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Voltage variation analysis by using gabor-transform

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ABSTRACT – Voltage variations which include voltage sag, swell and interruption are modeled and analyzed in this paper. Various types of models are built with the help of MATLAB Simulink. Simulated signals are studied by using time-frequency distribution (TFD) technique. The signal parameters like root mean square voltage (Vrms) and so on are extracted from the TFR to study the distinctives of the voltage variations. The PQ waveforms as well as signal parameters obtained are suitable to be further analyzed.

1. INTRODUCTION

Power Quality (PQ) is becoming a severe worry to users nowadays in all kinds of fields as the effects created by PQ cannot be overlooked [1]. Poor PQ can bring bad effects to the machines or production as indicated by IEEE Std. 1159-2009 [2]. In this research, voltage sag, swell and interruption are studied, and their parameters are being extracted. This paper presents the voltage variation signals by using the MATLAB Simulink models studied from the previous works [3].

Number of methods were reviewed by research workers for analysing PQ problems as such. In this research, Gabor-Transform technique is applied to analyse the disturbances of PQ by exhibiting the signals obtained in time-frequency representation (TFR) which consist of time and frequency format as to overcome the limitation of spectrogram in previous work [4].

2. RESEARCH METHOD

Figure 1 below shows the flowchart of this paper. The voltage variation signals which consist of voltage sag, swell and interruption will be simulated from MATLAB Simulink and then analysed through Gabor-Transform, which is one of the time-frequency distributions (TFDs) techniques. The Simulink modelling is referred from the previous works [3,4]. Power quality parameters such as root mean square voltage and instantaneous power will be calculated from the time-frequency representations (TFRs) obtained.

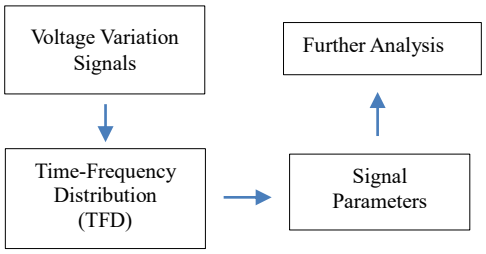


Figure 1 Flowchart of the research.

2.1 Gabor-Transform

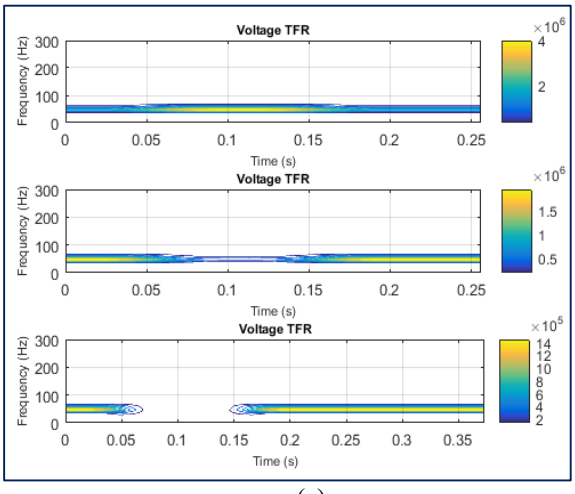
The time and frequency resolution for Gabor-Transform is differ with spectrogram [5]. It is defined as:

$$G(t,f)=\left|\int_{-\infty}^{\infty}x(\tau)e^{\frac{-(\tau-t)^2}{2\sigma^2}}e^{-j2\pi f\tau}d\tau\right|^2 \quad (1)$$

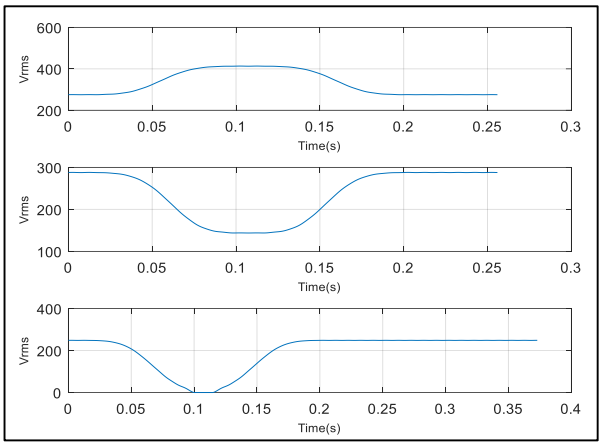
where $x(\tau)$ is the input signal and σ is sigma.

3. RESULTS AND DISCUSSION

The variation signals are obtained by simulated in the Simulink modelling. The fundamental frequency and sampling frequency is 50Hz and 12kHz respectively. The TFR and Vrms graph of Simulink models are presented in Figure 2(a) and (b). The parameters acquired from the TFD are tabulated in Table 1.



(a)



(b)

Figure 2(a) TFR of Simulink models (b) Vrms graph of Simulink models.

Table 1 Tabulation of power quality parameters.

Categories	Variation	Values Obtained
Root-mean square voltage (Vrms)	Interruption	231.02V
	Sag	257.99V
	Swell	262.07V
Total Harmonic distortion (THD)	Interruption	38.98%
	Sag	19.57%
	Swell	15.12%
Instantaneous Power	Interruption	1894.81W
	Sag	2596.10W
	Swell	2483.13W

Based on the TFRs and Vrms graphs obtained, the signals were detected at 50Hz. The higher the power was the lighter the color will be indicated, while the darker color indicated lower power. The voltage variation occurred from 0.05s until 0.15s (which had a period of 0.10s) with an increasing magnitude and Vrms differed from the initial value was voltage swell. During voltage sag, there was a sudden decrease in power magnitude from normal magnitude as well as Vrms in between 0.05s to 0.15s. During the occurrence of voltage interruption, there was a sudden halt between 0.05s to 0.15s in power magnitude where no magnitude was acquired. The Vrms during 0.05s to 0.15s dropped to zero when voltage interruption occurred. The Vrms was then returned to normal after the period of voltage interruption was over. The Vrms, instantaneous power and THD were extracted and calculated from the TFR obtained of each case.

In general, Gabor-Transform analysis is more computationally complex and this method enables direct energy projection in time-frequency plane. So, it is possible to evaluate the disturbance energy and localize it in time and frequency domains accurately. Therefore, Gabor-Transform can be applied in postprocessing to monitor the power supply and power quality.

4. CONCLUSION

Simulation of voltage variations has been performed with the help of MATLAB software. The signals simulated can be analysed by using TFD technique to extract the features of the signals. The features extracted can be applied for further analysis.

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