CHAPTER 7

LabVIEW BASED MLI FAULT DIAGNOSTIC SYSTEM

In this chapter, development of front panels of LabVIEW software for the fault diagnosis of multilevel inverter is discussed in detail.

7.1 SCHEMATIC OF LabVIEW BASED OVERALL FAULT DIAGNOSTIC SYSTEM

Real time application of the proposed fault diagnostic system is implemented through LabVIEW software, which is a sophisticated tool for developing and running real time applications. LabVIEW utilizes graphical programming language developed by National Instruments and it has been successfully applied for data acquisition, instrument control and industrial automation.

![Schematic of LabVIEW based fault diagnostic system of multilevel inverter](image-url)
Figure 7.1 shows the schematic of the overall fault diagnostic system developed for the identification of failure of power electronic switches in the multilevel inverter, it shows both hardware system and software system. Hardware system consists of the DC power supply, multilevel inverter, Induction Motor (IM) and data acquisition systems. NI USB 6251 is used for the capturing of output voltage signals of multilevel inverter and Agilent DSO is also used for visualization of voltage waveforms. Initially, both open and short switch faults are created by both simulation and experimental studies at different modulation index values and features are extracted from the voltage signal using FFT and DWT MRA analysis in Matlab. These features are given as an input to the ANN for offline training using Matlab. The trained pattern consisting of weight and bias values of the ANN is fed to the LabVIEW graphical programming language for fault diagnosis. Software program is developed in LabVIEW 8.5 version for the fault diagnosis of multilevel inverter consisting of FFT and DWT feature extraction techniques.

In the case of real time application, voltage sensor output is given to NI USB data acquisition system which is connected to PC. The voltage data is processed in the LabVIEW FFT and DWT feature extraction analysis and compared with the offline trained pattern. A user has the provision to select the type of feature extraction process in the front panel of the LabVIEW program. According to the type of feature extraction technique selected by the user, the LabVIEW program will use the respective offline trained ANN pattern for identification of faulty switch of multilevel inverter. Then LabVIEW GUI indicates the faulty switch of the multilevel inverter, which supports for maintaining the reliability of the system.
7.2 LabVIEW FRONT PANEL FOR CAPTURING OF OUTPUT VOLTAGE SIGNAL

![LabVIEW Front Panel](image)

**Figure 7.2** LabVIEW front panel of the output voltage capture and analysis of multilevel inverter

The complete fault diagnostic system has been developed using LabVIEW 8.5 software. Figure 7.2 shows the developed LabVIEW front panel consisting of output voltage capture and analysis module. The graphical user interface developed in LabVIEW displays the acquired output voltage waveforms in the front panel of the program. The front panel acts like a user interface where the user can input and extract data. Once the NI USB device is properly interfaced with this LabVIEW front panel, device communication indicator will blink in green. Front panel has control over output voltage signal parameters such as time scale, magnitude scale, sampling frequency and number of samples of each signal. Also, it is possible to set the number of
signals to be captured at a particular time using the acquisition settings such as Start Acquisition button and Stop Acquisition button. Separate subVI control is given for frequency domain analysis of voltage signals. Since the NI DAS and LabVIEW software has the facility to capture and analyze a set of data at a particular time, signals are captured continuously and stored in PC for further processing. This front panel also shows the variations in the rms value of the output voltage signal with respect to time which helps in understanding the trend analysis of the $V_{\text{rms}}$ parameter.

7.3 LabVIEW FRONT PANEL FOR FFT ANALYSIS

![FFT Analysis](image)

**Figure 7.3** LabVIEW front panel of FFT based frequency domain analysis

Figure 7.3 shows the front panel of LabVIEW developed for frequency domain analysis of output voltage signals using FFT technique. This module consists of control over the selection of signals for FFT analysis purpose. In this module, control is also given to track the individual FFT plot of voltage signal. Peak values of the harmonic frequencies are used to evaluate the harmonic ratios with respect to fundamental frequencies.
The FFT frequency domain harmonic analysis for the front panel is developed in this research work and it is shown in Figure 7.4. It is designed in such a way to view the various harmonic/fundamental ratios and THD value of the output voltage signal of multilevel inverter. In this window, it is also possible to track the harmonic plot of individual output voltage signals. This software module is developed in such a way to evaluate upto 11\textsuperscript{th} harmonic ratio. Trend analysis of THD value and harmonic ratios is possible in this front panel.

**7.4 LabVIEW FRONT PANEL FOR DWT ANALYSIS**

Figure 7.5 shows the wavelet transform analysis front panel developed in this work. In this window, it is possible to select the type of wavelet filter and the number of level of decomposition of output voltage signal. It also shows the standard deviation plot of wavelet decomposition of output voltage signal. The processed results are sent to MLI faulty switch analysis meter, which indicates the report about the nature of faulty switch.
This module tracks the standard deviation plot of each individual output voltage signals. In the present work, upto 9 level of decomposition is carried out in the output voltage signal and the corresponding standard deviation values are used as features of the fault condition. Software program is developed in such a way to select the type of feature extraction process such as FFT or DWT and therefore user gets the control over it.

Figure 7.6 shows the multilevel inverter faulty switch analysis module, which consists of a front panel that shows the report of the faulty switch. In this module, the user can load the already stored data in the PC system and select the FFT or DWT analysis for feature extraction process. This module compares the real time voltage signal features with offline trained pattern and identifies the faulty switch. It is also possible to take a print out of the report of the fault diagnosis. LabVIEW software allows the users to store the data in both text format and in excel format. In the present work, text format of data is used for analysis.
Figure 7.6 VI front panel of MLI faulty switch analysis

With the help of developed front panels, user can easily carry out the fault diagnostic studies even without much knowledge about the signal processing and soft computing techniques. In addition, this system can be used for real time applications. LabVIEW software provides the user to develop remote monitoring systems and hence user can visualize the results of fault diagnosis report from anywhere in the world using the internet communication technologies.