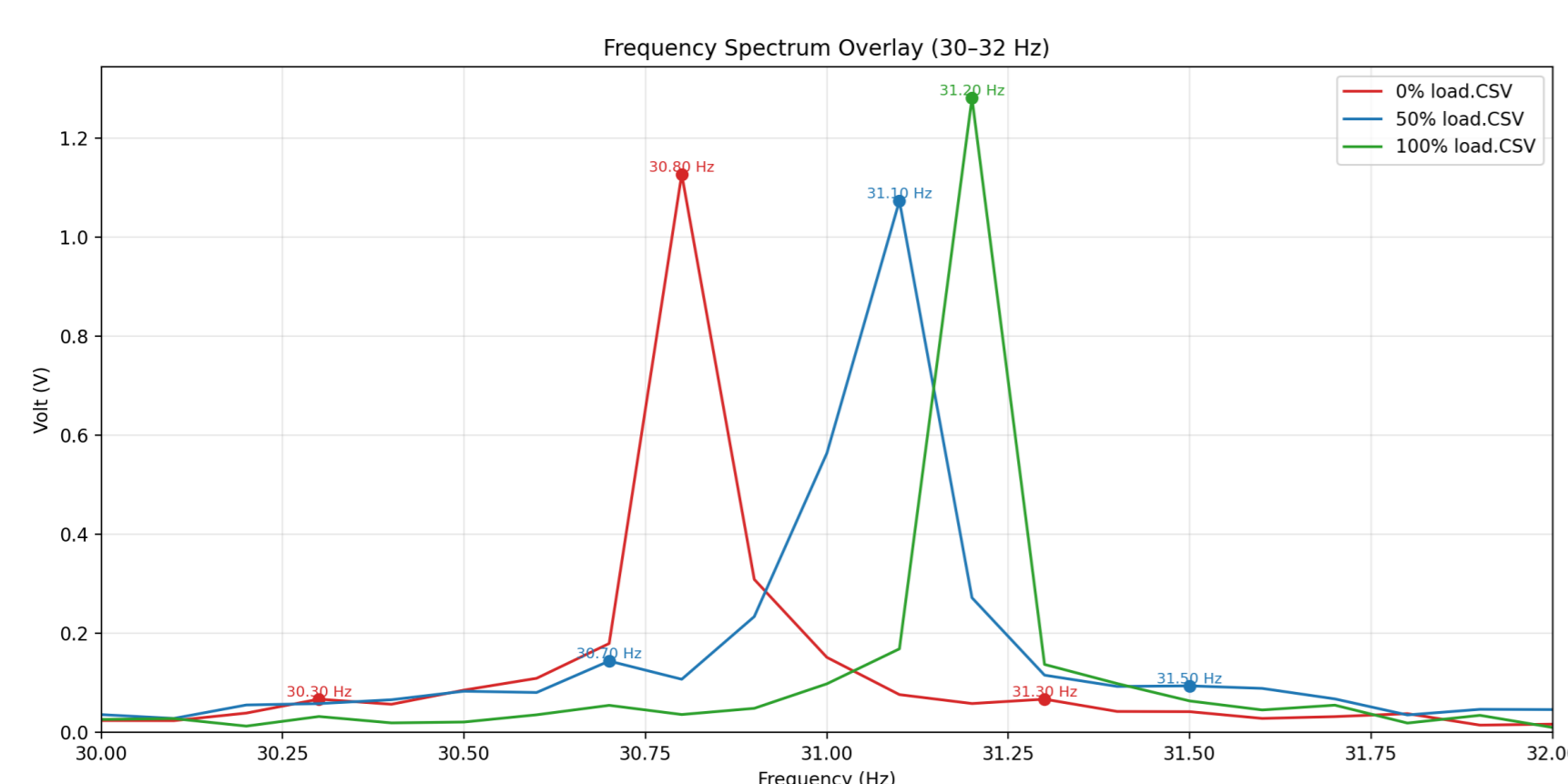


Fig. 4 Effect of Load on the Vibration Spectrum of a Healthy Induction Motor

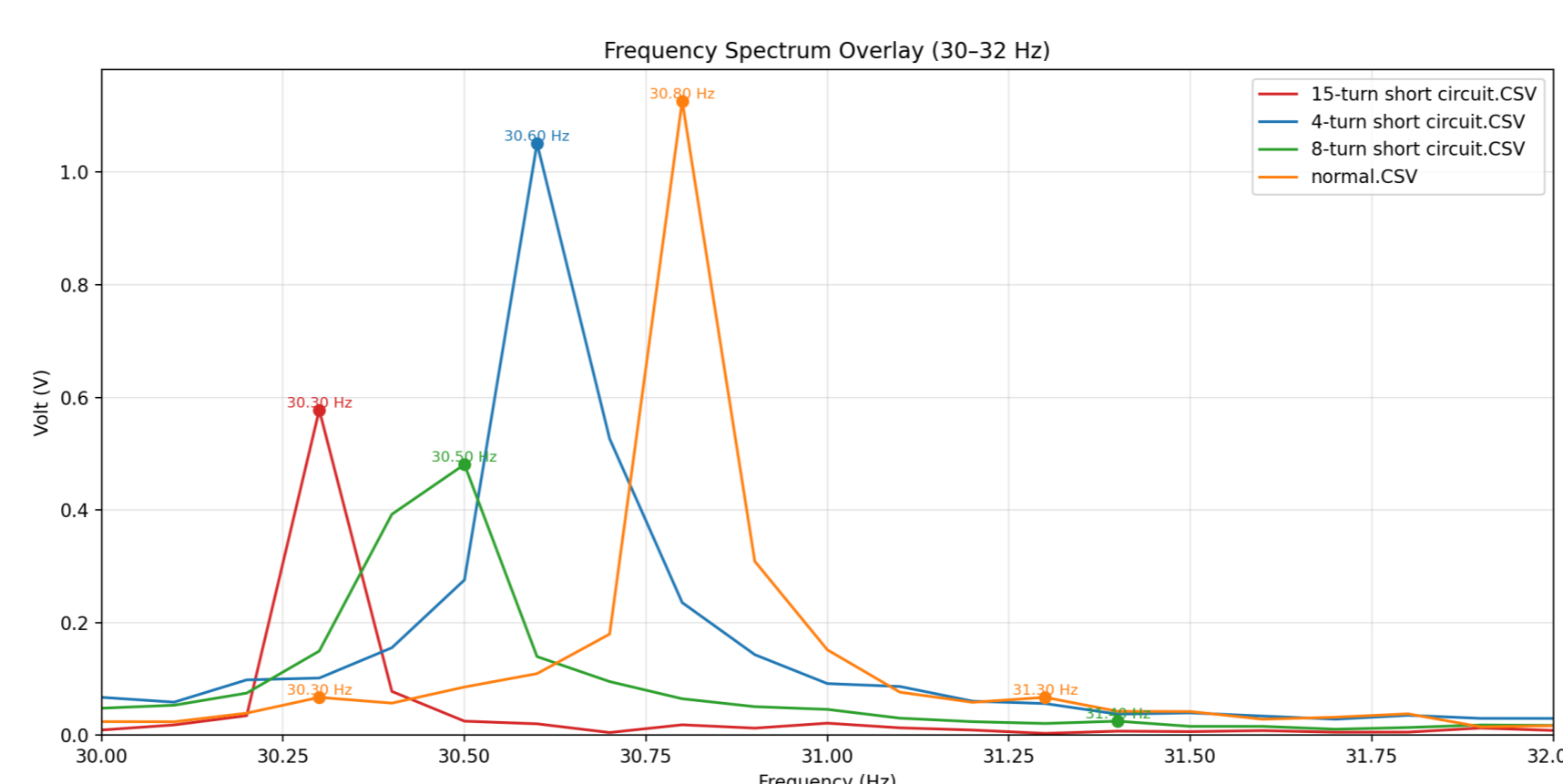


Fig. 5 Peak Shift Left under Inter-turn Short Circuit

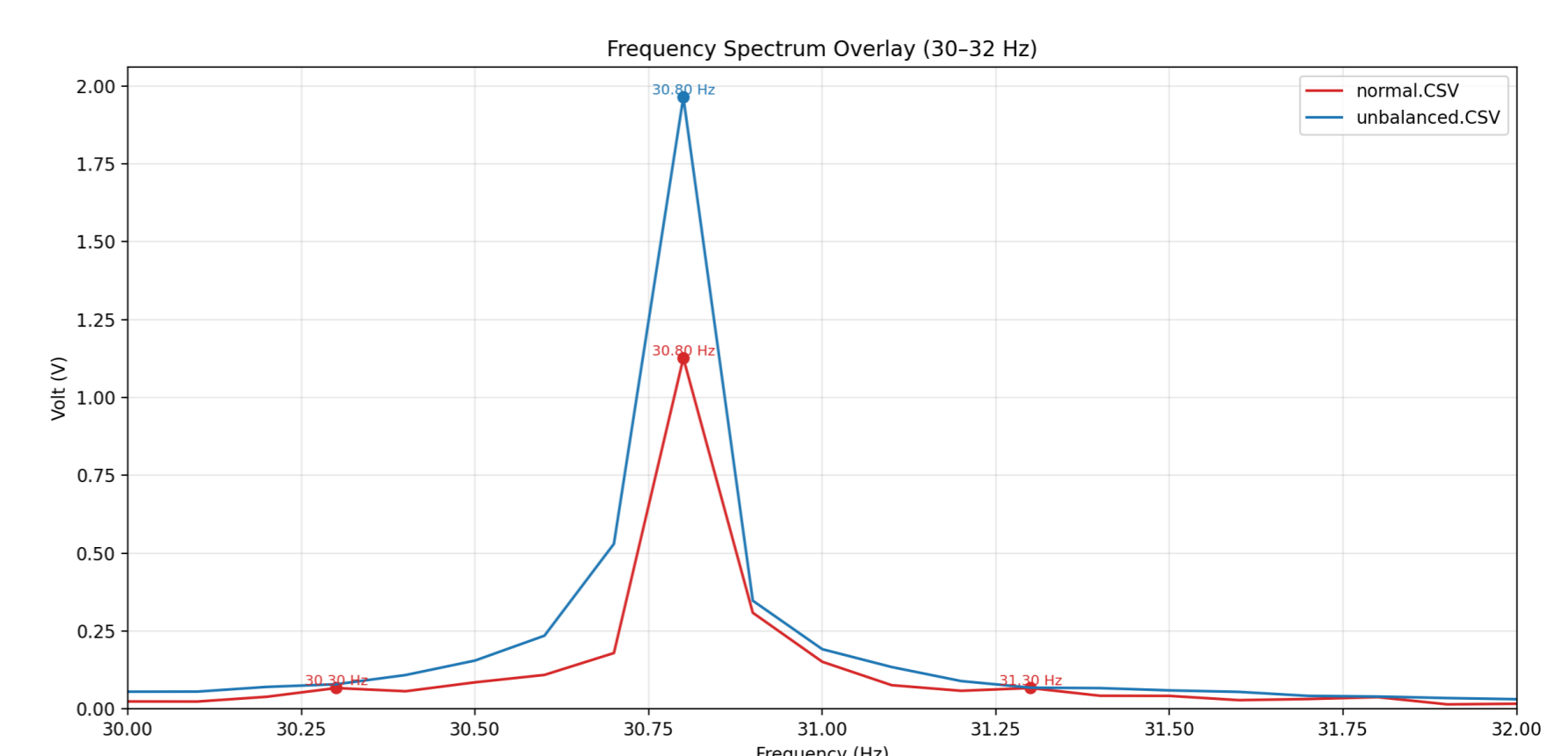


Fig. 6 Amplitude Increase under Rotor Unbalance

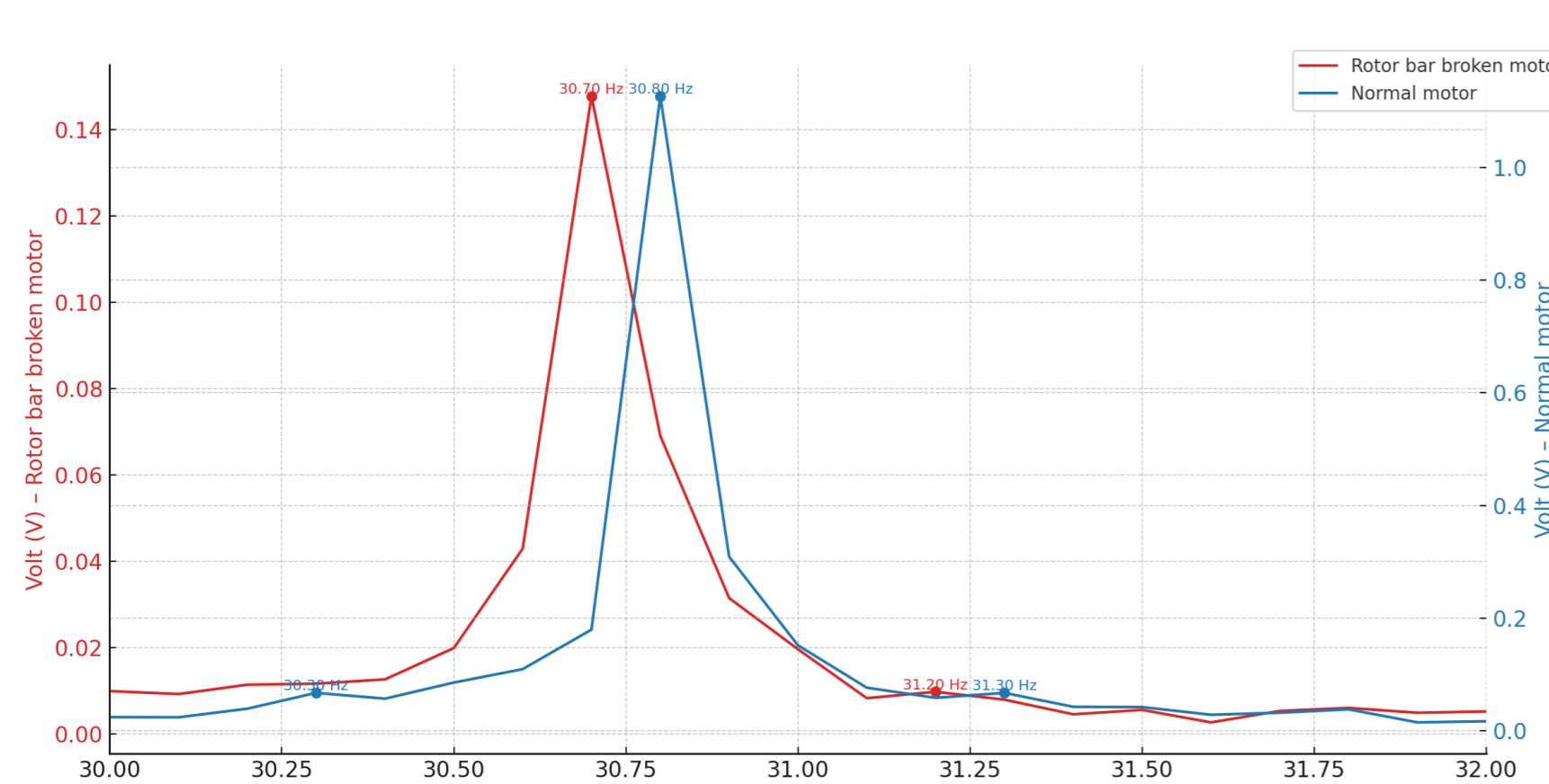


Fig. 7 Peak Shift Left under broken rotor bars fault

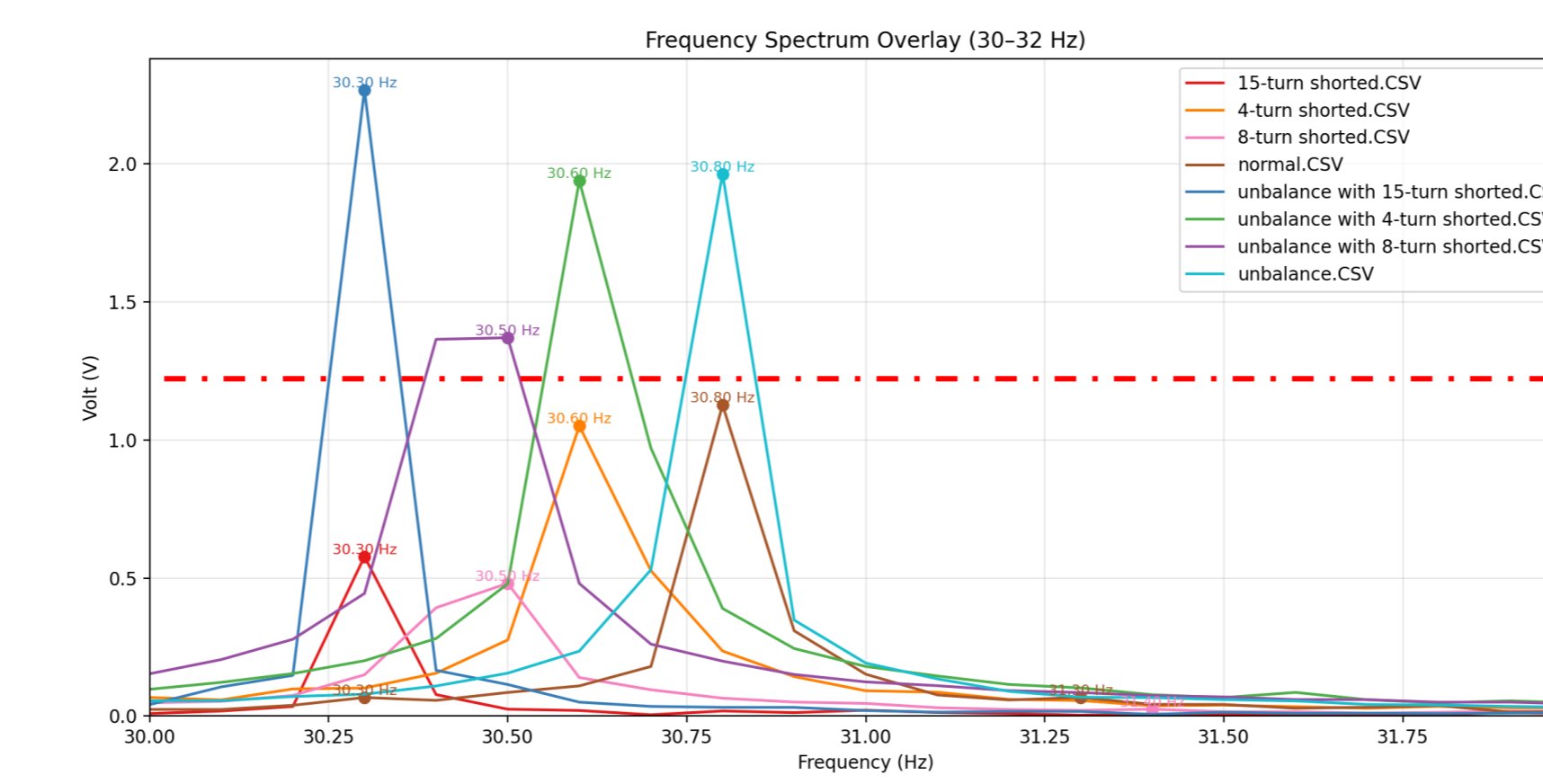


Fig. 8 Mixed faults

Conclusions

The results show that the proposed two-dimensional FBG vibration sensor can reliably detect motor behavior under normal operation, varying loads, and multiple fault types such as inter-turn short circuit, rotor unbalance, and broken rotor bars. Its immunity to electromagnetic interference ensures stable performance, demonstrating its sensitivity, stability, and effectiveness for fault detection in high-end industrial equipment.

Cost Assessment	Time	Cost
Estimation	50 days	3000 dollars
Actual Completion	30 days	3000 dollars

