Wind Speed Data Analysis for Various Seasons during a Decade by Wavelet and S transform

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ABSTRACT

The prediction of Weather forecasting can be done with the Wind Speed data. In this current paper the concept of using Wavelet and S-transform together for the analysis purpose of Wind data is introduced first time ever. In winter due to low convection process the agitation between wind particles is less. So, the Haar Wavelet is used to detect the discontinuity in the less agitated wind data samples of Winter. But due to abrupt changes in wind data in summer, it is difficult to track the data. So, in that case the concept of the S-transform is introduced.

KEYWORDS

Continuous Wavelet Transform, S-transform, Wind Speed.

1. Introduction

The present paper is focused on time-frequency analysis of wind speed data. Currently wind energy is a hot topic as it is one of the important non-conventional energies. We know that Weibull distribution is a very popular tool for wind energy purpose [2, 5]. The usefulness of signal processing tools are increasing in case of wind engineering purpose. For low wind speed analysis purpose use of discrete Hilbert transform (DHT) along with weibull distribution is shown in ref [2]. The discrete Hilbert Transform (DHT) can be used as minimum phase type filter for characterizing and forecasting purpose of Wind speed data is showed by Mukhopadhyay et al., [4]. Mukhopadhyay et al., also showed the optimized DHT and RBF neural network basis analysis for Wind power forecasting purpose [3]. The utility of Wavelet in weather related application was already shown by Panigrahi et al., [1]. The application of wavelet transform in the field of Ocean technology was shown by Liu et al., [8]. In 2005, the wavelet transform was used for wind data simulation of Saudi Arabia region by Siddiqi et al., [10]. Thereafter in 2010, the wavelet transform was used to analyze the wind data in Dongting lake cable stayed bridge region by He et al., [9]. Wind speed data of summer of Eastern region of India was analysed by the continuous wavelet transform and multifractality by Mukhopadhyay et al., [7]. Mukhopadhyay et al., previously applied s transform along with wavelet transform for wind speed data analysis over a year [12]. In this current work, authors are basically interested on the analysis of average wind speed data over a decade on the basis of Wavelet and S-transform.
2. Methodology

In winter (December-January) due to less agitation between wind particles, these wind data are easily analysed with the Continuous Wavelet Transform. Here we used the Daubechies-4 wavelet to detect the continuity between the data of winter. But in summer (April-June) due to high agitation between wind particles, these wind data are first fed into Median Filter to remove the fluctuations. Thereafter these data are fed into S-transformer to get the desired result. In the current work, the below flow chart is followed:

Wind data → Median Filtering → S-Transformer → The desired output

**Figure-1** Flow chart of steps for s-transform analysis of Wind data of summer

3. Results and Discussions

In below for experiment purpose we took average wind speed data during a decade consists of 3 months, such as- December, January and February. In each case of data, we applied Daubechies-4 Continuous Wavelet transform and tried to follow the continuity of the data plot shown in Figure-2a-2c.

![Graph](image)

**Fig-2a** Daubechies-4 Continuous Wavelet Transform for average wind speed data (during a decade) plot in case of December


Figure-2b Daubechies-4 Continuous Wavelet Transform for average wind speed data (during a decade) plot in case of January

Figure-2c Daubechies-4 Continuous Wavelet Transform for average wind speed data (during a decade) plot in case of February
Here, we noticed that in case of Figure-2c we couldn’t track the continuity of the average wind data in February month. Because from February due to rise in convection process, the agitation also exceeds. So, due to the agitations in wind speed data in we couldn’t track it by Daubechies-4 Continuous Wavelet Transform.

We also tried with other wavelets such as Symlets, Coiflets, Morlets etc on highly agitated wind speed data but were unable to get the desired results. So, for resolving this kind of problem, we employed s-transform for tracking the high fluctuations average wind speed data during a decade of summer. These fluctuated data are first fed into median filter. The plots are shown in the below Figure-3a to 3c.

![Figure-3a](image-url)

**Figure-3a** Average wind speed data (during a decade) plot of April after Median Filtering
Figure-3b Average wind speed data (during a decade) plot of May after Median Filtering

Figure-3c Average wind speed data (during a decade) plot of June after Median Filtering

After median filtering these average wind speed data of decade are fed into s-transform analysis purpose to get the desired result. The plots are shown in below Figure-4a to 4c.
Figure-4a S-transform of average wind speed data (during a decade) in April

Figure-4b S-transform of average wind speed data (during a decade) in May
4. CONCLUSIONS

From the above results and discussions, it is clear that Daubechies-4 Continuous Wavelet Transform is useful only for stratified average wind speed data analysis of winter for a decade. But in summer of decade S-transform on median filtered average wind speed data is very useful for the stratified Wind speed data analysis purpose. The authors hope that the current work will certainly establish a new era for the application of wavelet and s-transform in case of Wind Engineering purpose.

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