Matlab Simulation For Fault Analysis of Electrical Circuit on Hyperspectral Signal Processing

T. Arumuga Maria Devi, D. Muthukumar, Saji K.S.

Abstract*: *The power system contains generation, transmission and Distribution. Abnormal conditions which cause flow of huge current in the conductors through improper paths in the circuit can be defined as a fault. The fault created transient parts which contain inexhaustible flaw data and are resistant to the framework's anomaly have been broadly utilized in the fault examination. The simulation findings demonstrate the system voltage and load currents effects of faults. In this paper, the different voltage circuit information levels will be evaluated using Hyperspectral processing and it is used to determine the exact difference in voltage magnification and evaluate it through signal processing.

Keywords*: *RLC Resonant_circuit, Matlab Simulink implementation, Electrical Quality Analysis, Resistance, Measurement, Power_systems, Fault_Analysis.

I. INTRODUCTION

Power transmission is a foremost issue in electrical engineering after power generation. Fault in transmission line is common and main problem to deal with in this stream. The errors that occur in energy systems can be categorized as symmetrical and unsymmetrical errors. Increases in current and decreases in voltage and frequency in the failed stage characterize them. The different kinds of faults are single line and double line to ground fault[15]. The study of these faults are necessary to ensure that reliability and stability of the power system. Then paper approaches Matlab Application in which user friendly tool box will assist using that transmission line model design and various fault time will be given with the facilitate of signal builder[22].

After that various effects on bus system due to different are shown such as voltage, current and fault current output in terms of waveforms. By analyzing waveforms we can calculate which fault occurring is maximum[17]. A RLC circuit is contains a series or parallel linked resistor, inductor, and capacitor[23]. The circuit forms a harmonic present oscillator and resonates like an LC circuit. It enables to decay these oscillations by introducing the resistor (R).The resistor also decreases the frequency of the maximum resonant. In real circuits, a number of resistors are needed. The perfect LC or RLC circuit assumes the connecting conductors' 0 resistance.

A waveform is the shape of a curve that is acquired by plotting the immediate voltage or present values as ordered as abscissa against time. Figure 1.1.(a), 1.1.(b),1.1.(c) and 1.1.(d) indicates uneven waveforms, but each present or voltage cycle represents an exact replica of the prior one. Usually both positive and negative half waves have alternating electromotive force and currents generated by machines, the same shape as shown in Figure 1.1.(f) represents a sine wave of Alternate Current.

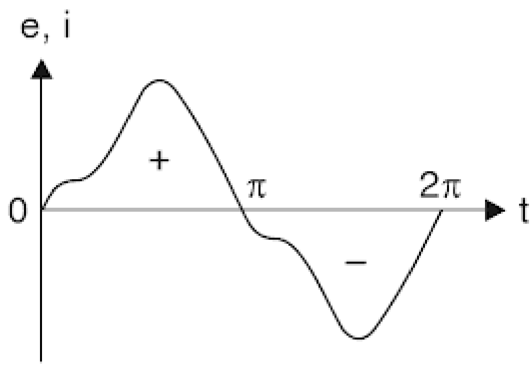

Figure 1.1.(a) Complex Wave

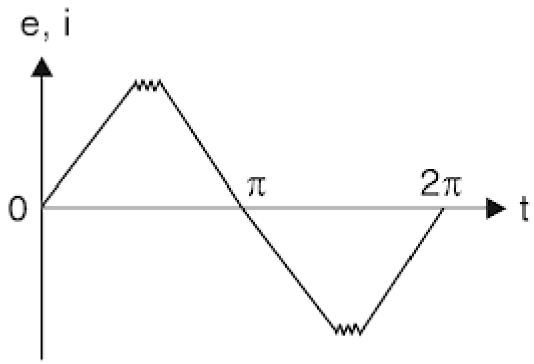

Figure 1.1.(b) Triangular Complex Wave

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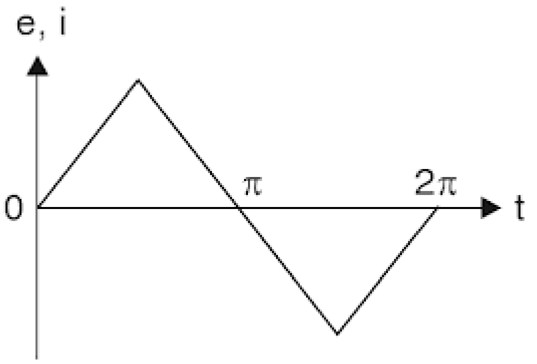

Figure 1.1.(c) Triangular Wave

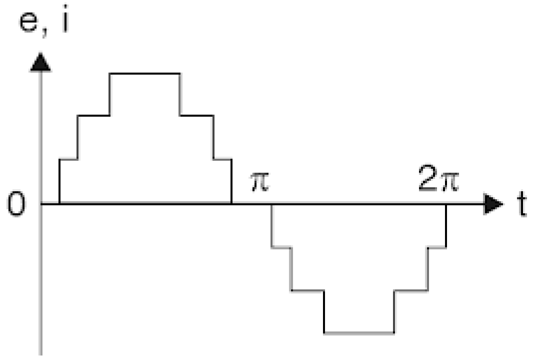

Figure 1.1.(d) Modified Square Wave

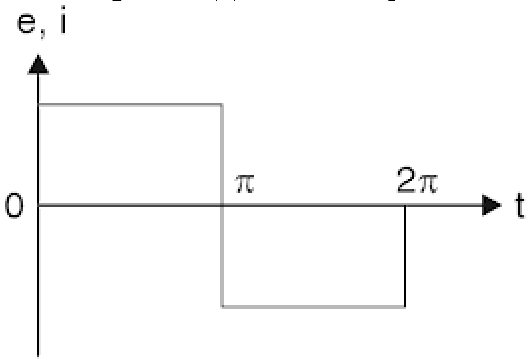

Figure 1.1.(e) Square Wave

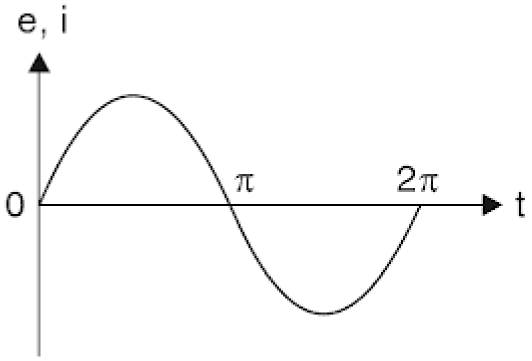

Figure 1.1.(f) Sine Wave

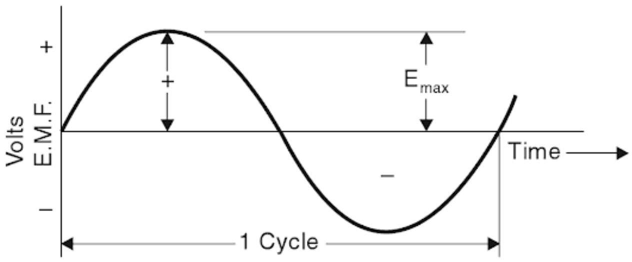

Figure 1.2 The sinusoidal voltage

The maximum value of an alternating quantity, whether positive or negative, is amplitude. The number of cycles is alternating volume frequency. Hertz (Hz) is its unit. The time taken to finish the cycle by an alternating amount is called the time period. A 50Hz AC current, for instance, has a 1/50 second time span.

Hyperspectral data analysis:

Hyperspectral data cube provides sufficient spectral information for more precise and comprehensive information extraction to recognize and differentiate spectrally comparable circuit data. Based on spectral data and spatial data, wide variety of sophisticated classification techniques is accessible[24].

To enhance classification precision, uncertainties in the image processing[10] chain must be identified and reduced[7]. Because of band continuity and limited sampling bandwidth, multiple mathematical techniques can be applied.

Hyperspectral information processing's main difficulties include reducing noise, recovering subtle absorption characteristics, analyzing spectral matching, classifying and creating library spectrum that can guide spectral classification.

Figure 1.2 demonstrates a Hyperspectral Data Cube spatial and spectral data.

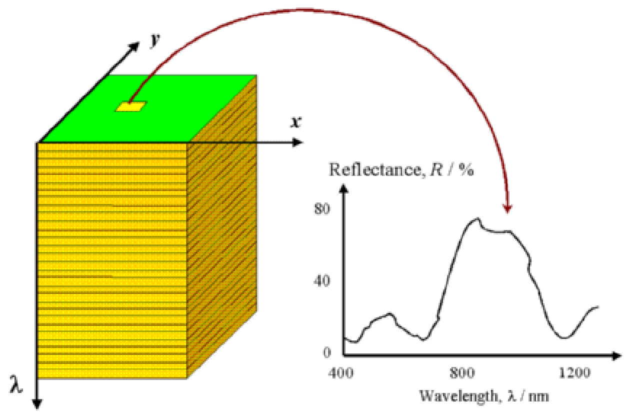

Figure 1.2 Hyperspectral Data cube

Figure 1.2 shows Spatial and Spectral information of Hyperspectral Data cube.

II. CIRCUIT ANALYSIS

Matlab Simulink is a dynamic systems modeling, simulation and analysis software package[14]. Simulink is integrated with MATLAB, which is used to model, simulate and analyze systems and also provides support for linear and nonlinear systems based on continuous time [1]. Multirate systems can also have distinct components that are sampled or updated in distinct ways, etc[18].

Using click and drag mouse activities. Simulink also involves a extensive block that can customize our own blocks and generate them[16].

The model integrates a sine wave with the sine wave and displays the outcome. The model's block diagram appears as Figure.2.1.

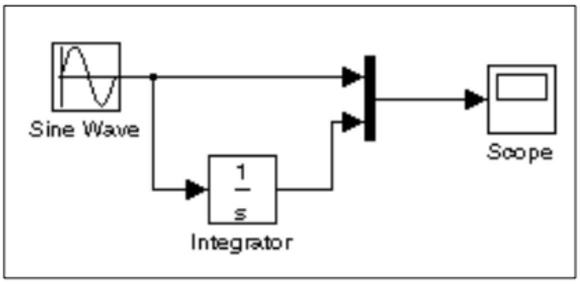

Figure 2.1 Block diagram of the Simulink model

A) Sim Power System

Simscape offers component libraries for electrical power systems modeling and simulation. These parts can be used to assess analog circuit architectures, create electrical drive schemes, and analyze grid-level electrical power generation, distribution, and consumption[21]. Sim Power System supports the development of control structures and performance testing at system level. Using Matlab variables and phrases, design control schemes for electrical systems in Simulink, we can parameterize our models.

B) Measuring Voltage and Current

The SimPower Systems Software package is a Matlab program element that enables you to analyze an electrical circuit by drawing it in an editing window[2]. The SimPower Systems model is shown in Figure 2.2 and enables the circuit present and voltage signal to be visualized and a unitary impulse[6]. The circuit's electrical parameters have the following values:

R=50[Ω]; L=1[H]

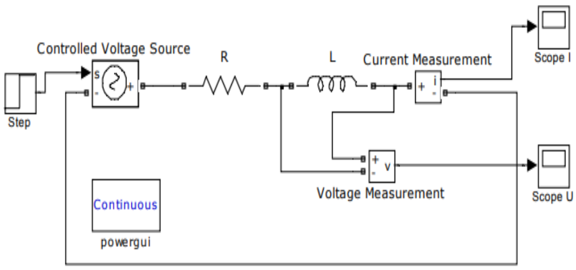

Figure 2.2 SimPower Systems model of an inductive circuit

To launch the simulation model, the Continuous Powergui analysis block must be present in the drawing window[11]. Figure 2.3 demonstrates the circuit's analytical PowerGUI window.

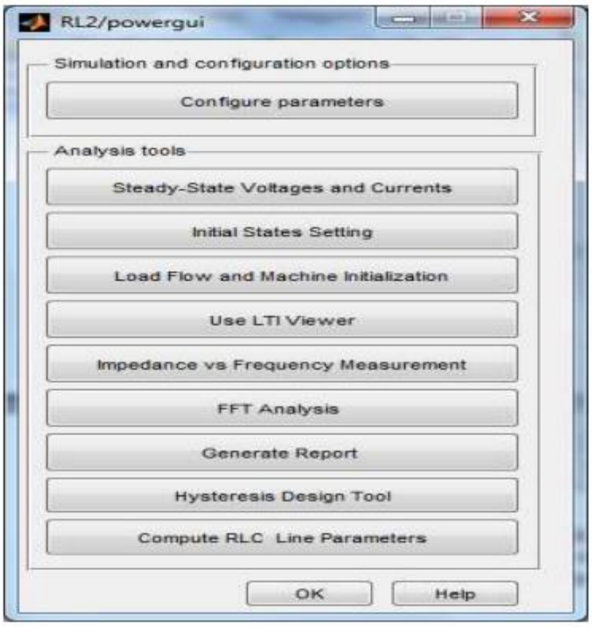

Figure 2.3 The analysis window of the circuit

C) Filtering Data using Signal Processing Toolbox

All filter design features work with standardized frequencies, so the system sampling rate is not required as an additional input argument[25].

This toolbox utilizes the convention defining unit frequency as half the frequency of sampling. Therefore, the normalized frequency is always in the 0<=f<=1 interval. 300 Hz is 300/500=0.6 for a scheme with a sampling frequency of 1000Hz. To convert the normalized frequency around the unit circle to the angular frequency, multiply by π. Multiply by half the sample frequency to transform normalized frequency back to hertz. Figure 2.4 displays signal visualization in the Filter Design Tool.

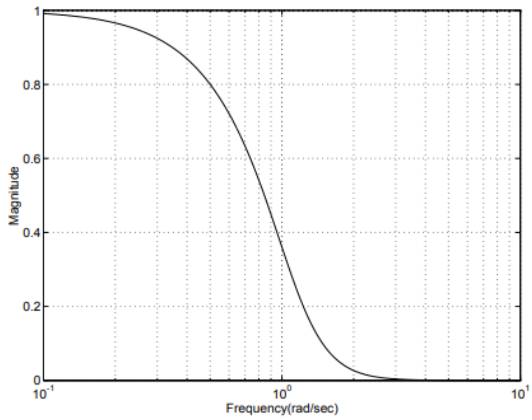

Figure 2.4 Filter Design to visualize the signal

Note that the frequency response was calculated throughout the standardized frequency range [-1 + 1] by passing the 'whole' option to 'freqz'. The reply was ' wrapped just as FFT data is using fftshift to plot the negative frequency information in a natural manner. Figure 2.5 shows Normalized frequency range with Magnitude Response.

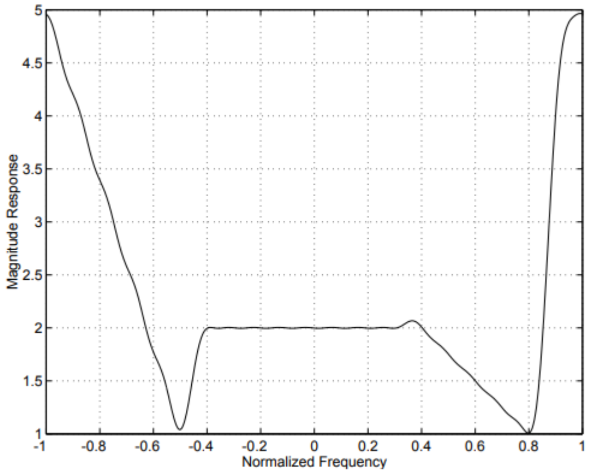

Figure 2.5 Normalized frequency range with Magnitude Response.

D) Medical Diagnosis

Bio-Electrical Engineering is a discipline involved with the growth and manufacture of prostheses, medical devices, diagnostic devices, medicines and so on, all of which require bioelectrical signals [3]. Typically these bioelectric signals are very low in amplitude and require amplification in order to correctly record, display and evaluate the signals. Measurement Techniques are[8]:

Head - (Magnetic Resonance Imaging/MRI)

Body - (Computed Tomography/CT)

Heart - (Electrocardiogram/ECG)

Muscles - (Electromyography/EMG)

Scalp - (Electroencephalograph/EEG)

Eyes - (Electrooculogram/EOG)

Head - (Hyperspectral Imaging/HSI)

To obtain the data needed from the biosignals[4]:

- Disturbance should be filtered out.
- The amount of data should be reduced by discriminating only the most significant ones related with required information.

Figure 2.1 shows Grayscale representation of Wavelength and Reflectance information of Hyperspectral image slice[5].

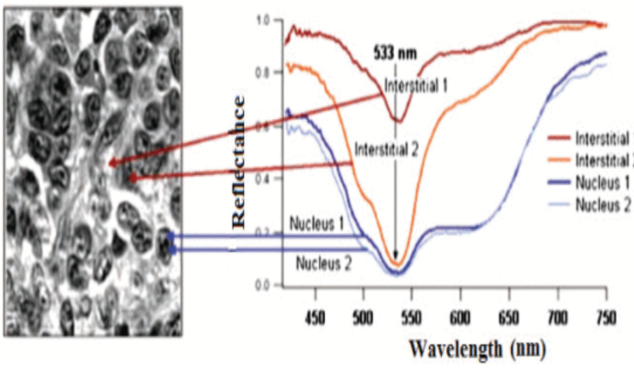

Figure 2.1 Hyperspectral signal visualization of Spectra in the nuclear and interstitial areas.

III. CIRCUIT ASSESMENT IN DIFFERENT VOLTAGE AND CURRENT LEVELS

A linear circuit is one whose parameters don't change with Voltage/Current. A non-linear system is one whose voltage or current parameters change.

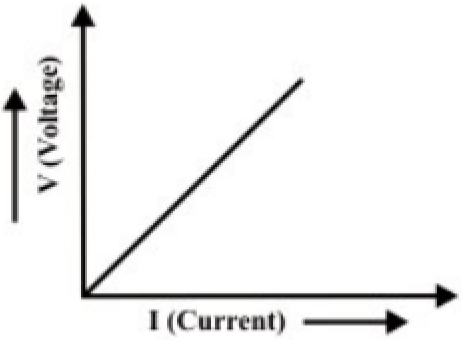

Figure 3.1 Voltage and Current Characteristics of linear element

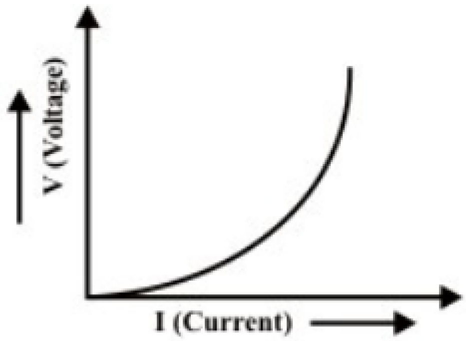

Figure 3.2 Voltage and Current characteristics of non-linear element

Table 3.1 Utility Component loads

Utility Load components	**Frequencies (Hertz)**	**Wavelength (λ=c/f)metre c=3.0x10^8 m/s**	**Time(Period) =1/f**
Local Commercial Power Supply (220-240V)	50Hz	λ1=6000000	T1=0.02
Local Commercial Power Supply (100-110V)	60Hz	λ2=5000000	T1=0.0166
Railways	25Hz	λ1=12000000	T1=0.04
Single base Distributing System	16.7Hz	λ1=17964071.86	T1=0.0598
Motor and Transmission needs	40Hz	λ1=7500000	T1=0.025
Aircraft, Space craft, Server Room, Militeryequipments	400Hz	λ1=750000	T1=0.0025

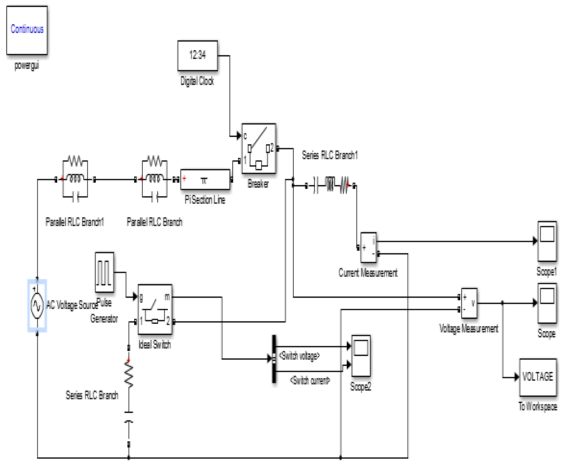

Figure 3.3. MATLAB-Simulink Circuit Design - RLC Series and Parallel circuits for 230V 50Hz AC input.

We obtain samples in Series and Parallel RLC circuits for 230V 50Hz AC in our study. Use the MATLAB Simulink Scope tool to view the signal information.

IV. FAULTS ON TRANSMISSON LINES – TRANSIENT FAULTS

The task of repair and maintenance can be assisted by rapid information about the type and location of the fault, minimizing the economic effects of power interruption. Transmission and distribution networks of voltage are the cornerstone of contemporary power generation and distribution systems. Transmission system failures can result in serious financial losses[19][20].

An assessment of system disturbances offers a wealth of useful data about the events of the energy scheme and security system behaviour. Helps enhance system reliability and accessibility.

System failures generally result in important modifications in the amounts of the system that can be used to different circumstances.

These include:

- Over current
- Under Voltage or Overvoltage
- Power factor and/or phase angle
- Impedance
- Frequency

Anyway, a sudden and usually substantial rise in current and reduce in phase voltage is the most prevalent fault indicator. Figure 4.1 shows different types of Power fault and their visualization.

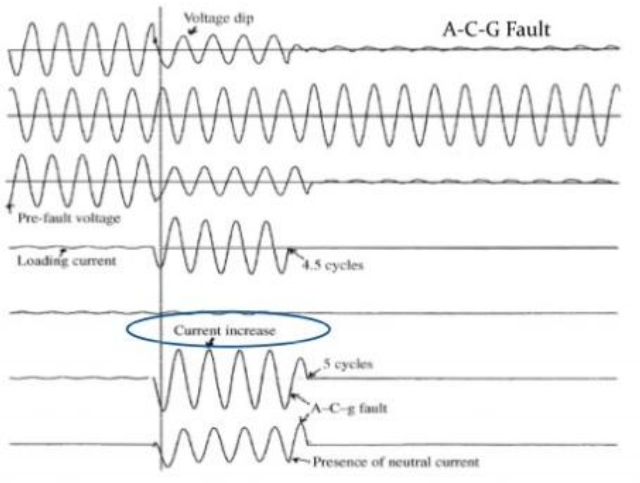

Figure 4.1 Different types of Power fault and their visualization.

V. ALGORITHM

The suggested simulation algorithm is outlined here:

Step-1. AC Voltage/Current source to input the distinct load.

Step-2. Connect the RLC branch of Series to flow in circuit load.

Step-3. Use the Pi Section Line, Digital Clock and Circuit Breaker instrument to assess in-between load flow.

Step-4. To measure the value using Scope instruments to assess the information of the visualization signal.

Step-5. Use the workspace tool to store the data value of the signal in vector array at different frequency levels

.

Step-6. Use the Scope viewer tool to view the signal's amplitude levels based on Time/Frequency range.

Step-7. The same technique applies to analyzing signal information with separate time series for distinct voltage or present load.

VI. EXPERIMENTAL RESULTS AND DISCUSSION

In this paper Matlab Simulation implemented for Fault Analysis of Electrical Circuit on Hyperspectral Signal Processing.

Figure 6.1 shows the waveform of 230V, 50Hz compared with 110V, 60Hz.

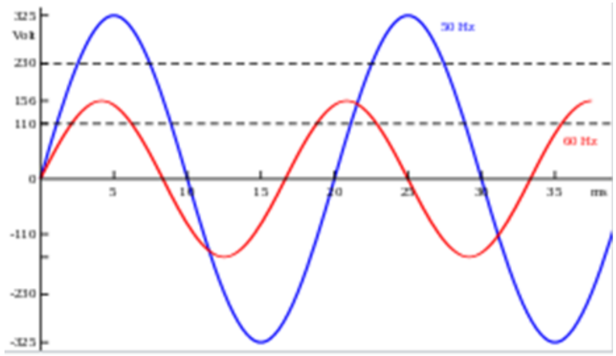

Figure 6.1 The waveform of 230V, 50Hz compared 110V, 60Hz.

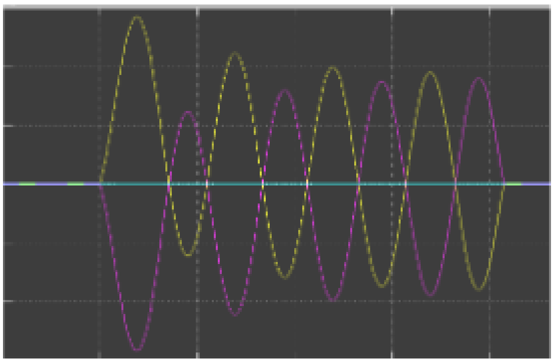

Figure 6.2 Two phase ground short-circuit current waveform

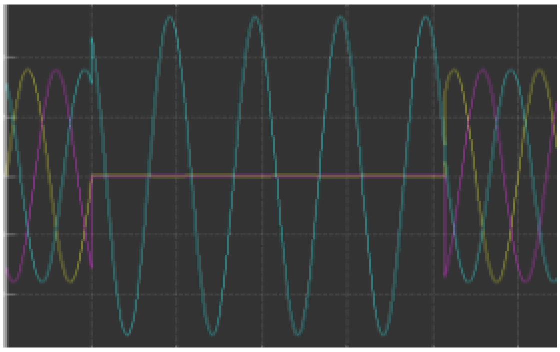

Figure 6.3 Two phase ground short-circuit voltage waveform

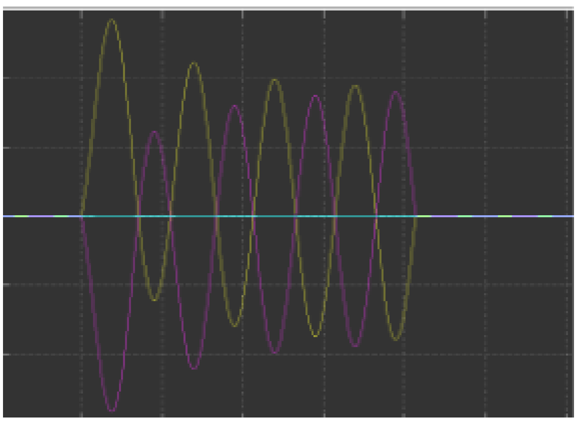

Figure 6.4 Two-Phase short circuit current waveform

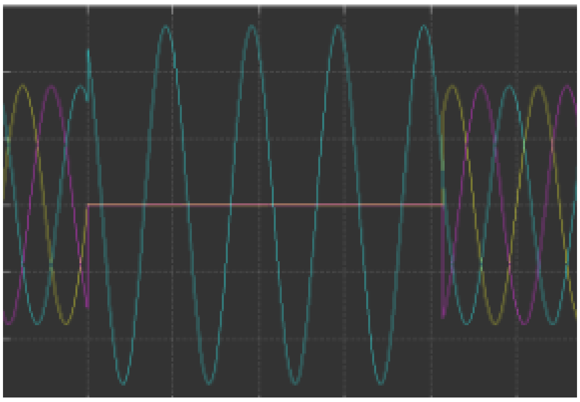

Figure 6.5 Two-phase short circuit voltage waveform

Figure 6.2 shows Two phase ground short circuit current waveform, Figure 6.3 shows Two phase ground short-circuit voltage waveform, Figure 6.4 shows Two phase short circuit current waveform and Figure 6.5 shows Two-phase short circuit voltage waveform.

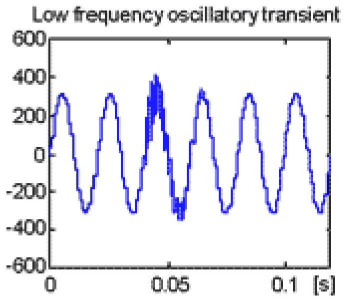

Figure 6.6 Low frequency oscillatory transient

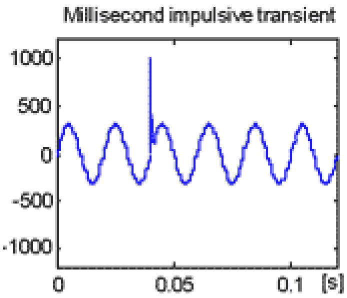

Figure 6.7 Millisecond impulsive transient

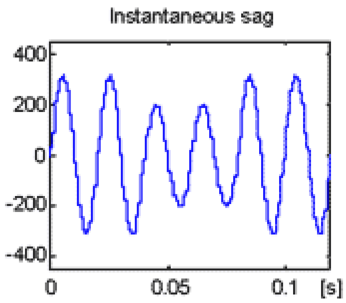

Figure 6.8 Instantaneous Sag

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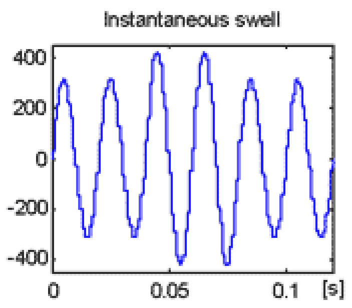

Figure 6.9 Instantaneous Swell

Table 6.1 Voltage, Current and Time/Frequency Data

Time/ Freq-uency	**Voltage Data**	Current Data
0	**0.00**	**0.00**
0.0001	**10.21**	**0.10**
0.0002	**20.41**	**0.20**
0.0003	**30.59**	**0.31**
0.0004	**40.73**	**0.41**
0.0005	**50.84**	**0.51**
0.0006	**60.90**	**0.61**
0.0007	**70.90**	**0.71**
0.0008	**80.82**	**0.81**
0.0009	**90.67**	**0.91**
0.001	**100.43**	**1.00**
0.0011	**110.09**	**1.10**
0.0012	**119.64**	**1.20**
0.0013	**129.07**	**1.29**
0.0014	**138.38**	**1.38**
0.0015	**147.55**	**1.48**

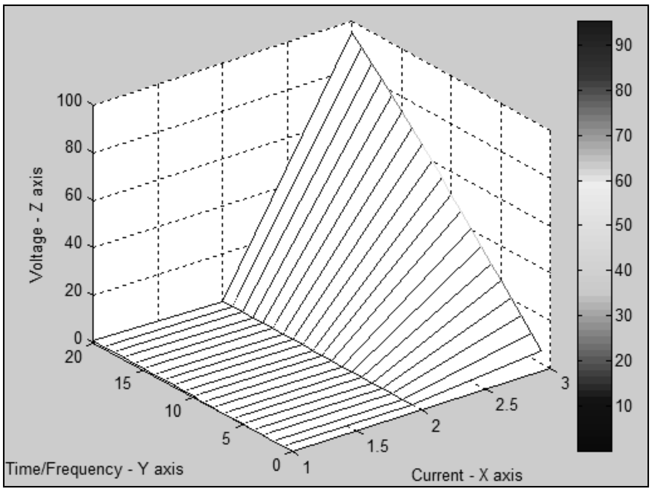

Figure 6.10 Voltage, Current and Time/Frequency Value Visualized in Hyperspectral 3D Mesh view

Figure 6.6 shows Low frequency oscillatory transient of Power disturbance wave, Figure 6.7 Millisecond impulsive transient wave signal, Figure 6.8 shows Instantaneous Sag wave, and Figure 6.9 shows Instantaneous Swell wave signal to view the different types of Power quality disturbance occurrences[9]. Table 6.1 shows Voltage, Current and Time/Frequency data. Figure 6.10 shows Voltage, Current and Time/Frequency Value Visualized in Hyperspectral 3D Mesh View[12][13].

VII. CONCLUSION

In this paper, an infinite power supply system is used to build a power system simulation model in Matlab, and the short-circuit current of several short-circuit faults is simulated and analyzed. The results are shown that the powerful Matlab simulation system provides an effective experimental research method for power system analysis and greatly simplifies the workload of calculation and analysis. In this paper, the Voltage and Current level analytical study showed that the statistical conduct of a device at differing time series data from the distinct level.

Voltage and current data are tested through Matlab Simulink application and retrieved data are visualized through Hyperspectral data cube. It gives accurate Voltage and Current magnification to monitor power quality. In our future study the same analytical study will be done using Ultra spectral signal Processing.

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