# *Temperature Monitoring System of Fiber Bragg Grating of Transformer Based on High-precision Demodulating Algorithm by Wavelet Denoising*

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***Abstract***

**Temperature accuracy of the temperature monitoring system can reach ±0.05℃ and the average wavelength error after wavelength demodulation is better than 0.5pm in the range of 60℃ to 80℃.**

## *Temperature Monitoring System*

Power transformer has 3 phases (A phase, B phase and C phase) and 6 windings. Except core and shell, windings of transformer are installed temperature monitoring system of fiber bragg grating. The light emitted by the Distributed Feedback Laser (DFB) enters circulator and FBG sensor. The reflected light is converted into current by the detector (PD), then converted into voltage by the logarithmic amplifier (LA), and enters the analog-to-digital converter (ADC). The temperature of Vertical Cavity Surface Emitting Laser is maintained at a constant value (30℃) under the control of temperature controller (TEC). Programmable circuit source (PCS) provides Sawtooth modulation current (10mA to 100mA) with a tuning rate up to 1 kHz is exerted for the laser. Analog-to-digital converter controlled by microcontroller unit (MCU) collects data of spectrum. Then data of spectrum is sent to personal computer for further wavelength demodulation and data processing.

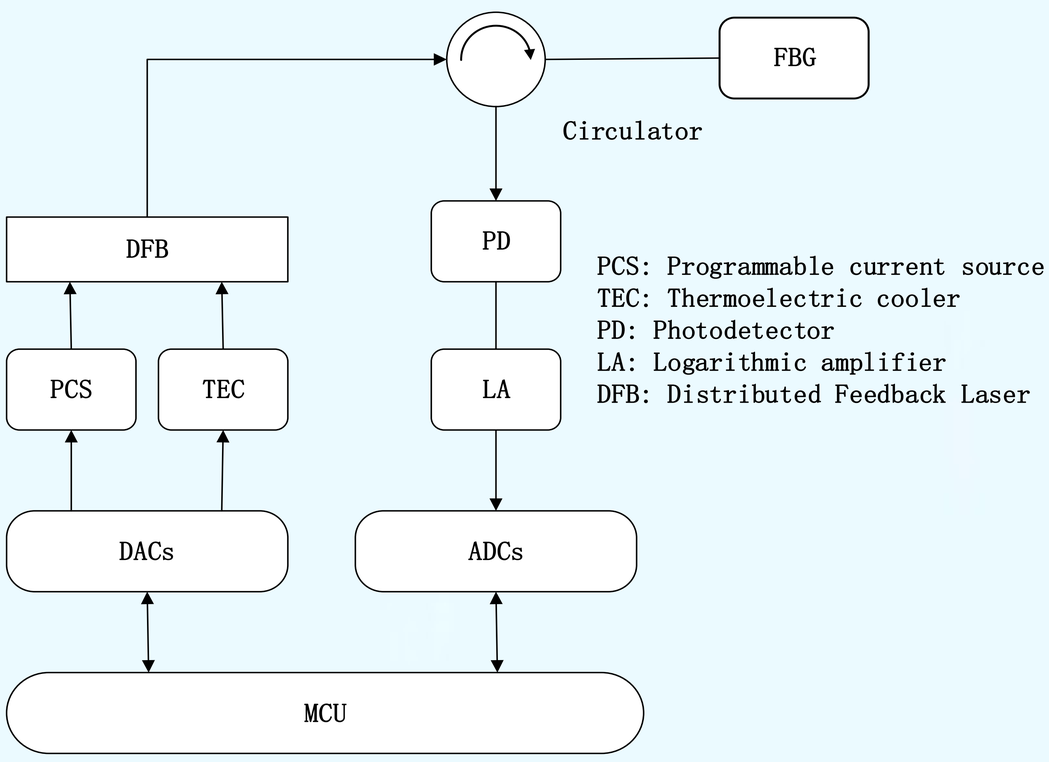



Figure.1. Schematic diagram of transformer temperature measurement system

## *Wavelet Denoising Algorithm*

Threshold increases from 15 to 105 and calculates corresponding correlation coefficient. Figure 2 shows the correspondence between threshold and correlation coefficient. From the picture we can see, the correlation coefficients are 0.9479 and 0.9480 respectively when the threshold is set 45 and 65. Though the correlation coefficient increase 0.0001, threshold rise 20. We set up 45 as threshold whose correlation coefficient is 0.9479 in case of waveform distortion. Figure 3 describes the original waveform and denoised waveform.

The implementation steps of the high-precision wavelength demodulation algorithm of fiber bragg grating based on wavelet denoising are as follows:

Step1: Collect the reflected spectrum waveform of the fiber bragg grating sensor.

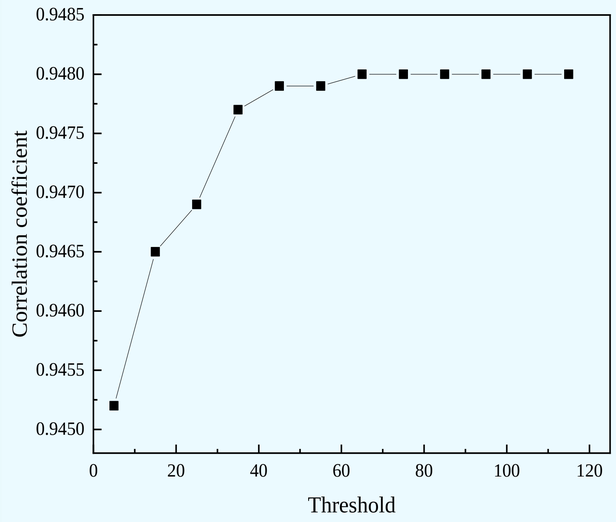
Step2: Spectrum waveform is denoised by wavelet threshold method.

Step3: Multiplicate function denoised with π and reciprocal to get new function.

Step4: Make convolution between function denoised and new function.

Step5: Calculate Independent variable that function value is more than zero.

Step6: Calculate the minimum of independent variable defined to be peak point.



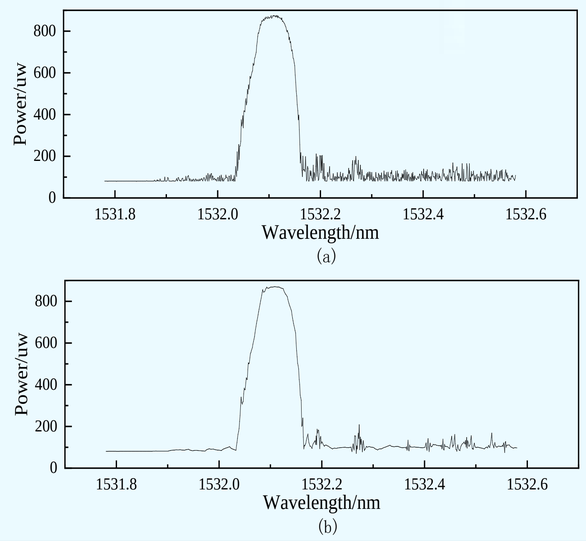




Figure.2. threshold and correlation coefficient Figure.3. Original spectrum and denoised spectrum

## *Experiment Procedure*

The experience contrasting temperature with wavelength is operated in a water tank that maintains a constant temperature in the range of 65.3℃ to 79.4℃. The temperature of windings of transformer is demodulated by finding peak directly algorithm, Polynomial fitting algorithm, Gaussian fitting algorithm and wavelet denoising algorithm respectively. Monitoring time is from 1:30 to 9:30. Figure 4 shows Winding temperature of A phase of transformer.

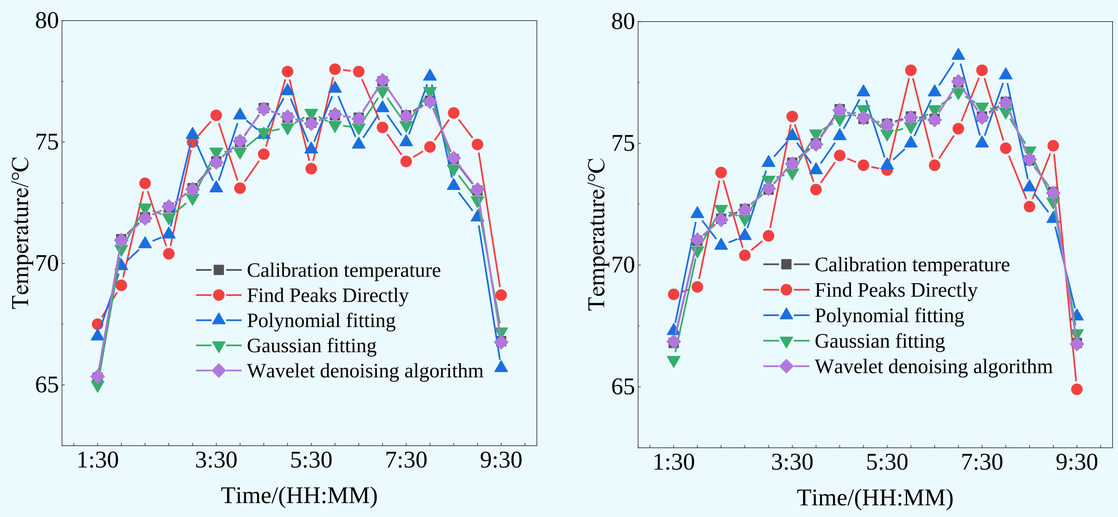



Figure.4. Winding temperature of transformer A phase(High phase and Low phase)

## *Conclusion*

The result shows that the features of temperature monitoring system of fiber bragg grating are highly speed and excellent stability. The temperature accuracy can reach ±0.05℃ and the average wavelength error after wavelength demodulation is better than 0.5pm in the range of 60℃ to 80℃. In conclusion, the temperature monitoring system of fiber bragg grating based on wavelet denoising algorithm can apply to real-time online high-precision temperature detection of transformers.

About the Author

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