# Real-time Traffic Data De-noising Based on Wavelet De-noising

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**Abstract.** As a variety of interference exists in the real-time traffic data in the actual sampling environment and the traffic data is not stable, we do wavelet decomposition for traffic data in this paper. In order to get better de-noising effect, we add the noise to a set of given similar traffic signal, and then use the soft and hard threshold to deal with the noisy signal. The simulation results show that the traffic signal after hard threshold de-noising can see the peak value and underestimate value clearly. Therefore, we select the hard threshold method to deal with the real time traffic signal, which can provide an effective basis for the prediction of the traffic intersection and the control of the signal.

#### Introduction

Intelligent transportation system is an effective way to solve the current congestion frequent traffic accidents and environmental pollution problems. Dynamic real-time traffic information plays an important role for the success application or not. The information collected in this complex measurement process makes the information collected far from the correct value due to the presence of various kinds of interference. Thus the actual sampling data generally will be subjected to different levels of noise pollution, which may lead to incorrect results and impact of the use of the data. Therefore, eliminating or reducing a variety of noise and errors and improving the quality of traffic information, have important practical significance and value [1,2]. Prediction time dimension based on a single and time series is difficult to solve the randomness and uncertainty of the problem in highly complex traffic flow, thus the effect of prediction is not satisfactory. In the time dimension traffic flow showed a strong nonlinear, time-varying and uncertainty that common prediction method is difficult to achieve forecast accuracy[3].

Therefore, we try to use wavelet transform for a frequency division and single reconstructed to give the corresponding high frequency components and low frequency component and the resulting component is relative simple and smooth. Higher overall traffic flow forecasting results obtained forecast accuracy is achieved through the full use of signal noise elimination process. Threshold de-noising is the process that removes only those details exceed a set of value and removes noise while preserving high frequency useful signal. Advantages de-noising by threshold method are the noise almost completely suppressed, the calculation speed threshold method done quickly, and the characteristics of the peak point of the original signal well preserved[4, 5].

#### De-noising by wavelet transform threshold

Transform Threshold method is also known as "wavelet shrinkage (wavelet shrinkage)", which de-noising method is as follows:

Supposed that a finite length signal superimposed white Gaussian noise can be expressed as:

$$y_i = x_i + Sz_i (i = 0, 1, L, n - 1)$$
 (1)

Among them,  $z_i$  ---- a standard Gaussian white noise; s ---- Noise level.

To recover from the noise pollution in the original signal  $y_i$  signal  $x_i$ , the wavelet threshold method is divided into the following three steps:

(1) Calculate the noisy signals orthogonal wavelet transform, Select the appropriate wavelet and wavelet decomposition level j, do the noisy signal wavelet decomposition to j layer, and give the corresponding wavelet coefficients.

(2) achieving the decomposition of the wavelet coefficients obtained by performing threshold processing, there are 2 types for the threshold processing method:

Hard threshold method:

$$\hat{x} = T_h(Y, t) = \begin{cases} 0 & |Y| \mathbf{p} \ t \\ Y & |Y| \ge t \end{cases}$$
(2)

Soft threshold method:

$$\hat{X} = T_h(Y, t) = \begin{cases} \text{sgn}(Y)(|Y| - t) & |Y| \ge t \\ 0 & |Y| < t \end{cases}$$

Inverse the wavelet transform .The threshold treated by wavelet coefficients reconstruction make us get the restoration of the original signal estimated value of  $\hat{x}$ . Wavelet transform has a "centralized" capability and it will focus on a small number of energy signals to the wavelet coefficients, and white noise on any orthogonal transform base is still white noise, and has the same magnitude [6]. Relatively speaking, the signal wavelet coefficients of wavelet coefficients must be greater than those of smaller energy dispersion and amplitude noise. Choose an appropriate threshold for wavelet coefficients threshold, so it can achieve the purpose of removing noise while retaining the useful signal.

(3)

Do wavelet reconstruction and inverse the process of decomposition of the low-frequency coefficients to get the high frequency coefficients that were sampled and low-pass and high-pass filtering, the wavelet reconstruction based on the N-layer low frequency coefficients and high frequency coefficients after demonetization process, the restoration of effective.

Reconstruction algorithms:

$$c_{j,n} = \sum_{k \in \mathbb{Z}} c_{j-1,n} h_{n-2k} + \sum_{k \in \mathbb{Z}} d_{j-1,n} g_{n-2k}$$
(4)

#### De-noising simulation of the soft, hard threshold methods

Advantages threshold de-noising noise almost completely suppressed. Threshold calculation speed quickly, and reflect the characteristics of the peak point of the original signal are well preserved. Wavelet analysis can signal de-noising on multiple scales wavelet decomposition. Signal and noise can be obtained in a number of different transfer characteristics and performance characteristics of different scales. Mainly for high frequency noise signals, so that the signal to noise separation is possible. It based on wavelet theory, combining the characteristics of the traffic flow, using threshold method de-noising observed traffic.

**Soft and hard threshold de-noising simulation.** This article will use the MATLAB simulation of a group of approaching traffic signal Noise-bump signal, joined the Gaussian white noise. The signal is then decomposed to use wavelet coefficients in 6 floors. Respectively soft and hard threshold to obtain a signal de-noised. Loading an original signal and adding white Gaussian noise, shown in Fig.1 as follows. The noise wavelet decomposition, the decomposition of six layers, each layer coefficient decomposed to determine the threshold. Then were de-noising soft threshold and hard threshold. Wavelet coefficients of wavelet reconstruction process, shown in Fig. 2:



Figure 1 Original signal and the noisy signal diagram



Figure 2 Both the threshold de-noising Graphics

Analysis of simulation results. As can be seen from the simulation results, the original signal waveform and two de-noised waveform comparison can be seen with a soft threshold waveform looked after more smooth, and more good overall continuity. But the peak of the signal and underestimate the value is not obvious, so it is drowned out by the noise. Although the threshold de-noising waveform after additional vibration, the singular point more obviously. we can clearly see peaks and underestimate the value of the signal waveform. Meanwhile, in order to be more accurately, it represents the de-noising results can be calculated after de-noising the signal to noise ratio (SNR) and root mean square error (RMSE).

Obtained from the above formula shows that the higher the signal to noise ratio. The root means square error of the original signal and the de-glitched smaller, more close to the original signal de-noising signal, de-noising effect is better[7]. Table 1 lists the two types of signal to noise ratio (SNR) and root mean square error (RMSE) of different treatment methods.

Performance	Soft	Hard
measurement	threshold	threshold
indicators	method	method
Signal to noise	85.1506	168.2430
ratio (SNR)		
Root mean square	19.3905	14.3344
error (RMSE)		

Table 1 SNR and RMS error of two methods of comparison

In this paper, through contrast, come with a hard threshold effect is more in line with our requirements. So the next hard threshold method to collect real-time traffic data de-noising.

## Using MATLAB wavelet decomposition

Zhuanghe is the link connecting the main road between the highway and the radial trunk roads and the central city roads. Currently the main road traffic information collection mode using an ultrasonic detector, hanging, divided lanes installed, the parameters collection is divided by vehicle traffic lane, speed. Data collected using GPRS network and Internet network transmission, the time interval is 15 minutes. The detector detects the data reflect a lane-day road traffic. Noise signal is not conducive to find out the rules, is not conducive to the traffic forecast. If there is no proper de-noising, its storage, retrieval, interactive and use will become a bottleneck, hence the need for de-noising dynamic traffic data.

The real-time collection of traffic data signal loading MATLAB, as shown in Fig. 3. You can see there are a lot of original traffic signal fluctuations, more noise, we can not clearly see its peak and underestimate the value. Wavelet reconstruction is shown in Fig. 4.



Figure 3 Loading original traffic data map Figure 4 After a hard threshold de-noising FIG. After a hard threshold, we can see different time periods of peak traffic and underestimate the value.

## Conclusions

Road traffic volume forecast is hot and difficult international ITS research. But multiple sources and diversity of road network makes traffic information processing difficult. In this paper, the original traffic data were de-noising processed based on wavelet analysis theory. So that the de-noised data better reflect better the nature and the changes of the traffic flow.

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