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EMPIRICAL MODE DECOMPOSITION FOR POWER QUALITY ASSESSMENT AND IMPROVEMENT

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Submitted

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CERTIFICATE

This is to certify that the thesis entitled “**Empirical Mode Decomposition For Power Quality Analysis And Improvement**” which is being submitted by Ms. Stuti Shukla to the Indian Institute of Technology Delhi, for the award of **Doctor of Philosophy**, is a bonafide research work carried out by her. She has worked under our supervision and guidance and has fulfilled the requirement for the submission of this thesis. The thesis, in our opinion, has attained a standard required for a Ph. D. degree of this institute. The results contained in this thesis have not been submitted elsewhere in part or full for the award of any degree or diploma.

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ABSTRACT

The emerging electric power network can be conceived as a medium which facilitates exchange of energy among its customers where customers of the network are not solely the end users of electricity. Moreover, with the growing number of customers need to maintain the reliability of the network also rises. Since the exchange of energy takes place through voltages and currents, these variables should strictly observe the constraints on their deviations from the nominal value. New advancements like integration of distributed generation to the network system and advancement in converter based loads such as adjustable speed drives (ASD) have given rise to several disturbances that cause interference in smooth exchange of energy among the network users. Moreover, electric power quality has become an important issue in the deregulated power systems. It is one of the differentiating factors among competitive suppliers. Hence it becomes necessary for any organization to employ effective power quality indicators that evaluate the quality and identify the disturbances and then obtain cost effective solutions to mitigate them. As more and more sensitive equipment continue to proliferate the studies of power quality require more emphasis.

Most of the research attempts are dedicated towards developing a robust technique for power quality assessment and improvement. Assessment of an event involves developing signatures for the event which forms the basis for disturbance identification. In this work, recently proposed Hilbert Huang Transform has been employed to extract the inherent features of an event. A comparative study between S-Transform and Hilbert Huang Transform is also made to judge the superiority of the later over former. Waveform processing is a multi-step task as the practical signal

may have presence of noisy components apart from the event characteristics and therefore corrupted signal has to be freed from noise before getting processed for feature extraction. De-noising requires exclusion of low energy components that are expected to be significantly corrupted by noise. In this work, a signal is decomposed into its inherent oscillating modes using EMD (Empirical Mode Decomposition) which are then thresholded to remove the noisy components. A comparative analysis between three de-noising methodologies (wavelet, S Transform, EMD) is also made in the work.

Since the frequency is informative about the energy balance between sources and loads it has a prominent role in monitored parameters and apart from white noise, system also has sine noise and therefore estimation of fundamental frequency component present in a harmonic embedded signal is an important aspect of power quality assessment. In this work, efficiency of signal processing techniques in online tracking of fundamental frequency is studied. A comparative analysis between three signal processing methodologies-Fourier Transform, S Transform and Hilbert Huang Transform is made in the work.

Major problems occurring due to these sine noises or harmonics include heating of the motor loads, increased neutral currents, relay malfunction etc. Therefore, it becomes imperative to install compensating device to eliminate the threats posed by these harmonics and the shunt active filters are viable solution to this concern. However the performance of the shunt AF mainly depends on the three phase reference current estimation which forms one of the important objectives in development of a robust device for power quality improvement. In the proposed work,

EMD (Empirical Mode Decomposition) is employed to improve the performance of a shunt active filter under varying system frequency, unknown system frequency and unbalanced load conditions. Design and simulations of AF are carried out in MATLAB SIMULINK and hardware implementation of EMD is realized using a DSP processor to validate the design and control algorithm.

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