

The Application of Wavelet Transform in Real-time Data Compression of Power System

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Abstract. For power system real-time data capacity is large, and the actual storage space is limited. This paper proposes a real-time data compression method based on wavelet transform. This method compress and decompress real-time data in power system through compactly supported orthonormal wavelet. The results show that this method achieves compression of the original data. It is possible to obtain a higher compression ratio and shorter compression time, and it is an effective real-time data compression method.

Introduction

With the development of automation and intelligent in power system, the real-time data is growing fast in electricity production. In order to improve production efficiency and optimize the operation, it must integrate a variety of real-time data. It is necessary to effectively save vast amounts of time series data formed many years, then power enterprise can use these data for analysis, mining and forecasting. The data in electricity production process is collected by various types of sensors, so it is dynamic. It is unrealistic to save the data in the form of raw data for long term, because the data collected by many sensors refresh fast, it is very large. So the study of data compression method suit for engineering applications and actual demand has become the urgent needs in power system[1-4].

Now the popular lossy compression algorithm are boxcar - backward slope method, revolving door compression algorithm and PLOT method[5-7]. Revolving door compression algorithm is more popular, it also knows as parallelogram algorithm. Overall, it is a linear trend compression algorithm, and its essence is to fit a series of consecutive data points by a determined straight line.

For specific data, this algorithm can find out the longest straight line trend as much as in a predetermined maximum allowable error range, that trend can be determined by the last two points, all points in the middle are discarded, so as to achieve the purpose of data compression [8].

Revolving door compression algorithm is relatively efficient in dealing with most real-time data channels, especially for the steady-state environment (without interference) can achieve very high compression ratio [9]. But the defect of this algorithm is also very obvious. Therefore, this article attempts to propose a compression method suitable for historical data which can efficiently compress steady and unsteady historical data and also can fast storage and access this data[10].

This paper proposes a time series data compression method based on wavelet transform. First, it processes time series data through wavelet decomposition technology, then abandons wavelet coefficients which have smaller mold through setting the threshold value, and then designs a compact compression to storage data after conversion.

Wavelet Transform Algorithm

Define $\Psi(t) \in (R)(L^2(R))$ as square integrable real space, namely it is finite energy signal space, its Fourier transform $\hat{\Psi}(\omega)$, when $\hat{\Psi}(\omega)$ meet permit conditions,

acquisition system itself, the substance of wavelet compression and wavelet denoising is same, so for processing applications in the compressed data, these compression errors do not have a big impact. Or in a sense, this algorithm can remove the noise effectively, and make data to be closer to the original data.

Experimental results

The following are some examples of power system measurement real-time data for compression which adopting Daubechies 10 wavelet method. the data quantity is about 1024.

With the wavelet transformation, it get the detailed coefficient as below:

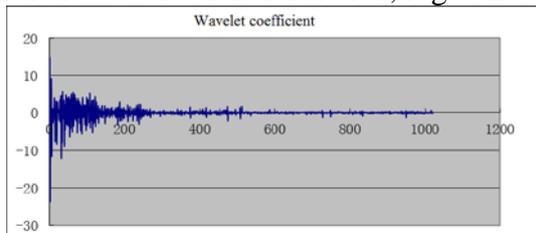


Fig.1 the wavelet coefficient of Daubechies 10 wavelet

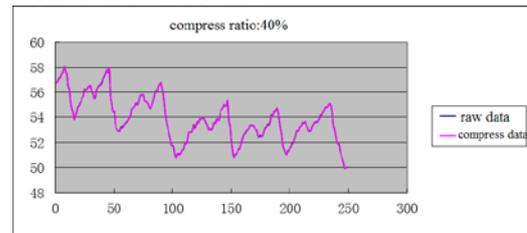


Fig.2 the compress ratio with the data error is 0.001

From the diagram, the most coefficients is 0 or close to 0, if the accuracy of the data error is 0.001, then the compress ratio is 0.4.

If the accuracy of the data error is 0.01, then the compress ratio is 0.95. As show Fig3.

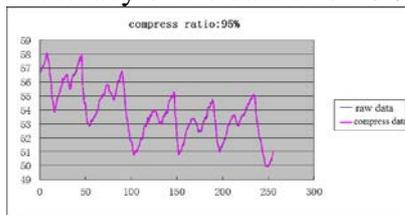


Fig.3 the compress ratio with the data error is 0.01

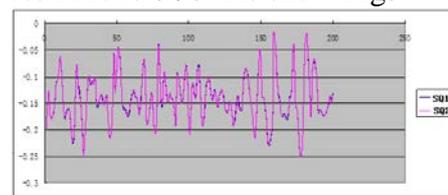


Fig.4 the compress ratio of jitter data with the data error is 0.001

If we do the experiment with jitter data, With the same accuracy of data error of 0.01, the compress ratio of irregular data is lower than the regular one whose compress ratio is 0.26. As show Fig.4.

If we do the experiment with a group of more regular data, we can see that with the accuracy of the data error of 0.0001, the compress ratio is 0.9, which is also very high. Show as Fig.5.

With the above data, if we make the comparison between wavelet transformation(WT) and Swing Door(SW) compressing in real-time data compress, we can get that the performance of compression is close. both of them are in the tolerance. The result is show as Fig.6.

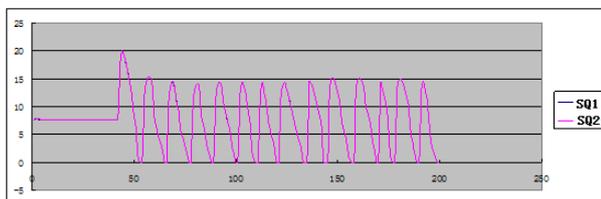


Fig.5 the compress ratio of regular data with the data error is 0.0001

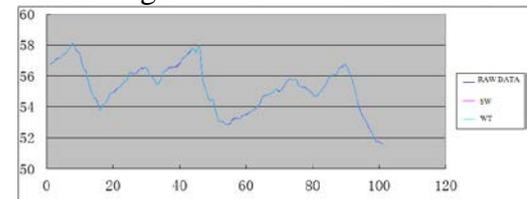


Fig.6 The comparison between wavelet transformation(WT) and Swing Door(SW)

On the other hand, we applied the test of timeliness to wavelet transformation compressing, we can get the wavelet response to regular or irregular tests according to the timeline show as Fig.7.

The relationship between data quantity and time of irregular exchange data show as Fig.8.

The diagram above shows that with the data quantity between 56 and 16384, the consumption time of compressing or uncompressing is proportional to the quantity of data. Because we need to consider the appropriate tolerance, it will take more time of uncompressing than compressing, so no matter compress or uncompressing. The unit of time is millisecond.

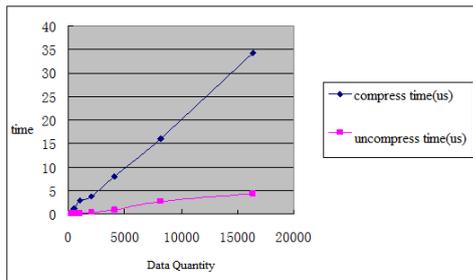


Fig.7 The relationship between data quantity and time consumption of regular exchange data

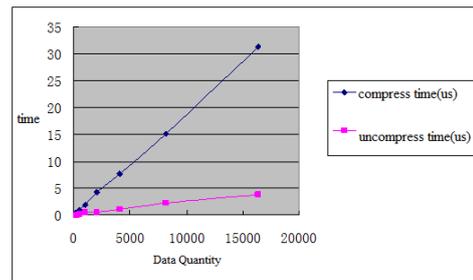


Fig.8 relationship between data quantity and time consumption of irregular exchange data

Conclusion

This paper proposed a power system real-time data compress method based on wavelet transformation. It verified by read data. With the result shows that this method is effective and correct. It is Wide application value in power system real-time data compress, because the compressing ratio is high, the loss of data is low and with the effect of noise reduction in raw data. Also, wavelet transformation data compress time consuming is small, when the value is smaller than 10000 points, the unit of time consuming is kept about millisecond, which is totally satisfied in the real-time processing of power system. This method can save the space for storing real-time data, and it can ensure the performance of data uncompressing. so it is convenient in the application of project, it can promote the intelligent power system to achieve a new era.

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